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An Explanatory and Comparative Analysis of Freight Transportation in EU and U.S. Highways

Luis Alberto Hernandez
University of Texas at El Paso, lahleon1@gmail.com

AN EXPLANATORY AND COMPARATIVE ANALYSIS OF FREIGHT TRANSPORTATION IN EU AND U.S. HIGHWAYS

LUIS HERNANDEZ

Department of Civil Engineering

APPROVED:

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Ruey Long Cheu, Ph.D.

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Carlos Ferregut, Ph.D.

____

prof. Dr. Ing. Miroslav Svitek, Ph.D.

____

Bess Sirmon-Taylor, Ph.D.
Interim Dean of the Graduate School

Dedication

I dedicate this thesis to my family, especially my parents for their continuous support and encouragement throughout all my studies.

AN EXPLANATORY AND COMPARATIVE ANALYSIS OF FREIGHT TRANSPORTATION IN EU AND U.S. HIGHWAYS

by

LUIS HERNANDEZ, BSCE

THESIS

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Declaration

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This thesis is jointly supervised by the following faculty members:

Ruey Long Cheu, Ph.D., The University of Texas at El Paso

Ing. Ladislav Bína, Ph.D., Czech Technical University

Ing. Tomáš Horák, Ph.D., Czech Technical University

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Abstract

This thesis provides resources for data collection regarding road freight transportation in the Unites States and the European Union, as well as an explanatory description of data available at each source. Afterwards, individual analysis of the current state of affairs of the highway freight transportation systems in U.S. and EU are performed. Thereafter, an explanatory and comparative analysis between the two land freight transportation systems is performed in terms of regulatory authorities and associations, trucks volume flow, freight weight and volume flow, major issues affecting the system, infrastructure funding sources, and major logistics hubs. Besides, a correlation analysis was performed using El Paso, Texas data concerning truck volume flow rate, warehousing area, and traffic accident data involving trucks. U.S. and EU highway freight transportation system's strengths and weaknesses are discussed, and recommendations on shift of current practices are made.

Keywords: freight transportation, authorities, road infrastructure, accident rates, logistics hubs

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Background

Freight transportation has always been considered an essential component for economic development. Nowadays, it has developed as one of the most critical, and active aspects of the transportation sector. Freight transportation is the main factor supporting global trade and commerce, and more generally of supply chains, which are intricate and effective integrated networks of manufacturing, trade, and service activities that account for all levels of production, from the transformation of raw materials into products, to the distribution of end products to customer markets (Leinbach and Capineri 2007).

Highway transportation has long dominated freight volume flow in the European Union (EU) and the Unites States (U.S.). It is estimated that by 2020, U.S. highway network, and truck fleet will move approximately eighteen billion and over one billion tons of domestic and international freight respectively. By 2020, cargo value in the U.S. would amount to $30 billion, and nearly 80 percent of freight value will be transported by land. In 2012, EU road freight transportation accounted for 1,675 billion ton-kilometers (Eurostat 2013) and about 137 billion vehicle-kilometers (Eurostat 2014a). However, the increasing demand of goods is causing the deterioration and overloading of infrastructure, and creating other problems such as ineffective energy consumption, high environmental costs, and traffic accidents which lead to high impacts to the global economy.

The highway freight transportation system, although sometimes similar, differs in U.S. and EU. Influencing factors such as the authorities and associations of highway freight transportation, road infrastructure funding sources, and the location of major logistics hubs have

shaped highway freight transportation differently in each region. Therefore, a comparison and contrast study between the land freight transportation in U.S. and EU could yield crucial data, and information for the optimization of Transatlantic freight movements that involve both systems, and to provide alternatives from the current state of practices.

1.2 Objectives and Scope

This thesis has several objectives, which are listed below:

1. To provide an extensive list of highway freight transportation data sources, and information on the type of data available on the subject.
2. To perform an explanatory analysis of the current state of affairs of highway freight transportation in U.S. and EU.
3. To perform a comparative and contrast analysis between the current state of affairs of highway freight transportation in U.S. and EU.
4. To perform a correlation analysis for El Paso, Texas based on truck volume flow, warehousing area, and truck-related traffic accidents in the warehousing area vicinity.

1.3 Organization of Thesis

This thesis is organized into five individual chapters, which are the following:

- Chapter 1 provides an introduction to the topic, and contains the objectives of this thesis.
- Chapter 2 provides data resources on a variety of field under the highway freight transportation topic, and a brief description of the type of data available at each source.

- Chapter 3 describes the current state of highway freight transportation in U.S. and EU on a variety of subtopics.
- Chapter 4 provides a correlation analysis performed for El Paso, Texas in terms of truck volume flow, warehousing area, and truck-related accidents.
- Chapter 5 provides a comparative and contrasting analysis between the highway freight transportation systems in U.S. and EU, contribution and opinion of the author, and conclusions.

Chapter 2: Data Sources of Highway Freight Transportation

2.1 Resources for Data in U.S.

For the United States of America (U.S.), data was collected from all possible sources that would provide for us current and appropriate information in order to perform an adequate analysis. Quality data was also desired to perform a comparison analysis between U.S. and European Union (EU). Some of the most essential data collected included, but was not limited to major highway truck corridors and truck volume data in U.S., rest areas and truck stops, warehouses and trucking companies in the nation, traffic accident data.

2.1.1 Major Highway Truck Corridors

U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework. (http://ops.fhwa.dot.gov/freight/freight_analysis/faf/)

This government office website offers several public accessible maps and studies containing information on major highways and corridors, and their corresponding traffic volumes used by freight trucks in U.S. Some of the maps encountered contained detail depictions of the National Highway Network (NHS), which is considered as the main highway network in this study. This network, including all its components can be seen in Figure 2.1 (FHWA 2014).

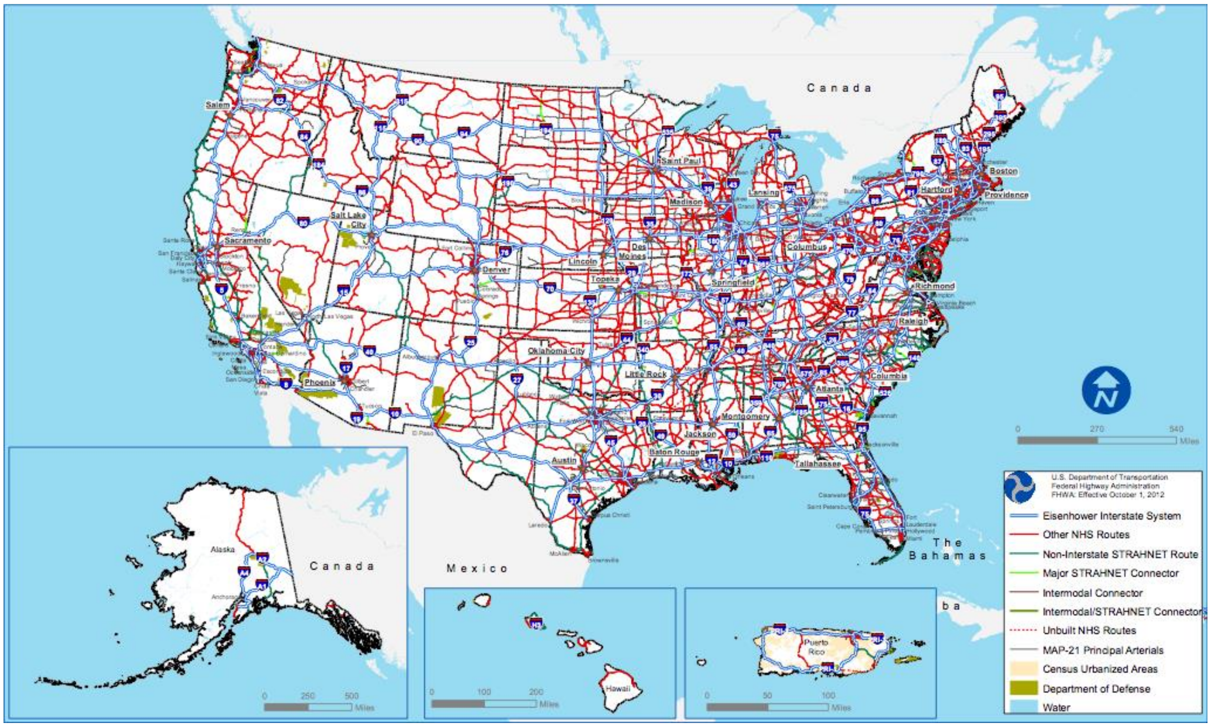


Figure 2.1: National Highway System

Source: (FHWA 2014)

2.1.2 Truck Volume Data

U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework. (http://ops.fhwa.dot.gov/freight/freight_analysis/faf/)

The Freight Analysis Framework (FAF3) also provided two maps containing the average daily long-haul freight truck traffic in the NHS for the year 2007, and a prediction for the year 2040. As seen in Figure 2.2, this map mostly emphasizes and shows the traffic volume for the Interstate Highway System and other important freight truck routes that are part of the NHS**.** The map for both years is shown in Figure 2.2 (FMCSA 2014a).

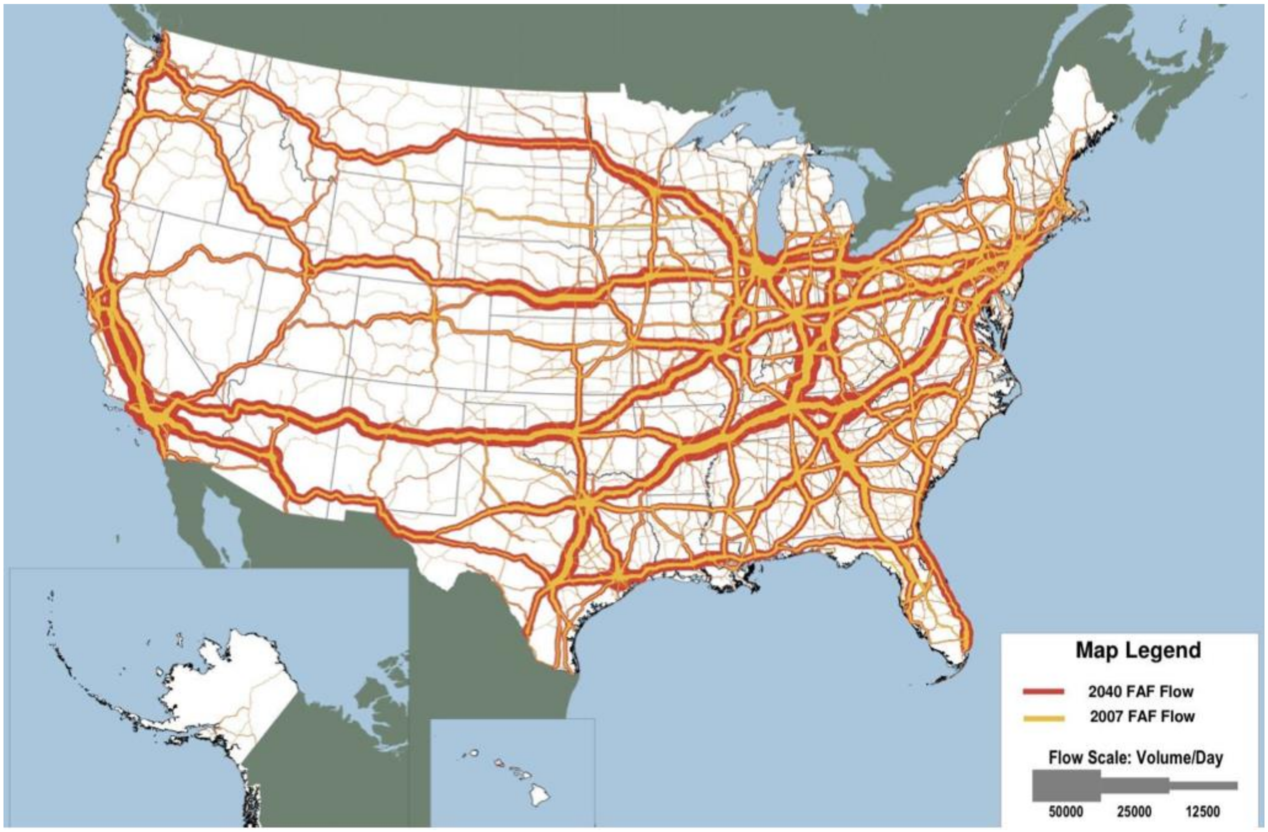


Figure 2.2: Average daily long-haul freight truck traffic on the National Highway System

Source: (FMCSA 2014a)

Another map was obtained from the same government website showing the major truck routes on the NHS containing more detailed information on the concentration of trucks in selected routes in the system for year 2007. The concentration is presented as the Average Annual Daily Truck Traffic for all freight hauling and other trucks containing six or more tires**.** This map is shown in Figure 2.3 (FMCSA 2014a).

Detailed data for freight truck traffic volume on individual states can be obtained from the individual state departments of transportation websites (e.g. www.txdot.gov and

www.dot.ca.gov for Texas and California respectively). The individual state maps contain detailed truck traffic volume data on different sections of major highways (FMCSA 2014a).

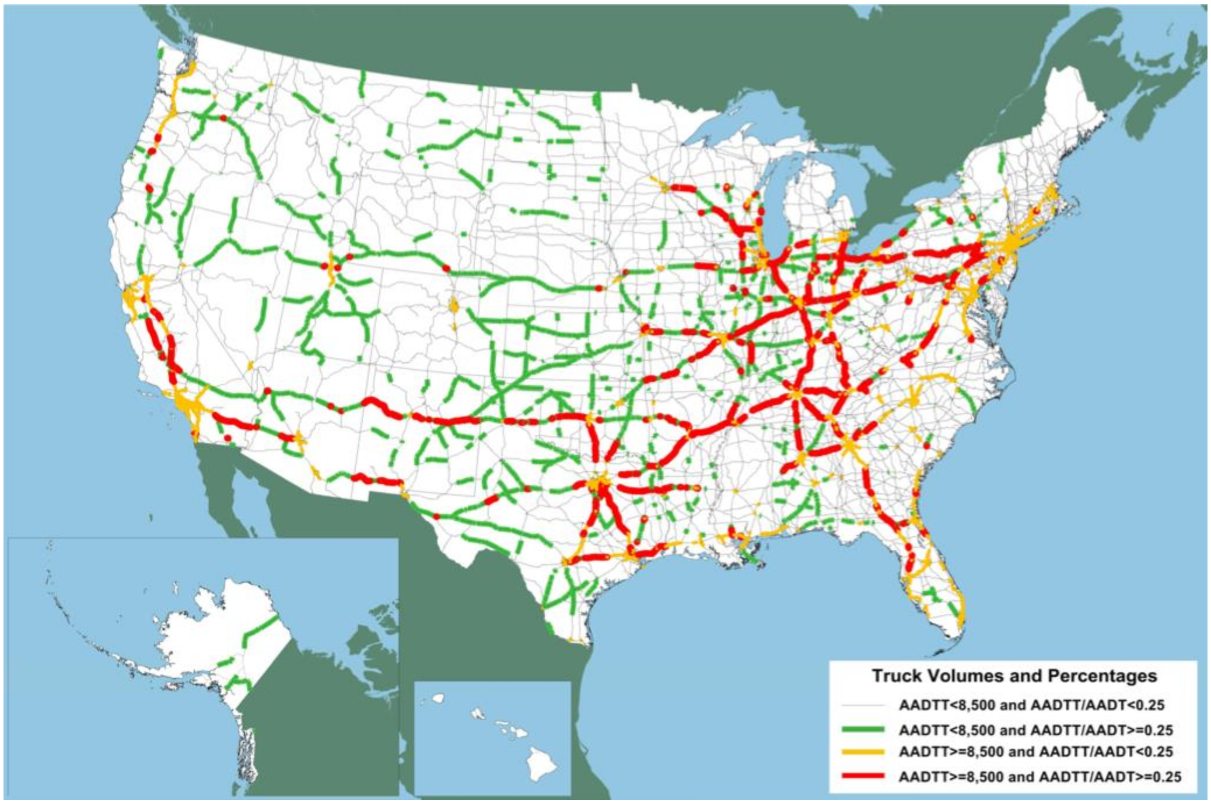


Figure 2.3: Major truck routes on the National Highway System in 2007

Source: (FMCSA 2014a)

2.1.3 Truck Rest Area Data

Federal Highway Administration Study: "Commercial Motor Vehicle Parking Shortage"

A study conducted by the Federal Highway Administration and submitted to U.S. Congress provides a map that identifies several rest areas and truck stops throughout U.S.

According to this study report, the sources of the location of rest areas and truck stops are three websites that specialize in providing all necessary information and equipment for truck drivers. The three listed websites in this report are www.dieselboss.com, www.altaonline.com and www.findfuelstops.com. The map of rest areas is shown in Figure 2.4 (FHWA 2012a).

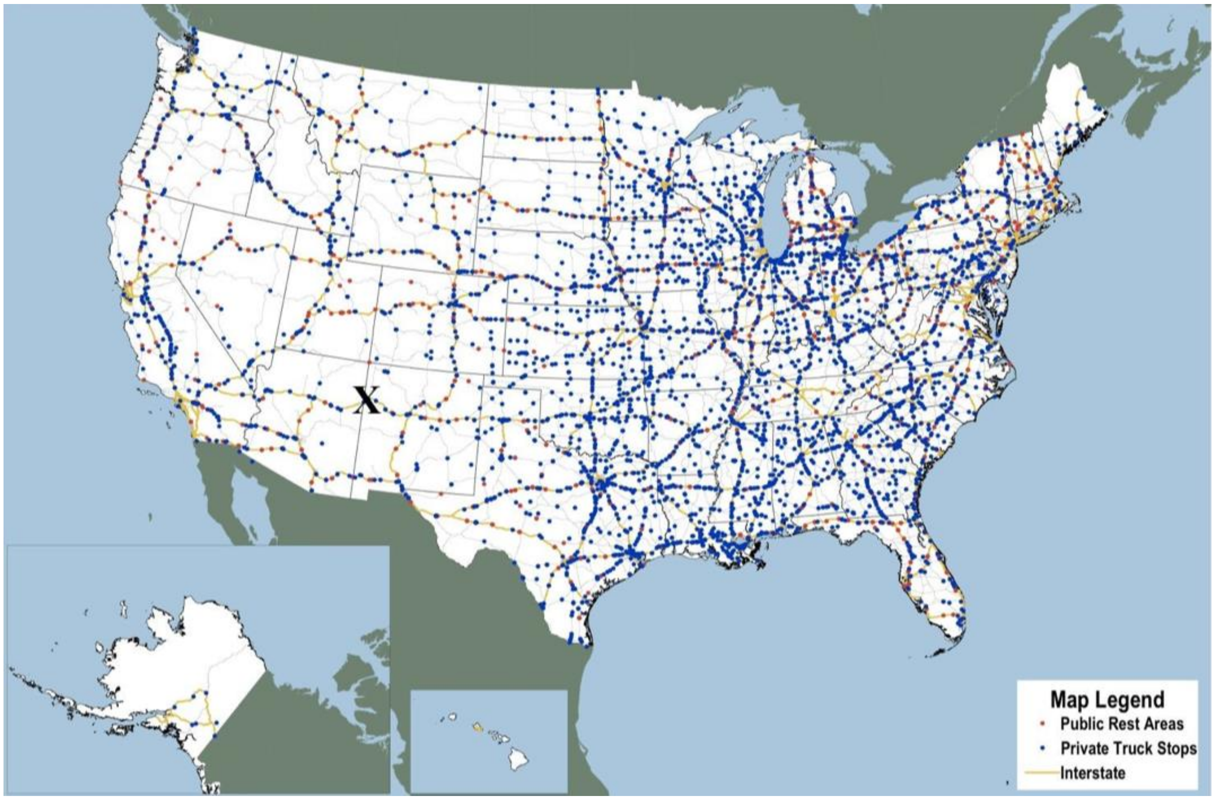


Figure 2.4: Public rest areas and private truck stops

Source: (FHWA 2012a)

This report also provides more information on the subject of truck rest areas such as the geography of tuck flows and facilities, truck parking program and responses, safety enforcement community observations, and rest area violations per state.

U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Truck Parking Facilities (http://ops.fhwa.dot.gov/freight/safetea_lu/1305_tpf.htm)

The Truck Parking Facilities program was developed by U.S. Congress, which provided three maps with the location of truck parking facilities. One of the maps identifies the rest areas along NHS, another map identifies the truck stops, and the final map identifies the sections on the NHS that are not within 30 squared miles from a rest area or truck stop. Figure 2.5 depicts the rest areas located in the FAF3 highway network. This program also contains information in the current programs, laws, projects and regulations concerning rest areas and truck stops in U.S.

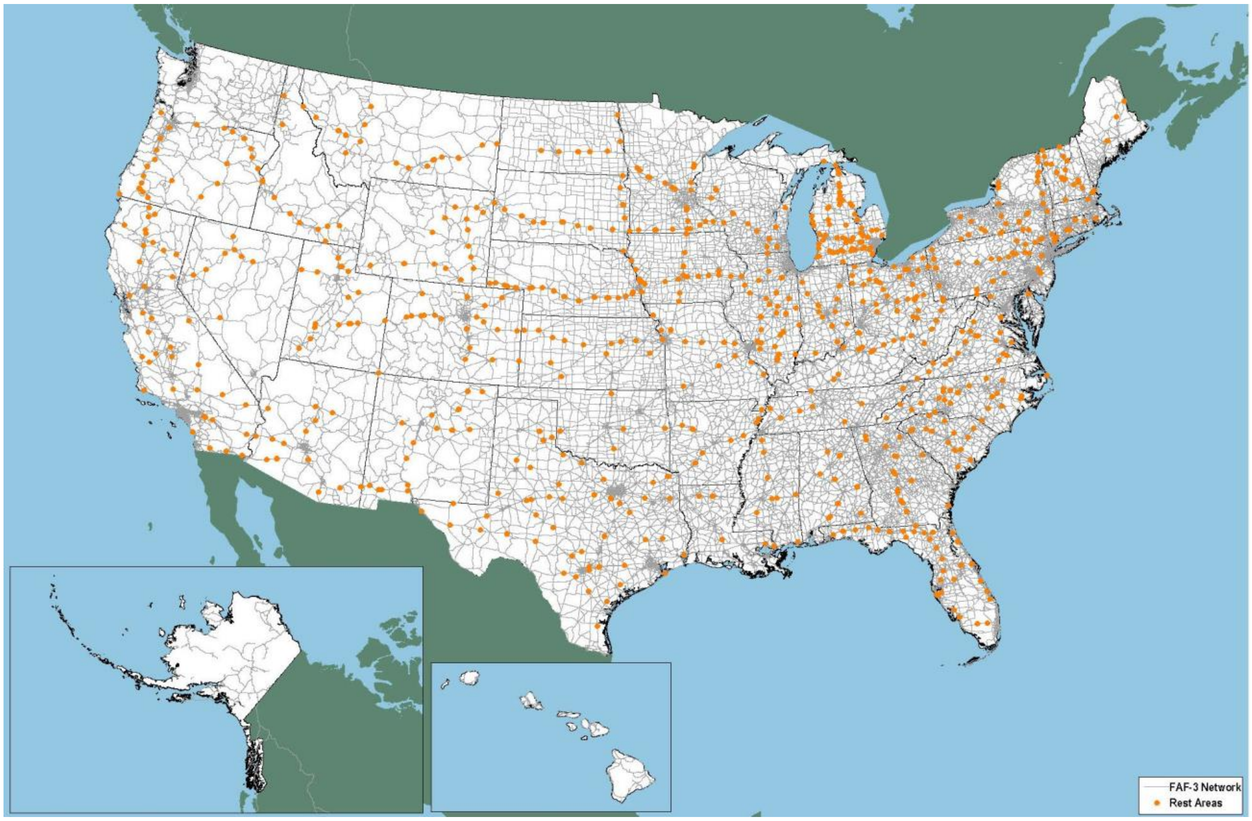


Figure 2.5: Rest areas in the FAF3 highway network
Source: (FHWA 2013a)

2.1.5 Truck Companies Data

U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Licensing and Insurance Public (http://www.fmcsa.dot.gov/registration-licensing/registration-licensing.htm)

The Federal Motor Carrier Safety Administration webpage provides a search engine for all trucking and carrier companies that are registered with U.S. Department of Transportation. The search engine has the options of searching for specific companies by several methods including the Unites States Department of Transportation (USDOT) number (this number required for all companies that operate commercial vehicles transporting cargo on interstate commerce), legal name of the company, and the state where the company is located. Once a company is located, information such as the address, telephone number, mail address, and insurance is readily available for the public.

2.1.6 Accident Data

U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Commercial Motor Vehicle Facts (http://www.fmcsa.dot.gov/documents/facts-research/CMV-Facts.pdf)

On this website, there are several tables available containing information and statistics about traffic crashes involving large trucks of over 10,000 pounds. Some of the information that can be obtained from these tables includes the numbers of police reported motor vehicle traffic crashes, number of traffic accident victims, fatality and injury rates, and the estimated cost of commercial motor vehicle crashes. In Table 2.1, it can be seen the table containing data for the number of police reported motor vehicle crashes.

Table 2.1: Police-reported motor vehicle traffic crashes

Police-Reported Motor Vehicle Traffic Crashes																
	Fatal				Injury				Property Damage Only				Total			
Year	Large Trucks	Buses	Large Trucks and Buses	All Vehicles	Large Trucks	Buses	Large Trucks and Buses	All Vehicles	Large Trucks	Buses	Large Trucks and Buses	All Vehicles	Large Trucks	Buses	Large Trucks and Buses	All Vehicles
2011	3,341	242	*3,568	29,757	60,000	13,000	73,000	1,530,000	210,000	43,000	252,000	3,778,000	273,000	56,000	329,000	5,338,000
2010	3,271	247	*3,512	30,296	56,000	12,000	67,000	1,542,000	207,000	42,000	247,000	3,847,000	266,000	54,000	318,000	5,419,000
2009	2,983	221	*3,193	30,862	51,000	9,000	60,000	1,517,000	232,000	47,000	278,000	3,957,000	286,000	56,000	341,000	5,505,000

Source: (FMCSA 2014a)

<u>U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Crash Statistics, Summary Tables (http://ai.fmcsa.dot.gov/ltccs/default.asp?page=reports)</u>

This section of the Motor Carrier Safety Administrations contains summary tables concerning traffic crashes involving trucks of more than 10,000 pounds of Gross Vehicle Weight (GVW). Data contained in this tables include, but is not limited to crashes by vehicle count, severity level, roadway type, crash type (as seen in Table 2.2), and the number of trucks by vehicle configuration, cargo body type, pre-crash movements, and pre-crash event.

Table 2.2: Crashes by crash type in U.S.

Crash Type	Crash Count	Percentage
Rear-end	231	24%
Roadside Departure	158	16%
Sideswipe, Same Direction	111	12%
Turn Across or Into Path	94	10%
Intersecting Vehicles, Straight	64	7%
Rollover	61	6%
Hit Object in Road	43	5%
Sideswipe, Opposite Direction	42	4%
Head-on	34	4%
No Impact – includes incidents such as fire or immersion.	12	1%
Backing	7	1%
Other – principally trucks not involved in first harmful event, or cargo spills	106	11%
Total	*963*	*100%*

Source: (FMCSA 2014c)

2.2 Resources for Data in EU

After researching and obtaining data concerning the Unites States, a second research was performed in order to obtain similar data for countries comprising European Union. European data obtained from the main resources discussed in this section 2.2 of Chapter 2 will later be analyzed, contrasted and compared in Chapter 3 against the data obtained from U.S. study.

2.2.1 Major Highway Truck Corridors

European Commission, Mobility and Transport, Trans-European Transport Network TENtec (http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/main.jsp)

The TENtec Information System of European Commission stores and manages technical and financial data regarding the implementation of the Trans-European Transport Network (TEN-T) program. This website contains dynamic maps, facts and figures about the TEN-T network; however, only the road network map is of importance for this study. Therefore, a trans-European road network map, and an interactive map for all modes was obtained from this website. Figure 2.6 depicts the TERN.

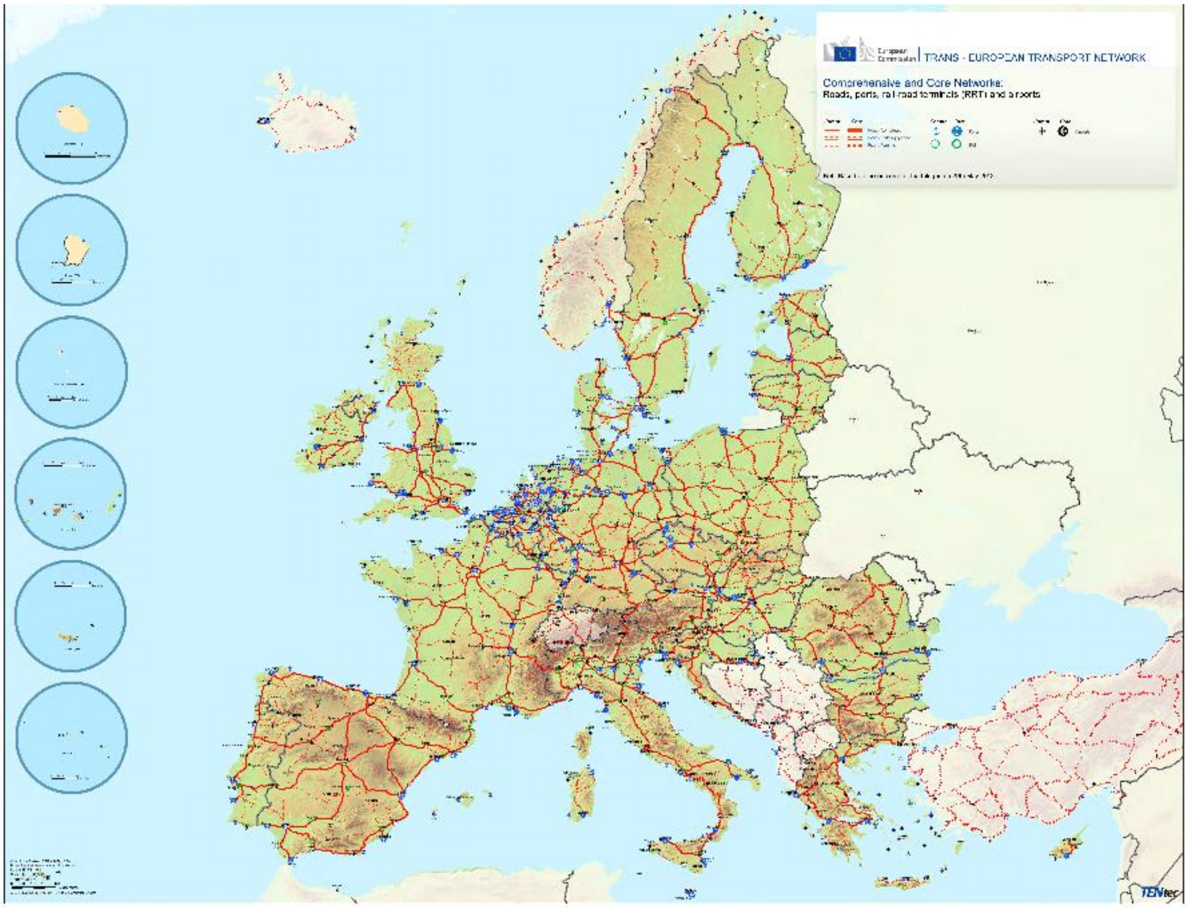


Figure 2.6: Trans-European Road Network

Source: (European Commission 2014a)

European Commission, Mobility and Transport, SETPOS, Background Information and Considerations For Secure Truck Parking (http://ec.europa.eu/transport/modes/road/parking/doc/2010_04_background_information_and_considerations_for_secure_truck_parking.pdf)

The Background Information and Considerations for Secure Truck Parking report created for the Secure European Truck Parking Operational Services project by the Directorate-General

for Energy and Transport of European Commission provided a map and information about the Pan-European Road network, which is shown in Figure 2.7.

Figure 2.7: Pan-European Road Network
Source: (European Commission 2009)

European Commission, Eurostat, Statistics, Road Transport (http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database)

The statistical office of European Commission, Eurostat, facilitated several tables with data and statistics on topics such as regional transport; transport, volume and modal split; and railway, road, inland waterways, oil pipeline, maritime and air transport. Table 2.3 shows a table with statistics on the length of European highways, which was obtained from the road transport infrastructure section.

Table 2.3: Length of highways in EU

State	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	1,747	1,763	1,763	1,763	1,763	1,763	:	:
Bulgaria	331	394	418	418	418	437	458	541
Czech Republic	564*(r)*	633	657	691	729	734	745	751
Denmark	:	1,071	1,111	1,128	:	:	:	:
Germany (until 1990 former territory of the FRG)	12,363	12,531	12,594	12,645	12,813	12,819	12,845	12,879
Estonia	99	99	96	104	100	115	115	124
Ireland	247	:	269	423	663	:	:	:
Greece	:	:	:	:	:	:	:	:
Spain	11,432	12,073	13,013	13,518	14,021	14,262	14,531	14,701
France	10,800	10,848	10,958	11,042	11,163	11,392	11,412	:
Italy	6,542	6,554	6,588	6,629	6,661	6,668	6,668	:
Cyprus	276	257	257	257	257	257	257	257
Latvia	0	0	0	0	0	0	0	0
Lithuania	417	309	309	309	309	309	309	:
Luxembourg	147*(r)*	147	147	147	152	:	:	:
Hungary	636	785	858	1,273.70	1,273	:	:	:
Netherlands	2,600*(r)*	2,604*(r)*	2,582*(r)*	2,637*(r)*	2,631	:	:	:
Austria	1,677	1,678	1,696	1,696	1,696	1,719	1,719	1,719
Poland	552	663	663	765	849	857	1,070	1,365
Portugal	:	2,545	2,613	2,673	2,705	2,737	2,737	2,988
Romania	228	228	281	281	321	332	350	550
Slovenia	569	579	579	696	747*(p)*	771*(p)*	768*(p)*	769*(p)*
Slovakia	327.5	327.5	364.5	384	391	415.7	419.2	419.2
Finland	693	700	700	739	765	779	790	:
Sweden	1,677	1,744	1,806*(r)*	1,855	1,891	:	:	:
United Kingdom	3,629	3,665*(r)*	3,669	3,673*(r)*	3,673.90	3,673	3,685.70	:
Croatia	1,016*(r)*	1,081*(r)*	1,156*(r)*	1,199*(r)*	1,244*(r)*	1,244*(r)*	1,254	1,254
Former Yugoslav Republic of Macedonia, the	216	216	221	237	251	251	259	:
Turkey	1,667	1,908	1,908	1,922	2,036	2,080	2,119	2,127
Iceland	11*(e)*	:	:	:	:	:	:	:
Liechtenstein	:*(z)*	:*(z)*	:*(z)*	:*(z)*	:*(z)*	:	:	:
Norway	264*(r)*	271	239	253	344	381	393	392

Notes: b: break in time series; c: confidential; d: definition differs, see metadata; e: estimated; f: forecast; i: see meta data; n: not significant; p: provisional; r: revised; s: Eurostat estimate; u: low reliability; z: not applicable; : - not available.

Source: (Eurostat 2014a)

2.2.2 Truck Volume Data

European Commission, Eurostat, Statistics, Road Transport (http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database)

A table containing data on Annual Road Freight Transport in Millions of Vehicle-kilometers was obtained from Eurostat, the statistical office of European Commission. The table, shown in Table 2.4, was found on the road freight transport measurements section of the transport database.

Table 2.4: Summary of annual road freight transport (million vehicle-kilometers)

State	2005	2006	2007	2008	2009	2010	2011	2012
European Union (27 Countries)	:	:	:	:	:	:	:	136,825
European Union (25 Countries)	:	:	:	:	:	:	:	132,600
European Union (15 Countries)	:	:	:	:	:	:	:	96,390
Belgium	3,355	3,419	3,173	2,678	2,584	2,478	2,392	1,722
Bulgaria	:	1,581	1,658	1,774	1,902	1,944	2,060	2,204
Czech Republic	5,222	5,463	5,279	5,364	4,550	4,876	5,028	4,788
Denmark	2,267	2,210	2,246	2,163	1,863	1,692	1,697	1,691
Germany (until 1990 former territory of the FRG)	28,853	30,243	31,460	31,787	29,142	29,295	30,347	29,106
Estonia	493	497	537	603	433	429	451	438
Ireland	2,522	2,481	2,635	2,373	1,514	1,437	1,337	1,307
Greece	2,491	3,048	2,893	3,068	3,040	3,109	2,208	2,142
Spain	20,160	20,903	22,270	20,637	18,206	17,581	17,200	16,468
France	21,367	21,588	22,053	20,794	18,276	18,966	19,672	18,022
Croatia	:	:	:	1,120	951	879	890	860
Italy	13,864	11,648	11,419	11,196	10,646	11,254	9,027	7,975
Cyprus	196	155	161	210	136	150	151	137
Latvia	840	1,464	1,657	1,030	685	846	966	963
Lithuania	1,413	1,575	1,709	1,645	1,424	1,449	1,626	1,789
Luxembourg	670	682	742	680	531	532	528	525
Hungary	2,491	2,898	3,334	3,295	3,206	3,016	3,058	2,937
Netherlands	9,700	9,769	9,204	9,386	8,994	8,171	8,176	7,645
Austria	3,137	3,391	3,327	3,154	2,778	2,709	2,690	2,512
Poland	13,010	14,276	15,904	16,901	18,099	19,298	19,639	20,480
Portugal	3,986	4,084	4,136	3,633	3,286	3,228	3,163	2,691
Romania	:	3,482	3,529	3,320	2,241	1,647	1,739	2,021
Slovenia	1,104	1,123	1,258	1,423	1,296	1,385	1,389	1,313
Slovakia	3,158	3,010	3,004	3,576	3,438	3,420	3,498	3,365
Finland	2,650	2,541	2,539	2,694	2,420	2,521	2,452	2,138
Sweden	2,683	2,704	2,826	2,929	2,642	2,738	2,669	2,445
United Kingdom	22,271	22,392	22,579	21,212	18,854	18,776	20,347	:
Liechtenstein	30	24	23	22	19	20	21	21
Norway	1,784	1,837	1,887	2,016	1,864	1,958	1,940	2,084
Turkey	:	:	:	1,980	1,925	1,968	1,968	1,918

Notes: b: break in time series; c: confidential; d: definition differs, see metadata; e: estimated; f: forecast; i: see meta data; n: not significant; p: provisional; r: revised; s: Eurostat estimate; u: low reliability; z: not applicable; : - not available.

Source: Source: (Eurostat 2014a)

2.2.3 Truck Rest Areas

Label: A Certification Scheme for European Truck Parking Areas (http://truckparkinglabel.eu/)

Data concerning EU truck rest areas, or parking areas as they are called in Europe, was obtained from a European Commission funded project called LABEL project. The goal of this project is to introduce a European standard certification scheme for truck parking areas along the TEN-T road network. Rest area sites are certified considering aspects such as security; comfort and dignity; food and shopping; services, and safety. A certified truck parking areas map was obtained from the site, which is shown in Figure 2.8; however, as mentioned before, the map only considers Label certified truck rest areas, and it does not represent all existing rest areas in European highway networks.

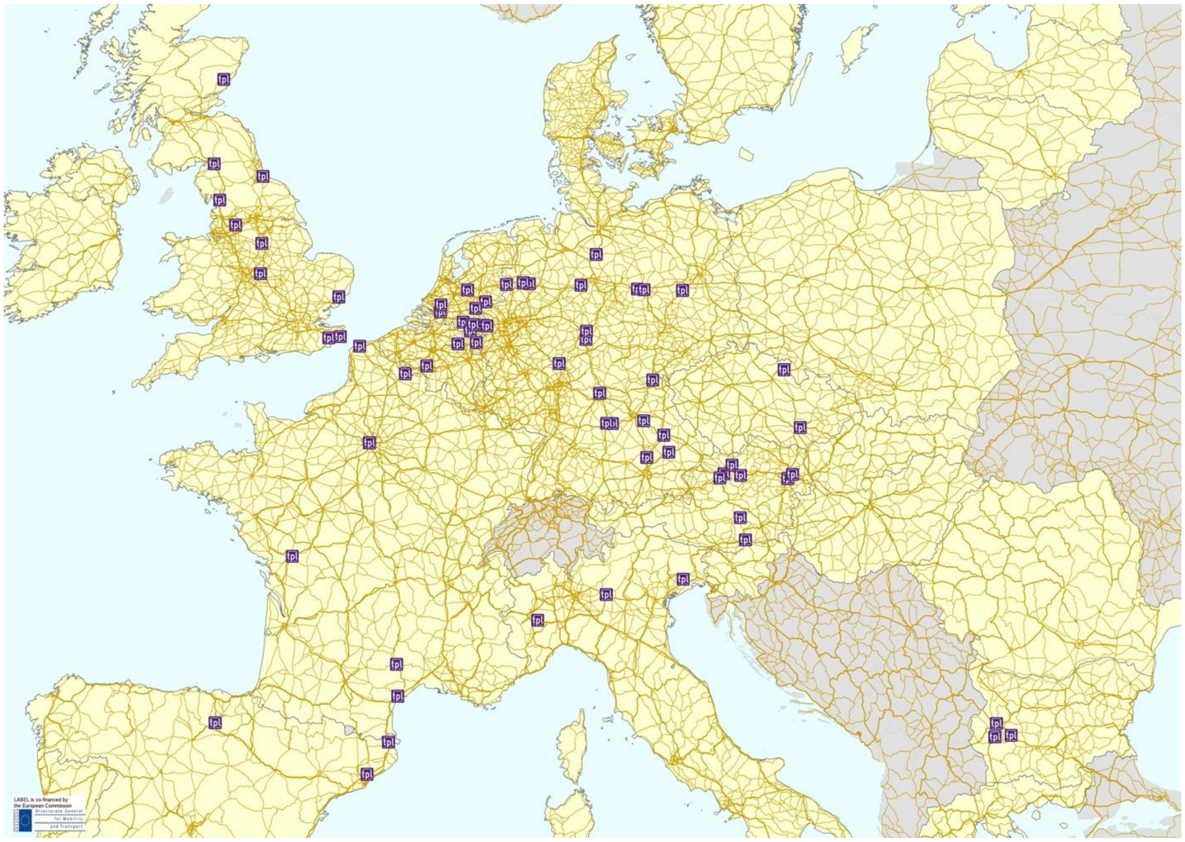


Figure 2.8: **C**ertified truck rest areas in the TEN-T Road Network
Source: (Label 2008)

2.2.4 Warehouses and Truck Companies Data

<u>Europe's Most Desirable Logistics Locations, Logistics Facility User Survey 2013 (http://www.prologis.com/docs/Europes-Most-Desirable-Logistics-Locations.pdf)</u>

A map illustrating Europe's most desirable logistic locations was obtained from a survey performed by Prologis, a private company and the leading owner, operator, and developer of industrial real state across America, Europe, and Asia. The most desirable location were determined according to 13 criteria, with the three most important criteria being the proximity to

economic networks and proximity transportation access; proximity to customers; and labor availability and flexibility. The preferred locations are shown in the map on Figure 2.9.

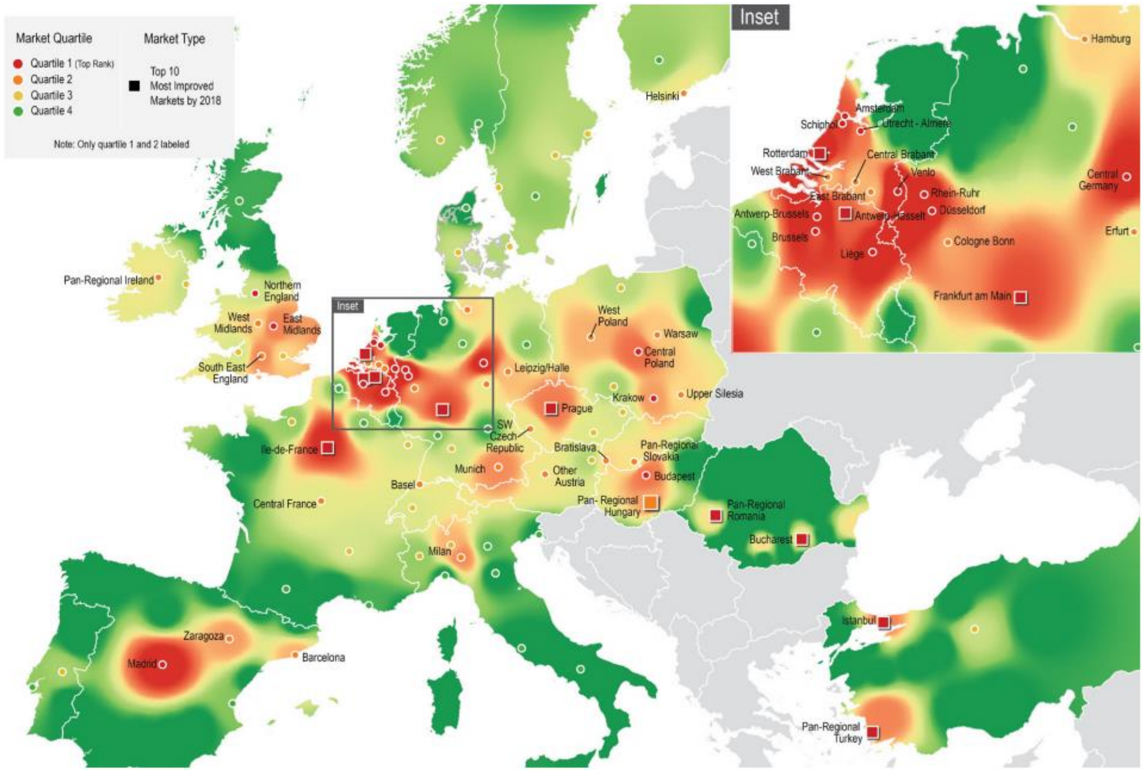


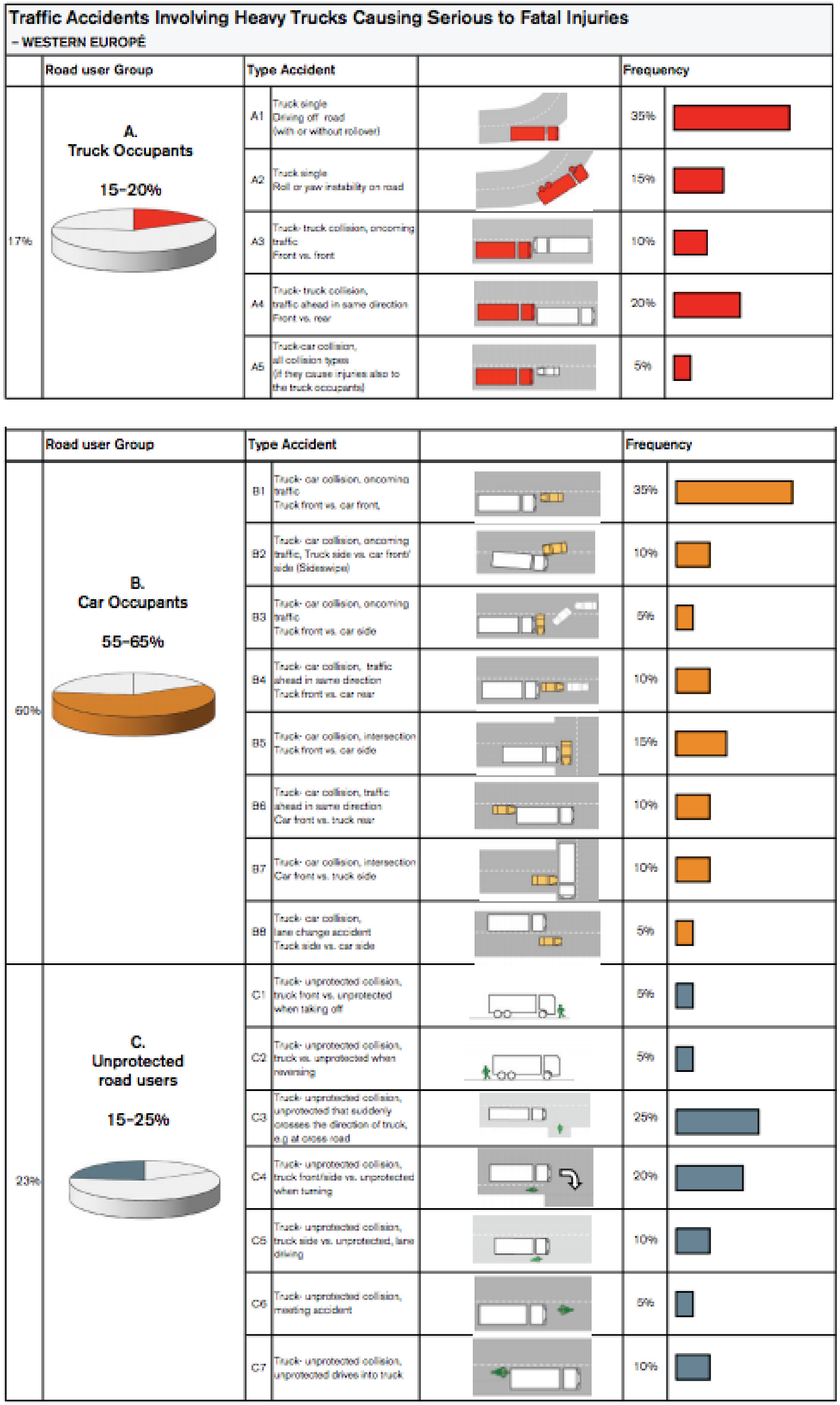
Figure 2.9: Europe’s most desirable logistics locations

Source: (Prologis 2013)

2.4.5 Accident Data

European Accident Research and Safety Report 2013, Volvo Trucks (http://www.volvotrucks.com/SiteCollectionDocuments/VTC/Corporate/Values/ART%20Report%202013_150dpi.pdf)

Several tables containing accident data were obtained from a study performed by Volvo on European heavy truck accidents. This study team main goal is to explain why these accidents occur, and to identify priorities for future development. The tables attained contain information on road user group (e.g. truck occupants, car occupants, etc.), the type of accident and the frequency at which each type of accident occurs. This information can be analyzed in more detail on Figure 2.10.



Traffic Accidents Involving Heavy Trucks Causing Serious to Fatal Injuries
– WESTERN EUROPÉ

	Road user Group	Type Accident			Frequency
17%	A. Truck Occupants 15–20%	A1	Truck single Driving off road (with or without rollover)		35%
		A2	Truck single Roll or yaw instability on road		15%
		A3	Truck- truck collision, oncoming traffic Front vs. front		10%
		A4	Truck- truck collision, traffic ahead in same direction Front vs. rear		20%
		A5	Truck-car collision, all collision types (if they cause injuries also to the truck occupants)		5%

	Road user Group	Type Accident			Frequency
60%	B. Car Occupants 55–65%	B1	Truck- car collision, oncoming traffic Truck front vs. car front,		35%
		B2	Truck- car collision, oncoming traffic, Truck side vs. car front/ side (Sideswipe)		10%
		B3	Truck- car collision, oncoming traffic Truck front vs. car side		5%
		B4	Truck- car collision, traffic ahead in same direction Truck front vs. car rear		10%
		B5	Truck- car collision, intersection Truck front vs. car side		15%
		B6	Truck- car collision, traffic ahead in same direction Car front vs. truck rear		10%
		B7	Truck- car collision, intersection Car front vs. truck side		10%
		B8	Truck- car collision, lane change accident Truck side vs. car side		5%
23%	C. Unprotected road users 15–25%	C1	Truck- unprotected collision, truck front vs. unprotected when taking off		5%
		C2	Truck- unprotected collision, truck vs. unprotected when reversing		5%
		C3	Truck- unprotected collision, unprotected that suddenly crosses the direction of truck, e.g at cross road		25%
		C4	Truck- unprotected collision, truck front/side vs. unprotected when turning		20%
		C5	Truck- unprotected collision, truck side vs. unprotected, lane driving		10%
		C6	Truck- unprotected collision, meeting accident		5%
		C7	Truck- unprotected collision, unprotected drives into truck		10%

Figure 2.10: Traffic accidents involving heavy trucks causing serious to fatal injuries

Source: (Volvo 2013)

Traffic Safety Basic Facts 2012, Heavy Goods Vehicles and Buses (http://ec.europa.eu/transport/road_safety/pdf/statistics/dacota/bfs2012_dacota_intras_hgvs.pdf)

The Traffic Safety Basic Facts 2012, a report co-financed and issued by European Commission Directorate-General for Mobility and Transport contains tables with information and data on the number of fatalities in accidents involving heavy trucks and buses, fatality rate per million population in accidents involving trucks, type of casualties and type of roads, time at which accidents happened, and more information on fatalities involving heavy trucks and buses. The numbers of fatalities involving heavy truck on EU from 2001 to 2010 can be seen in Table 2.5.

Table 2.5: Fatalities in accidents involving heavy goods vehicles

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BE	193	178	136	143	161	133	156	122	117	111
CZ	222	234	241	257	240	215	220	169	163	175
DK	78	80	69	65	79	49	66	62	35	36
DE	824	836	815	738	684	719	687	625	536	534
IE	70	42	54	55	51	57	40	44	22	13
EL	220	219	217	181	158	167	141	138	113	127
ES	803	860	834	766	714	659	528	452	353	333
FR	1.057	988	758	727	726	683	658	596	502	552
IT	1.412	1.438	1.312	1.244	1.174	1.140	1.017	977	785	835
LU	6	12	9	6	4	7	7	2	2	9
NL	169	129	158	137	103	129	123	107	95	-
AT	122	143	140	144	126	120	89	107	81	97
PL	1.443	1.474	1.462	1.487	1.425	1.374	1.246	1.155	952	947
PT	197	214	213	187	163	130	145	112	120	95
RO	193	191	224	207	297	263	271	292	252	191
SI	15	19	11	21	21	4	20	7	12	7
FI	118	105	97	107	92	82	97	106	70	92
SE	118	135	92	59	61	83	92	72	45	-
UK	607	561	548	478	510	434	449	380	287	282
EU-19[2]	7.867	7.858	7.390	7.009	6.789	6.448	6.052	5.525	4.542	4.576
Yearly reduction		0,1%	6,0%	5,2%	3,1%	5,0%	6,1%	8,7%	17,8%	-0,7%
EE	-	-	-	-	50	37	35	32	21	-
LV	-	-	-	85	81	81	97	46	38	41
HU	-	-	115	264	251	239	218	173	118	144
MT	-	-	-	-	0	1	0	1	0	1
SK	-	-	-	-	134	122	144	141	69	106
CH	-	-	-	56	-	-	-	39	45	29
IS	-	3	2	4	3	2	4	4	3	1
NO	-	-	-	-	-	-	-	-	-	71

Source: (European Commission 2012b)

Chapter 3: The State of Highway Freight Transportation in U.S. and EU

3.1 Current State of Highway Freight Transportation in U.S.

3.1.1 Authorities of Highway Freight Transportation

<u>United States Department of Transportation</u>

The United States Department of Transportation (USDOT) is a cabinet-level executive department of U.S. government. The mission of USDOT is to provide an economical and efficient national transportation system through the development and coordination of policies, while taking fair consideration for need, the environment, and national defense. As part of the federal government, USDOT is the main agency with the responsibility for creating and administering policies and programs regarding the safety, capability and efficiency of the transportation system and services (USDOT 2014a).

USDOT is composed of the Office of the Secretary of Transportation (OST), and 11 individual Operating Administrations among which are of importance to this thesis topic the Federal Highway Administration (FHWA), the Federal Motor Carrier Safety Administration (FMCSA), the National Highway Traffic Safety Administration (NHTSA), the Research and Innovative Technologies Administration (RITA), and the Surface Transportation Board (STB) (USDOT 2014a).

<u>Federal Highway Administration: Office of Freight Management and Operations,</u>

The Federal Highway Administration (FHWA) is an agency within the USDOT. Through the Federal Aid Highway Program and the Federal Lands Highway Program, FHWA provides

technical and financial support to state and local government in the processes of designing, constructing, and maintaining the Nation's Highway Program and several tribally and federally owned lands respectively. FHWA mission is to improve the mobility on U.S. highways through national leadership, innovations and program delivery (FHWA 2012c).

Some of the core highway topics the FHWA deals with include environmental issues, federal and Indian lands, highway funding, research and technology, road operation and congestion, roads and bridges, road users, and safety (FHWA 2012c).

The Office of Freight Management and Operations was established in 1999 as part of the Office of Operations under FHWA. It promotes the efficient, smooth, and secure flow of freight in U.S. transportation system and across the borders as a mean to improve U.S. economy and global connectivity. Some of the core functions performed by the Office of Freight Management and Operations include (FHWA 2013b):

- Conducting research and developing analytical tools and data;
- Developing the knowledge and skills necessary for transportation and planning professionals;
- Provides funding for projects of national and regional significance such as the Truck Parking Facility Program;
- Conducts intelligent transportation system technologies tests and promotes the standardization for freight information exchange; and
- Certifies that states are complying with the Federal truck size and weights standards.

Research and Innovative Technology Administration: Bureau of Transportation Statistics

All the United States Department of Transportation research programs are managed and coordinated by the Research and Innovative Technology Administration (RITA), which is also in charge of expanding the utilization of interlinked technologies to improve U.S. transportation system. Some of the responsibilities of RITA inside the DOT are (USDOT 2014b):

- Coordinating, facilitating and evaluating the DOT research and development programs and activities,
- Enhancing innovative technologies such as intelligent transportation systems,
- Researching, analyzing, and reporting extensive transportation statistics, and
- Providing education and training in transportation and transportation related fields.

The Bureau of Transportation Statistics (BTS) was established as a statistical agency in 1992 to collect, analyze and report data and to ensure the usage of transportation-monitoring resources in the most cost effective way. BTS main goal over the years has become to collect, analyze, and publish a comprehensive set of transportation statistics, making the statistics easily accessible, and continue implementing a long-term data collection program (USDOT 2014c).

Pipeline and Hazardous Materials Safety Administration

The Pipeline and Hazardous Materials Safety Administration (PHMSA) main goal is to establish and enforce national policies and standards, educate, and perform research to protect people and the environment from the risks of transporting hazardous materials. The PHMSA also reduces the consequences of occurring incidents preparing the public and first responders. The PHMSA also focuses on new ways to improve public health and safety by reducing the risk of transportation-related death and injuries, to reduce transportation disruptions and property

damage, and encourage environmentally sustainable strategies and investments to reduce harmful emissions from transportation sources (USDOT 2014d).

Federal Motor Carrier Safety Administration

The Federal Motor Carrier Safety Administration (FMCSA) was established in January 1, 2000 as part of the United Stated Department of Transportation. The FMCSA main mission is to prevent Commercial Motor Vehicle (CMV) accidents, thus reducing CMV-related fatalities and injuries. To realize this mission the FMCSA closely works with Federal, State and local enforcement agencies, labor safety interest groups, and the motor carrier industry (trucking companies and organizations). Some of the activities performed by the FMCSA contribute to (FMCSA 2014d):

- Strongly enforce safety regulations to ensure safe motor carrier operations,
- Aim for high-risk carriers, and commercial motor vehicle drivers,
- Enhancing CMV technologies and safety information systems,
- Strengthening CMV equipment and operating standards, and
- Increase safety awareness

3.1.2 Associations of Highway Freight Transportation

American Trucking Associations (ATA)

Founded in 1933, the American Trucking Associations is the largest national trade association in U.S. trucking industry. ATA is a federation composed of three essential parts, consisting of 50 affiliated state trucking associations, trucking industry-related conferences and

councils, and the ATA professional staff. According to the ATA webpage, the association mission is “to serve and represent the trucking industry with a single, united voice to influence policies beneficial to the industry; promote safety on America’s highways; improve the industry's image, efficiency, and competitiveness; educate the public about the critical role trucking plays in the economy; research significant industry issues all while striving for a healthy business environment (ATA 2013).”

Through its 50 affiliated state trucking associations, ATA represents approximately 35,000 trucking companies before U.S. state and federal government. Additionally, according to the ATA webpage, the four conferences currently being imparted by ATA are the following (ATA 2013):

- Automobile Carriers Conference (ACC), a conference directed at manufacturers, dealers and consumers interested in the transportation of trucks and automobiles;
- Agricultural & Food Transporters Conference (AFTC), a conference on the critical issues affecting agricultural commodity and the transportation of food;
- Intermodal Motor Carrier Conference (IMCC), a conference for all member companies engaged in transportation and handling of intermodal containers; and
- Regional & Distribution Carriers Conference (RDCC), a conference for ATA motor carrier members with local, regional and inter-regional operations, in addition to allied members of ATA supporting these operations.

3.1.3 Volume, Weight and VMT Transported

According to the 2012 Freight Facts and Figures, in 2007 approximately 50 percent of all freight tonnage and 40 percent of the value of goods were moved between origin and destination a distance of less than 100 miles. At such short distances, trucks are responsible of moving almost 85 percent of all freight tonnage, and continue to carry the biggest share of goods for distances up to 750 miles and for distances of more than 2,000 miles. Trucks are replaced by rail as the main transportation mode for distances in-between 750 and 2,000 miles. Trucks also moved the largest percentage of goods by value across all distances, with 84 percent of the value of goods being the maximum share obtained by trucks for short distances of less than 100 miles. As seen on Table 3.1, approximately 13,000 million tons of goods where transported by trucks in 2007, with the total tonnage slightly decreasing in the year of 2011 to 11,000 million and the estimated amount for 2040 rises to almost 19,000 million tons (FHWA 2012b).

Table 3.1: Weight of shipment by transportation mode 2007, 2011, and 2040 (millions of tons)

	2007				2011				2040			
	Total	Domestic	Exports	Imports	Total	Domestic	Exports	Imports	Total	Domestic	Exports	Imports
Total	**18,879**	**16,851**	**655**	**1,372**	**17,622**	**15,336**	**895**	**1,390**	**28,520**	**23,095**	**2,632**	**2,794**
Truck	12,778	12,587	95	97	11,301	11,065	107	130	18,786	18,083	368	335
Rail	1,900	1,745	61	93	1,895	1,695	108	92	2,770	2,182	388	201
Water	950	504	65	381	825	501	75	248	1,070	559	164	347
Air, air & truck	13	3	4	6	17	3	5	10	53	6	20	27
Multiple modes & mail	1,415	419	389	606	1,618	409	547	662	3,575	645	1,546	1,383
Pipeline	1,507	1,328	4	175	1,652	1,412	6	235	1,740	1,257	17	467
Other & unknown	316	266	36	14	313	251	48	14	526	362	130	34

Source: (FHWA 2012b)

The value of freight moved by trucks is expected to grow faster than the total weight of goods as demonstrated on Table 3.2. The value of freight transported by trucks in 2007

amounted $10,780 billions equivalent to approximately $882 per ton, while the total value of truck-freight for the year of 2040 is estimated to be around $21,500 billion, or $1,376 per ton (FHWA 2012b).

International trade and the movement of these goods within the Unites States has grown considerably, and trucks are the main transportation mode for the movement of imports and exports from, to and between international gateways and inland locations. This trend is expected to continue, with the tonnage of international trade transportation growing at a rate of 3.4 percent per year from 2007 to 2040 (FHWA 2012b).

Table 3.2: Value of shipments by transportation mode (billions of 2007 dollars)

	2007				2011				2040			
	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]	Total	Domestic	Exports[2]	Imports[2]
Total	**16,651**	**13,457**	**1,196**	**1,997**	**16,804**	**13,200**	**1,285**	**2,319**	**39,265**	**27,131**	**5,303**	**6,831**
Truck	10,780	10,225	267	287	10,573	9,921	266	386	21,465	19,315	985	1,166
Rail	512	374	45	93	515	380	47	88	898	555	148	195
Water	340	158	15	167	279	151	19	108	337	138	46	153
Air, air & truck	1,077	151	422	505	1,219	158	420	641	5,043	834	1,997	2,212
Multiple modes & mail	2,877	1,639	394	844	3,099	1,658	473	968	9,925	5,203	1,911	2,811
Pipeline	723	658	4	61	779	693	5	81	776	605	17	154
Other & unknown	341	252	48	41	341	239	55	47	821	482	199	139

Source: (FHWA 2012b)

According to the measurements by the Commodity Flow Survey, trucks transported more than one-half of all the hazardous materials moved within the United States. However, truck ton-miles of hazardous materials cargoes accounted for only one-third of the total ton-miles, which is a much smaller share compared to the total tonnage. As seen in Table 3.3, since the average distance traveled by trucks carrying hazardous materials is only 59 miles in contrast to 578 miles for rail, this accounts for the smaller share of truck ton-miles compared to the actual total weight of hazardous materials (FHWA 2012b).

Table 3.3: Hazardous materials shipments by transportation mode

Mode of transportation	Value		Tons		Ton-miles		Average miles per shipment
	(Billions $)	Percent	(Millions)	Percent	(Billions)	Percent	
All modes	**1,448**	100	**2,231**	100	**323**	100	**96**
Single modes	**1,371**	94.6	**2,112**	94.6	**279**	86.3	**65**
Truck	837	57.8	1,203	53.9	104	32.2	59
For-hire truck	359	24.8	495	22.2	63	19.6	214
Private truck	478	33.0	708	31.7	41	12.6	32
Rail	69	4.8	130	5.8	92	28.5	578
Water	69	4.8	150	6.7	37	11.5	383
Air	2	0.1	S	S	S	S	1,095
Pipeline	393	27.2	629	28.2	S	S	S
Multiple modes	**71**	4.9	**111**	5.0	**43**	13.3	**834**
Parcel, U.S.P.S. or courier	8	0.5	<1	<0.1	<1	<0.1	836
Other multiple modes	28	1.9	57	2.5	17	5.3	233
Other and unknown modes	**7**	0.5	**8**	0.4	**1**	0.5	**58**

Key: S = Estimate does not meet publication standards because of high sampling variability or other reasons.

Source: (FHWA 2012b)

Truck traffic increased considerably over the past two decades to the point of doubling in number; however, truck traffic remains a really small percentage of highway traffic as a whole. Despite its increase in number, truck traffic in 2010 amounted for only 10% of the highway Vehicle Miles Traveled (VMT). As shown in Figure 3.1, truck tractors hauling semitrailers, and other combination trucks account for 6% of the whole highway VMT or 59% of the total truck VMT, while single-unit 2-axle trucks with 6 or more tires accounted for only 4% of the whole VMT and 41% of the total truck VMT (FHWA 2012b).

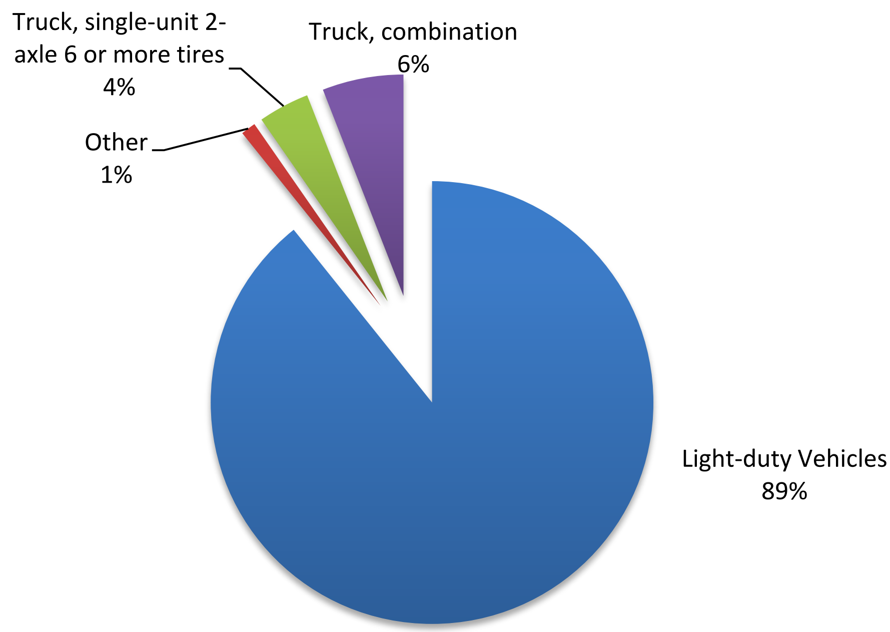


Figure 3.1: Share of highway vehicle miles traveled by vehicle type in 2010

Source: (FHWA 2012b)

The United States truck fleet has grown significantly in number of vehicles and distance traveled. The distance traveled by trucks has more than doubled from 1987 to 2002 when U.S. Census Vehicle Inventory and Use Survey was discontinued. As shown in Table 3.4, the VMT more than doubled for truck weighing between 10,000 and 26,000 pounds, and for trucks of over 80,000 pounds. Trucks weighing between 60,000 and 80,000 pounds are the biggest in number and have the largest VMT, mainly due to this category of trucks being the largest and heaviest kind of trucks allowed in the highway system without special permits.

Table 3.4: Trucks and truck miles by average truck weight

	1987		1992		1997		2002		Percent Change, 1987 to 2002	
Average weight (pounds)	Number (thousands)	VMT (millions)	Number (thousands)	VMT (millions)	Number (thousands)	VMT (millions)	Number (thousands)	VMT (millions)	Number	VMT
Total	**3,624**	**89,972**	**4,008**	**104,987**	**4,701**	**147,876**	**5,415**	**145,624**	**49.4**	**61.9**
Light-heavy	**1,030**	**10,768**	**1,259**	**14,012**	**1,436**	**19,815**	**1,914**	**26,256**	**85.9**	**143.8**
10,001 to 14,000	525	5,440	694	8,000	819	11,502	1,142	15,186	117.6	179.2
14,001 to 16,000	242	2,738	282	2,977	316	3,951	396	5,908	63.6	115.8
16,001 to 19,500	263	2,590	282	3,035	301	4,362	376	5,161	43.2	99.3
Medium-heavy	**766**	**7,581**	**732**	**8,143**	**729**	**10,129**	**910**	**11,766**	**18.8**	**55.2**
19,501 to 26,000	766	7,581	732	8,143	729	10,129	910	11,766	18.8	55.2
Heavy-heavy	**1,829**	**71,623**	**2,017**	**82,832**	**2,536**	**117,931**	**2,591**	**107,602**	**41.7**	**50.2**
26,001 to 33,000	377	5,411	387	5,694	428	7,093	437	5,845	15.9	8.0
33,001 to 40,000	209	4,113	233	5,285	257	6,594	229	3,770	9.7	-8.4
40,001 to 50,000	292	7,625	339	9,622	400	13,078	318	6,698	9.0	-12.2
50,001 to 60,000	188	7,157	227	8,699	311	12,653	327	8,950	73.8	25.1
60,001 to 80,000	723	45,439	781	51,044	1,070	74,724	1,179	77,489	63.1	70.5
80,001 to 100,000	28	1,254	33	1,529	46	2,427	69	2,950	144.3	135.2
100,001 to 130,000	8	440	12	734	18	1,051	26	1,571	238.5	257.2
130,001 or more	4	185	5	227	6	312	6	329	43.2	77.9

Source: (FHWA 2012b)

From Figure 3.2, we can appreciate the increase of VMT over the last two decades. From this graph created with public data for highway statistics, it can be seen that VMT has more than doubled from the 54.5 million VMT in 1990 to 110.3 million of VMT in the year of 2010. It can also be seen that the VMT has constantly increased over the years, until more recently when the VMT has stayed relatively constant since 2007.

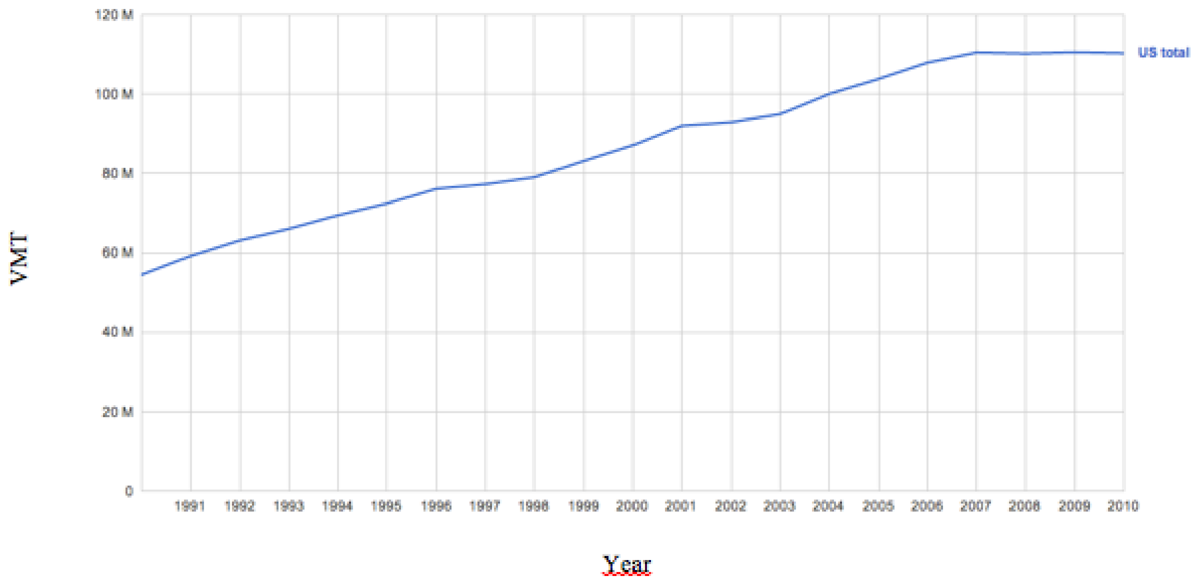


Figure 3.2: Trucks vehicle miles traveled

3.1.4 Major Truck Routes and Truck Volume

According to the 2010 Status of the Nation's Highways, Bridges, and Transit Conditions & Performance: Report to Congress by the United States Department of Transportation, Federal Highway Administration, and the Federal Transit Administration, the Unites States National Highway System, illustrated in Figure 3.3, comprises a vast network of roadways to facilitate the overall movement of people and goods. The National Highway System promotes and supports the growth of the national economy by providing access to a vast scope of markets, ranging from local and regional markets to national and international markets. Furthermore, the National Highway System also supports the defense of the Nation by providing the means for a fast deployment of the military forces and their support systems (USDOT 2010).

The NHS is integrated by five components. The first component is the Interstate System, or as it is called these days, the Dwight D. Eisenhower National System of Interstate and Defense Highways, which is about 47,714 miles long (76,788 km). The Interstate System is the basic core of the NHS and its highways are used to accelerate regional and interstates commerce, improve the competitiveness of U.S. on international markets, improve personal mobility, military mobilization, and metropolitan development (USDOT 2010). The second component of the NHS includes other principal roads or arterials regarded important for commerce and trade, the third component is the Strategic Highway Network (STRAHNET), which includes highways critical for a rapid military deployment. The fourth is a system of roads connecting the STRAHNET with military facilities and installations. The final component is a system of roads connecting the other four components of the NHS to major passenger and freight intermodal facilities (USDOT 2010).

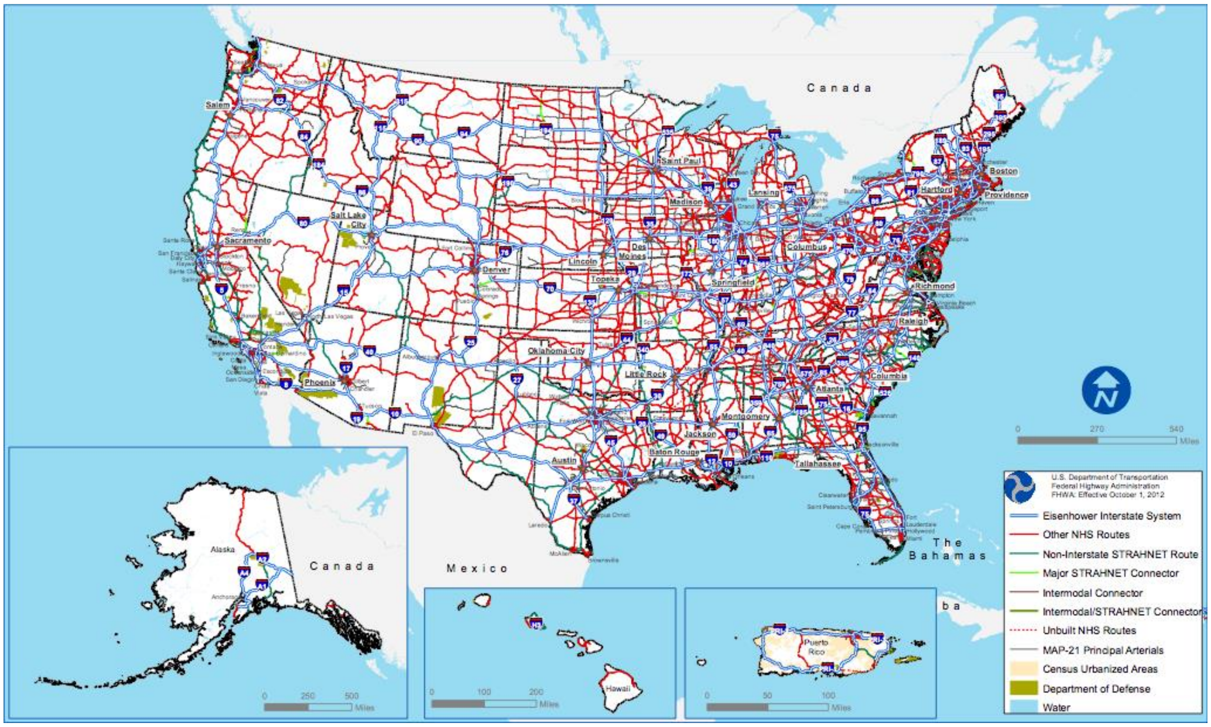


Figure 3.3: National Highway System

Source: (FHWA 2014)

There are two national highway networks that can be considered to contain the major truck routes and roadways for tuck freight movement. The NHS previously discussed is one of them; the second major truck route network is called the National Network. According to Schmitt and Strocko (2008) both the National Network and the NHS are approximately 200,000 miles in length, but the National Network includes 65,000 miles of highways beyond the NHS, and the NHS includes 50,000 miles of highways that are not in the National Network. The NHS, and the National Network are shown in Figure 3.4. A similarity between both networks is that the purpose for their creation was supporting interstate trade and commerce; however, a difference is that the National Network relies on regulating truck size and weight, while the NHS focuses in Federal investment (Schmitt and Strocko 2008).

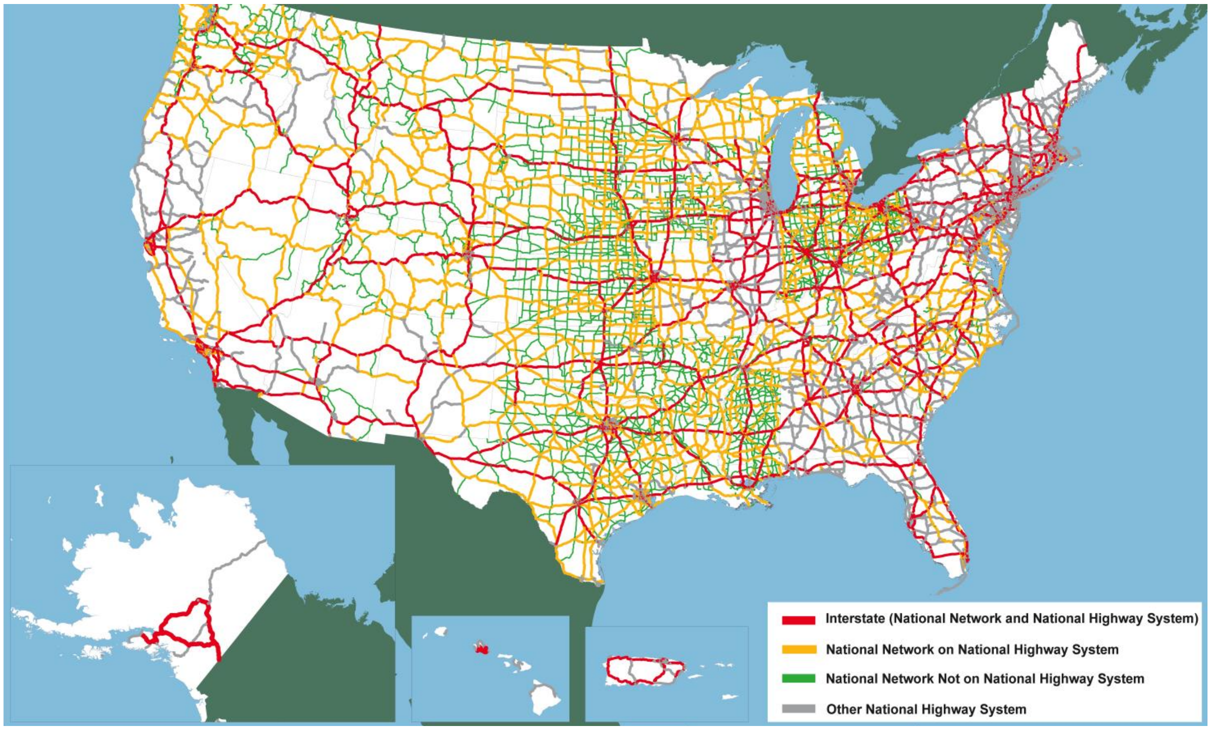


Figure 3.4: National network and National Highway System for conventional combination trucks

Source: (Schmitt and Strocko 2008)

According to Schmitt and Strocko (2008), the National Network was authorized by the Surface Transportation Assistance Act of 1982 (P.L. 97-424) and has since been specified in U.S. Code of Federal Regulations (23 CFR 658) a requirement for states to allow conventional combinations trucks on the Interstate System and other portions of the Federal-Aid Primary System that link principal cities and highly dense populated areas of U.S., and are also allowed on high volume routes greatly used by large vehicle for interstate commerce, and with no unusual characteristics that may cause or be considered a safety hazard (Schmitt and Strocko 2008).

Combination trucks, as defined in 2010 Status of the Nation's Highways, Bridges, and Transit Conditions & Performance: Report to Congress, are “up to 102 inches wide and include tractors with a single semitrailer up to 48 feet in length or with two 28-foot trailers”. However, most states are currently allowing conventional combinations with a single trailer up to 53 feet in length (USDOT 2010). Otherwise, as defined by the Federal Motor Carrier Safety Administration, combination vehicles or Group A include “any combination of vehicles with a gross combination weight rating (GCWR) of 11,794 kilograms or more (26,001 pounds or more) provided the GVWR of the vehicle(s) being towed is in excess of 4,536 kilograms (10,000 pounds)” (FMCSA 2014b).

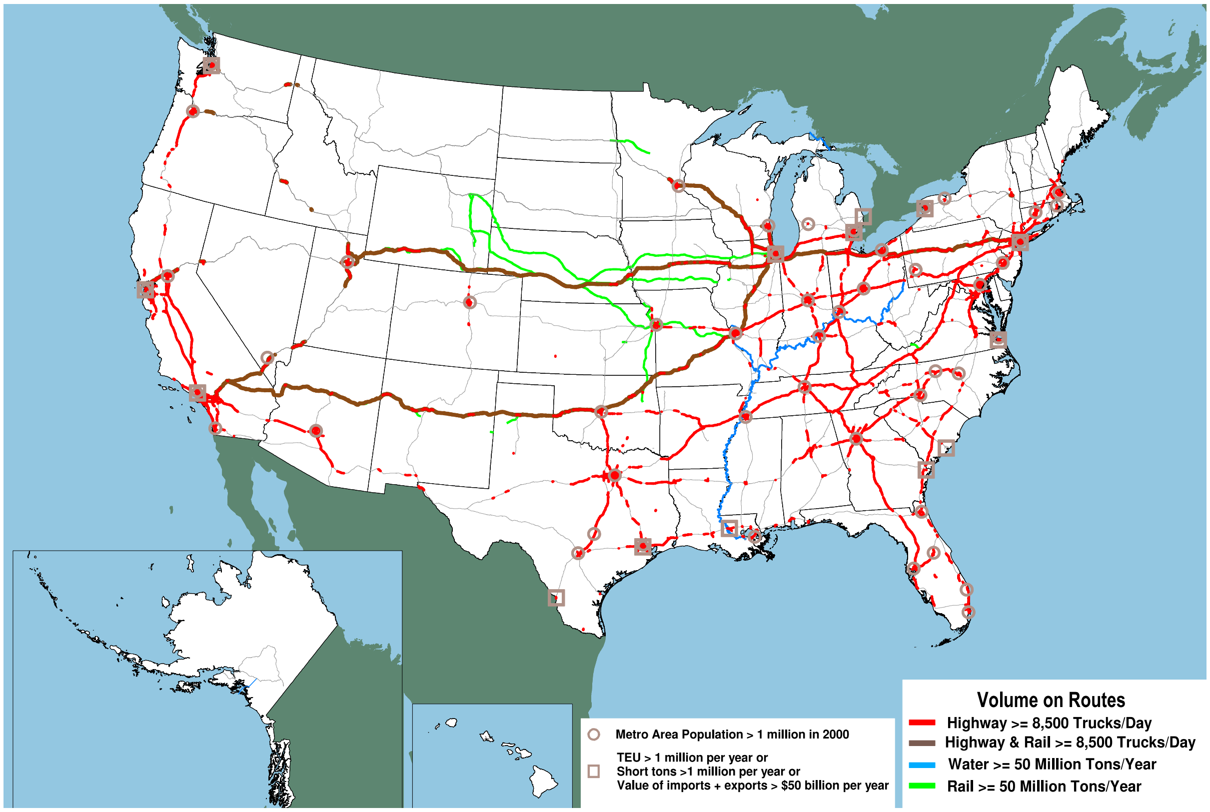


Figure 3.5: Components of major freight corridors

Source: (Schmitt and Strocko 2008)

Schmitt and Strocko (2008) described that the largest freight flows are concentrated on a relatively small number of corridors. Highlighted in Figure 3.5 are several segments of the freight transportation network carrying more than 50 million tons per year. Part of these freight high-flow corridors include highway segments that can carry at least 8,500 truck per day, which is the number necessary to carry the 50 million tons per year specified before at 16 tons per truck. As can be appreciated from Figure 3.5, most freight high-flow highways are not directly connected to each other. In order to illustrate a better freight highway corridors network, gaps of less than 440 miles (which is the distance a truck is capable of traveling in 8 hours at a speed of

55 mph) separating densely traveled highway segments were connected. In Figure 3.6, it can be appreciated the approximately 27,000 miles of highways that were concluded to constitute the major highway freight corridors, of which 95 percent are part of the Interstate System. The total mileage of the major freight corridors include almost 60 percent of the Interstate System and only 17 percent of the National Network for conventional combination trucks as previously discussed (Schmitt and Strocko 2008).

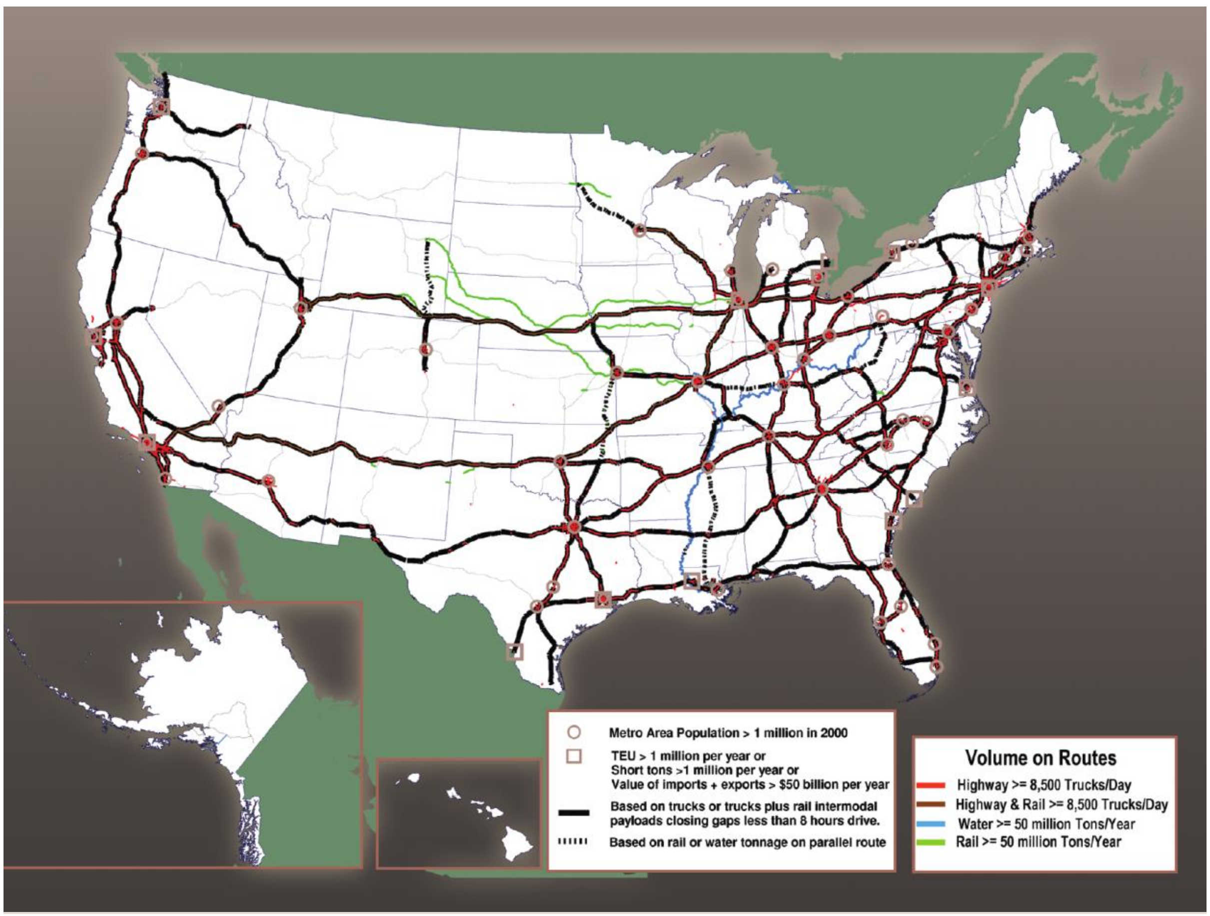


Figure 3.6: Major freight corridors

Source: (Schmitt and Strocko 2008)

Furthermore, according to the 2012 Freight Facts and Figures, except for Route 99 in California and a few toll roads and border connections, most of the heaviest freight traveled routes are part of the Interstate System. Figure 3.7 illustrates the long-haul freight truck traffic in the Unites States for the year of 2007 and an estimation of the truck traffic for the year of 2040, which is expected to considerably increase along the NHS, with forecasts indicating an increase to up to 590 million miles per day (FHWA 2012b).

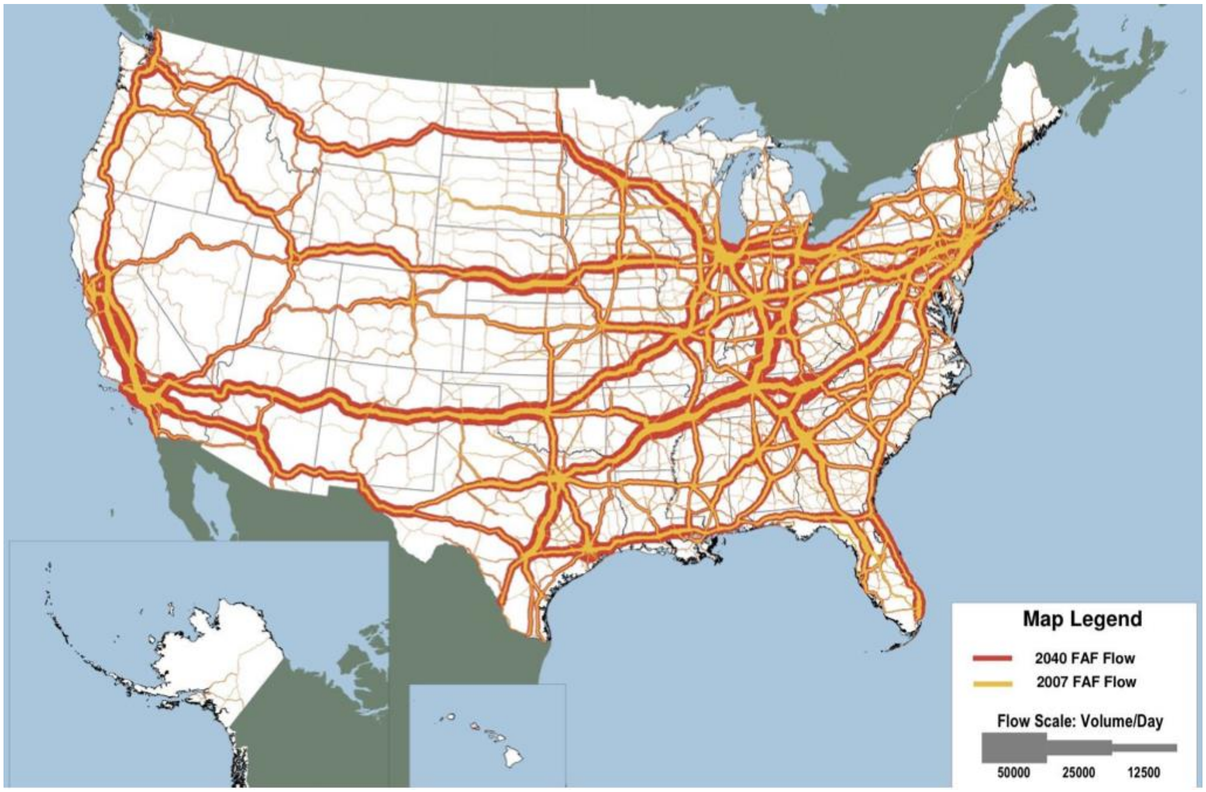


Figure 3.7: Average daily long-haul freight truck traffic on the National Highway System

Source: (FMCSA 2014a)

As mentioned before, only a selection of routes are capable of carrying a significant concentration of trucks in the NHS. Only nearly 6,000 miles in length of the NHS is capable of

carrying 50 million tons per year, with a truck traffic flow of 8,500 Annual Average Daily Traffic (AADT), each truck carrying approximately 16 tons of freight. These major truck routes, shown in Figure 3.8, include segments of the NHS where every 1 in 4 vehicles is a truck.

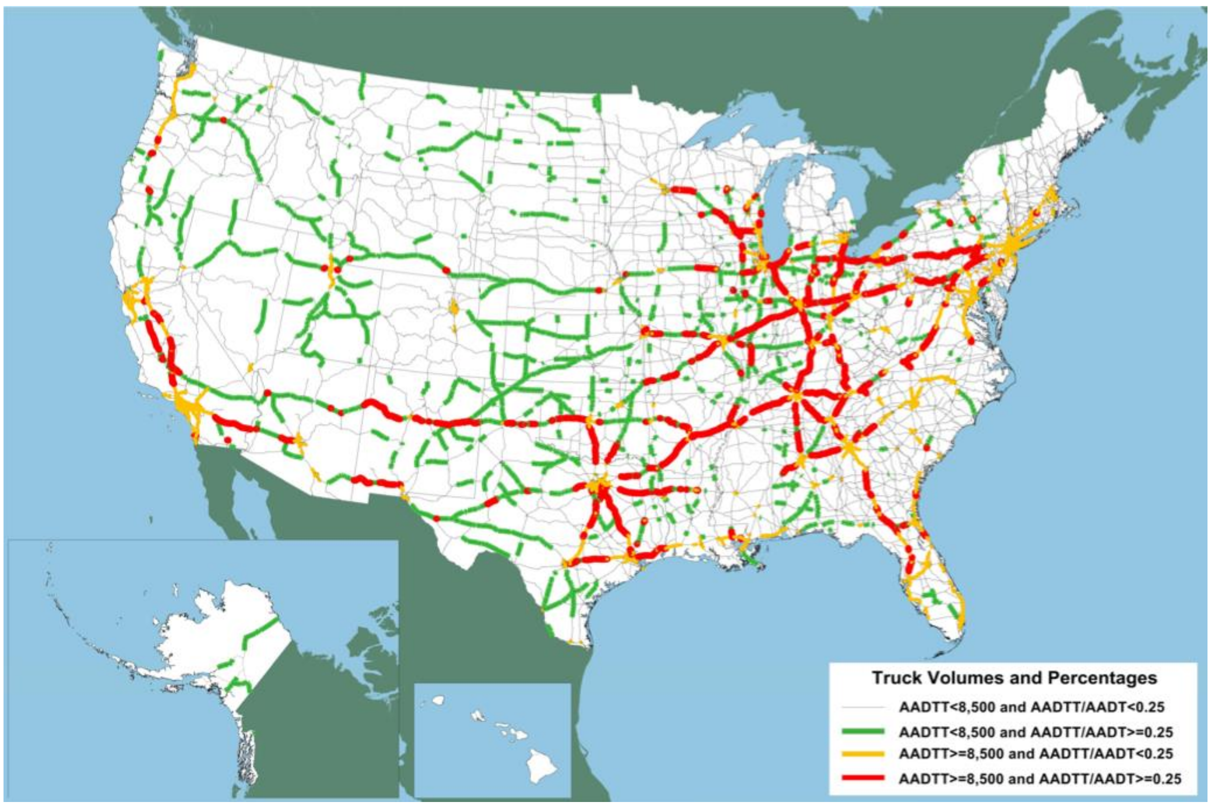


Figure 3.8: Major truck routes on the National Highway System in 2007

Source: (FMCSA 2014a)

3.1.5 Accident Rates

In the year of 2010 the number of trucks involved in fatal crashes increased 9 percent from 2009, amounting 3,484 large trucks. For the same year, the number of large trucks involved

in injury crashes reached 58,000, and 214,000 were involved in crashes with Property Damage Only (PDO) consequences (FMCSA 2012).

Over the past decade, from 2000 through 2010, the number of large trucks involved in fatal crashes decreased by 30 percent; from 4,995 large trucks in 2000 to 3,484 large trucks in 2010. Also, the number of large trucks involved in crashes resulting in injuries decreased by 42 percent, decreasing from 101,000 in 2000 to 58,000 in 2010. Finally, the number of large trucks involved in PDO crashes also decreased by 39 percent, reducing from 351,000 to 214,000 in 2000 and 2010 respectively. Data containing the number of large trucks involved in crashes with fatal, injuring, and PDO consequences can be analyzed in Table 3.5 (FMCSA 2012).

Table 3.5: Large trucks fatal, injury, and property damage only crash statistics

Year	Fatal Crashes Involving Large Trucks	Large Trucks Involved in Fatal Crashes	Occupant Fatalities in Large Truck Crashes	Total Fatalities in Large Truck Crashes	Million Vehicle Miles Traveled by Large Trucks	Rates per 100 Million Vehicle Miles Traveled by Large Trucks			Large Trucks Registered
						Fatal Crashes Involving Large Trucks	Large Trucks Involved in Fatal Crashes	Fatalities in Large Truck Crashes	
2000	4,573	4,995	754	5,282	205,520	2.23	2.43	2.57	8,022,649
2001	4,451	4,823	708	5,111	208,928	2.13	2.31	2.45	7,857,675
2002	4,224	4,587	689	4,939	214,603	1.97	2.14	2.30	7,927,280
2003	4,335	4,721	726	5,036	217,876	1.99	2.17	2.31	7,756,888
2004	4,478	4,902	766	5,235	220,811	2.03	2.22	2.37	8,171,364
2005	4,551	4,951	804	5,240	222,523	2.05	2.22	2.35	8,481,999
2006	4,350	4,766	805	5,027	222,513	1.95	2.14	2.26	8,819,007
2007	4,204	4,633	805	4,822	304,178	1.38	1.52	1.59	10,752,019
2008	3,754	4,089	682	4,245	310,680	1.21	1.32	1.37	10,873,275
2009	2,983	3,211	499	3,380	288,306	1.03	1.11	1.17	10,973,214
2010	3,261	3,484	529	3,675	286,585	1.14	1.22	1.28	10,770,054

Year	Injury Crashes Involving Large Trucks	Large Trucks Involved in Injury Crashes	Persons Injured in Large Truck Crashes	Million Vehicle Miles Traveled by Large Trucks	Rates per 100 Million Vehicle Miles Traveled by Large Trucks			Large Trucks Registered
					Injury Crashes Involving Large Trucks	Large Trucks Involved in Injury Crashes	Persons Injured in Large Truck Crashes	
2000	96,000	101,000	140,000	205,520	46.9	48.9	68.0	8,022,649
2001	86,000	90,000	131,000	208,928	41.0	43.0	62.5	7,857,675
2002	90,000	94,000	130,000	214,603	41.9	43.9	60.4	7,927,280
2003	85,000	89,000	122,000	217,876	38.8	40.8	56.0	7,756,888
2004	83,000	87,000	116,000	220,811	37.5	39.3	52.6	8,171,364
2005	78,000	82,000	114,000	222,523	34.8	37.0	51.2	8,481,999
2006	77,000	80,000	106,000	222,513	34.5	36.1	47.5	8,819,007
2007	72,000	76,000	101,000	304,178	23.8	24.9	33.2	10,752,019
2008	64,000	66,000	90,000	310,680	20.5	21.3	28.8	10,873,275
2009	51,000	53,000	74,000	288,306	17.8	18.5	25.6	10,973,214
2010	56,000	58,000	80,000	286,585	19.4	20.3	27.9	10,770,054

Year	PDO Crashes Involving Large Trucks	Large Trucks Involved in PDO Crashes	Million Vehicle Miles Traveled by Large Trucks	Rates per 100 Million Vehicle Miles Traveled by Large Trucks		Large Trucks Registered
				PDO Crashes Involving Large Trucks	Large Trucks Involved in PDO Crashes	
2000	337,000	351,000	205,520	163.9	170.9	8,022,649
2001	319,000	335,000	208,928	152.8	160.3	7,857,675
2002	322,000	336,000	214,603	150.2	156.3	7,927,280
2003	347,000	363,000	217,876	159.4	166.7	7,756,888
2004	312,000	324,000	220,811	141.2	146.9	8,171,364
2005	341,000	354,000	222,523	153.2	159.2	8,481,999
2006	287,000	300,000	222,513	128.9	134.7	8,819,007
2007	317,000	333,000	304,178	104.3	109.5	10,752,019
2008	297,000	309,000	310,680	95.7	99.6	10,873,275
2009	232,000	239,000	288,306	80.5	83.0	10,973,214
2010	207,000	214,000	286,585	72.2	74.7	10,770,054

Notes: A large truck is defined as a truck with a gross vehicle weight rating (GVWR) of more than 10,000 pounds. For injury and towaway crashes, a large truck is defined here as a truck, used for commercial purposes, with a gross vehicle weight rating (GVWR) or gross combination weight rating greater than 10,000 pounds.
Source: (FMCSA 2012)

As seen on Table 3.6, in 2010, truck tractors pulling a single semi-trailer (often called singles) account for approximately half or more of the large truck crashes in all severity fields accounting for more than 62 percent of the large trucks involved in fatal crashes, over 46 percent

of the total large trucks involved in injury crashes, and more than 49 percent of all trucks involved in PDO crashes (FMCSA 2012).

Truck tractors pulling two trailers (often called doubles) only accounted for about 3 percent of the total large trucks involved in fatal crashes, slightly above 2 percent for injury crashes, and just below 3 percent for POD crashes (FMCSA 2012).

Finally, tractors pulling three trailers (called triples) accounted for just 0.1 percent of all large trucks involved in crashes on any of the three severity levels (FMCSA 2012).

Table 3.6: Large trucks in crashes by vehicle configuration and crash severity in 2010

	Fatal Crashes		Injury Crashes (MCMIS Data)		Towaway Crashes (MCMIS Data)	
Vehicle Configuration	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Single-Unit, 2 Axles	578	16.6%	9,014	19.2%	12,213	12.1%
Single-Unit, 3+ Axles	399	11.5%	6,195	13.2%	7,547	10.6%
Truck/Trailer(s)	100	2.9%	4,758	10.2%	8,356	11.7%
Truck Tractor (Bobtail)	66	1.9%	1,571	3.4%	2,244	3.1%
Tractor/Semi-trailer	2,166	62.2%	21,628	46.2%	35,066	49.2%
Tractor/Double	94	2.7%	1,101	2.3%	2,007	2.8%
Tractor/Triple	5	0.1%	36	0.1%	64	0.1%
Light Truck (HM Placard)	—	—	20	*	12	*
Unknown	76	2.2%	2,337	5.0%	3,522	4.9%
Missing	—	—	201	0.4%	241	0.3%
Total	**3,484**	**100.0%**	**46,861**	**100.0%**	**71,272**	**100.0%**

**Less than 0.05 percent.   — Not applicable.*

Source: (FMCSA 2012)

Table 3.7 presents data on crashes involving large trucks according to vehicle weight rating and crash severity. From analyzing this data it can be observed that more than 3/4 of all crashes involving large trucks can be attributed to trucks with a Gross Vehicle Weight Rating (GVWR) of 26,001 pounds or more (11,794 kilograms or more); this category of large trucks

accounted for 85 percent of large trucks involved in fatal crashes, almost 77 percent of all large trucks involved in injury crashes, and almost 79 percent of crashes requiring tow away (FMCSA 2012).

The rest of the accidents were accounted to another category of large truck with GVWR ranging from 10,001 pounds (4,536 kilograms) to 26,000 pounds (11,794 kilograms) were the previously discussed category starts. This category is only responsible for almost 15 percent of fatal crashes, and just below 22 percent of injury accidents (FMCSA 2012).

Table 3.7: Large trucks in crashes by gross vehicle weight rating and crash severity in 2010

Gross Vehicle Weight Rating	Fatal Crashes		Injury Crashes (MCMIS Data)		Towaway Crashes (MCMIS Data)	
	Number	Percent	Number	Percent	Number	Percent
≤10,000 lb	0	0.0%	409	0.9%	584	0.8%
10,001 - 26,000 lb	516	14.8%	10,023	21.4%	14,145	19.8%
≥26,001 lb	2,962	85.0%	36,035	76.9%	55,888	78.4%
Unknown	6	0.2%	394	0.8%	655	0.9%
Total	**3,484**	**100.0%**	**46,861**	**100.0%**	**71,272**	**100.0%**

Notes: For fatal crashes, a large truck is defined as a truck with a gross vehicle weight rating (GVWR) of more than 10,000 pounds. For injury and towaway crashes, a large truck is defined here as a truck, used for commercial purposes, with a gross vehicle weight rating (GVWR) or gross combination weight rating greater than 10,000 pounds.

Source: (FMCSA 2012)

Collision with a vehicle in transport was recorded as the most harmful event, as seen on Table 3.8, accounting for 76 percent of all crashes involving large trucks, and 94 percent of all crashes involving multiple vehicles. Other crash-causing events included collisions with fixed objects, pedestrians, parked vehicles, and overturns, but none of these events accounted for more than 10 percent of the total crashes involving large trucks (FMCSA 2012).

Approximately 3,675 people lost their lives in crashes involving large trucks, of which 3,446 were drivers of a large truck. Approximately 4 percent or 133 persons of all the drivers were 25 years of age or younger, and 144 were 66 years of age or older. Of all the drivers of large trucks involved in fatal crashes, 359 were not wearing a seatbelt, and approximately 24 percent of those 359 were completely or partially ejected from the vehicle (FMCSA 2012).

Table 3.8: Crashes involving large trucks by first harmful event and crash severity in 2010

First Harmful Event	Single-Vehicle Crashes		Multiple-Vehicle Crashes		Total	
	Number	Percent	Number	Percent	Number	Percent
Fatal Crashes						
Collision with Vehicle in Transport	0	0.0%	2,488	94.1%	**2,488**	**76.3%**
Collision with Fixed Object	192	31.1%	83	3.1%	**275**	**8.4%**
Collision with Pedestrian	195	31.6%	25	0.9%	**220**	**6.7%**
Overturn (Rollover)	101	16.4%	22	0.8%	**123**	**3.8%**
Collision with Pedalcycle or Other Personal Conveyance	67	10.9%	0	0.0%	**67**	**2.1%**
Collision with Parked Motor Vehicle	27	4.4%	7	0.3%	**34**	**1.0%**
Collision with Train	14	2.3%	0	0.0%	**14**	**0.4%**
Collision with Other Object	7	1.1%	4	0.2%	**11**	**0.3%**
Collision with Animal	2	0.3%	5	0.2%	**7**	**0.2%**
Explosion/Fire	1	0.2%	0	0.0%	**1**	*
Jackknife	2	0.3%	3	0.1%	**5**	**0.2%**
Pavement Surface Irregularity	0	0.0%	1	*	**1**	*
Cargo Equipment Loss or Shift	1	0.2%	3	0.1%	**4**	**0.1%**
Other	8	1.3%	3	0.1%	**11**	**0.3%**
Total	**617**	**100.0%**	**2,644**	**100.0%**	**3,261**	**100.0%**
Injury Crashes						
Collision with Vehicle in Transport	*	*	45,000	95.6%	**45,000**	**80.3%**
Collision with Fixed Object	3,000	38.8%	1,000	2.1%	**4,000**	**8.0%**
Collision with Pedestrian	1,000	10.1%	*	*	**1,000**	**1.6%**
Overturn (Rollover)	3,000	28.2%	1,000	1.6%	**3,000**	**5.8%**
Collision with Pedalcycle or Other Personal Conveyance	*	4.3%	*	*	*	**0.7%**
Collision with Parked Motor Vehicle	1,000	13.8%	*	*	**1,000**	**2.2%**
Collision with Train	*	*	*	*	*	*
Collision with Other Object	*	1.1%	*	0.3%	*	**0.4%**
Collision with Animal	*	0.4%	*	*	*	**0.1%**
Explosion/Fire	*	0.7%	*	*	*	**0.1%**
Jackknife	*	1.3%	*	0.3%	*	**0.4%**
Pavement Surface Irregularity	*	*	*	*	*	*
Cargo Equipment Loss or Shift	*	*	*	*	*	*
Other	*	1.2%	*	*	*	**0.2%**
Total	**9,000**	**100.0%**	**47,000**	**100.0%**	**56,000**	**100.0%**
Property Damage Only Crashes						
Collision with Vehicle in Transport	*	*	158,000	98.3%	**158,000**	**76.3%**
Collision with Fixed Object	21,000	45.8%	2,000	1.1%	**23,000**	**11.1%**
Collision with Pedestrian	*	*	*	*	*	*
Overturn (Rollover)	3,000	6.0%	*	*	**3,000**	**1.4%**
Collision with Pedalcycle or Other Personal Conveyance	*	*	*	*	*	*
Collision with Parked Motor Vehicle	15,000	33.4%	*	*	**15,000**	**7.5%**
Collision with Train	*	0.2%	*	*	*	**0.1%**
Collision with Other Object	1,000	1.2%	*	0.3%	**1,000**	**0.5%**
Collision with Animal	4,000	9.4%	*	*	**4,000**	**2.1%**
Explosion/Fire	*	0.7%	*	*	*	**0.1%**
Jackknife	1,000	1.7%	*	0.2%	**1,000**	**0.6%**
Pavement Surface Irregularity	*	*	*	*	*	*
Cargo Equipment Loss or Shift	*	0.1%	*	*	*	*
Other	1,000	1.5%	*	*	**1,000**	**0.4%**
Total	**46,000**	**100.0%**	**161,000**	**100.0%**	**207,000**	**100.0%**

**Less than 500 or less than 0.05 percent.*

Source: (FMCSA 2012)

As seen on Table 3.9, the highest number of victims in fatal crashes involving large trucks is accounted by drivers of other motor vehicles with 2,110 persons or almost 60 percent of the fatalities. The second and third highest number of fatalities goes to passengers on other motor vehicles with 20 percent of the casualties, and the drivers of large trucks with almost 13 percent of the fatalities (FMCSA 2012).

Table 3.9: People killed and injured in crashes involving large trucks in 2010

Person Type	Single-Vehicle Crashes		Multiple-Vehicle Crashes		Total	
	Number	Percent	Number	Percent	Number	Percent
Persons Killed						
Driver of Large Truck	309	51.4%	166	5.4%	**475**	**12.9%**
Driver of Other Motor Vehicle	0	0.0%	2,110	68.6%	**2,110**	**57.4%**
Passenger of Large Truck in Transport	28	4.7%	26	0.8%	**54**	**1.5%**
Passenger of Other Motor Vehicle in Transport	0	0.0%	678	22.1%	**678**	**18.4%**
Occupant of Motor Vehicle Not in Transport	7	1.2%	1	*	**8**	**0.2%**
Occupant of Non-Motor Vehicle Transport Device**	0	0.0%	0	0.0%	**0**	**0.0%**
Pedestrian	190	31.6%	88	2.9%	**278**	**7.6%**
Bicyclist	58	9.7%	0	0.0%	**58**	**1.6%**
Other Cyclist	0	0.0%	0	0.0%	**0**	**0.0%**
Other Person on Personal Conveyance/In Building	9	1.5%	3	0.1%	**12**	**0.3%**
Unknown Occupant Type in Motor Vehicle in Transport	0	0.0%	2	0.1%	**2**	**0.1%**
Total	**601**	**100.0%**	**3,074**	**100.0%**	**3,675**	**100.0%**
Persons Injured						
Driver of Large Truck	7,000	67.4%	9,000	13.4%	**17,000**	**20.7%**
Driver of Other Motor Vehicle	*	*	41,000	59.2%	**41,000**	**51.2%**
Passenger of Large Truck in Transport	2,000	16.4%	1,000	2.0%	**3,000**	**4.0%**
Passenger of Other Motor Vehicle in Transport	*	*	17,000	25.1%	**17,000**	**21.7%**
Occupant of Motor Vehicle Not in Transport	*	3.2%	*	0.1%	*****	**0.5%**
Occupant of Non-Motor Vehicle Transport Device**	*	0.9%	*	*	*****	**0.1%**
Pedestrian	1,000	8.8%	*	0.2%	**1,000**	**1.4%**
Bicyclist	*	3.2%	*	*	*****	**0.4%**
Other Nonoccupant	*	*	*	*	*****	*****
Unknown Occupant Type in Motor Vehicle in Transport	*	*	*	*	*****	*****
Total	**11,000**	**100.0%**	**69,000**	**100.0%**	**80,000**	**100.0%**

**Less than 500 or less than 0.05 percent.*

***Refers to a person riding in an animal-drawn conveyance or on an animal, or an occupant of a railway train, etc..*

Source: (FMCSA 2012)

Hazardous material (HM) sign was present in 3 percent of all large trucks involved in fatal crashes and in 2 percent of nonfatal crashes. In 12 percent of the trucks labeled with the hazardous material placard, the hazardous material was released from the cargo compartments. As seen on Table 3.10, flammable liquids (gasoline, fuel oil, etc.) accounted for most of the accidents involving large trucks and hazardous materials, with almost 50 percent of all fatal crashes, and just below 40 percent of nonfatal crashes (FMCSA 2012).

Table 3.10: Large trucks in crashes by hazardous material cargo type, release and crash severity in 2010

	HM Release							
	Yes		No		Unknown		Total	
HM Cargo Type	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Fatal Crashes								
Explosives	1	2.8%	3	5.3%	0	0.0%	4	3.7%
Gases	4	11.1%	13	22.8%	0	0.0%	17	15.9%
Flammable Liquids	22	61.1%	26	45.6%	3	21.4%	51	47.7%
Flammable Solids	0	0.0%	1	1.8%	0	0.0%	1	0.9%
Oxidizing Substances	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Poisonous and Infectious Substances	1	2.8%	1	1.8%	0	0.0%	2	1.9%
Radioactive Materials	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Corrosives	2	5.6%	3	5.3%	0	0.0%	5	4.7%
Miscellaneous Dangerous Goods	1	2.8%	0	0.0%	0	0.0%	1	0.9%
Unknown	5	13.9%	10	17.5%	11	78.6%	26	24.3%
Total	**36**	**100.0%**	**57**	**100.0%**	**14**	**100.0%**	**107**	**100.0%**
Nonfatal Crashes (MCMIS Data)								
Explosives	3	1.2%	34	1.9%	18	3.8%	55	2.2%
Gases	31	12.3%	222	12.7%	68	14.3%	321	13.0%
Flammable Liquids	106	41.9%	678	38.7%	191	40.3%	975	39.3%
Flammable Solids	0	0.0%	15	0.9%	6	1.3%	21	0.8%
Oxidizing Substances	5	2.0%	18	1.0%	2	0.4%	25	1.0%
Poisonous and Infectious Substances	2	0.8%	13	0.7%	3	0.6%	18	0.7%
Radioactive Materials	0	0.0%	2	0.1%	0	0.0%	2	0.1%
Corrosives	20	7.9%	109	6.2%	46	9.7%	175	7.1%
Miscellaneous Dangerous Goods	41	16.2%	158	9.0%	12	2.5%	211	8.5%
Unknown	45	17.8%	502	28.7%	128	27.0%	675	27.2%
Total	**253**	**100.0%**	**1,751**	**100.0%**	**474**	**100.0%**	**2,478**	**100.0%**

Source: (FMCSA 2012)

3.1.6 Major Issues/Concerns in Highway Freight Transportation

According to Hillestad et al. (2009), one of the major issues in highway freight transportation in U.S. is traffic congestion. The deteriorating infrastructure of U.S. contribute to the formation of traffic jams, and one way to help mitigate them is by increasing the capacity of the highway freight corridors, and the national highway network in general. Most projections indicate that the capacity of major highway corridors is getting close to their limits and soon can become a constraining factor for the movement of goods and economic growth of the country. About 79 percent of the nation's freight by weight and 75 percent by value are moved on highways by trucks, so naturally congestions are a very significant factor in freight delay and shipping costs. The total amount of highway freight movement in U.S. is projected to increase 75 percent by 2020, while 40 percent of the NHS is expected to experience traffic congestions during peak hours. Additionally, there are extra costs directly related to congestions; for example traffic accidents are more likely to happen during congestion, the amount of fuel consumption increases and thereby truck emissions increase contributing to global warming (Hillestad et al. 2009).

According to a report by Cambridge Systematic on freight bottlenecks, the delays created by bottlenecks in U.S. amount to more than 243 million hours of truck delay, which is equivalent to a loss of approximately $7.8 billions to truckers (Cambridge Systematics 2005). Even though bottlenecks are the main contributor (40%) to congestions, they are not the only factor causing traffic jams. As can be seen in Figure 3.9, by reducing the amount of bottlenecks, other congestion causing factors such as traffic accidents could be also reduced (e.g. bottleneck-related accidents) (Cambridge Systematics 2005).

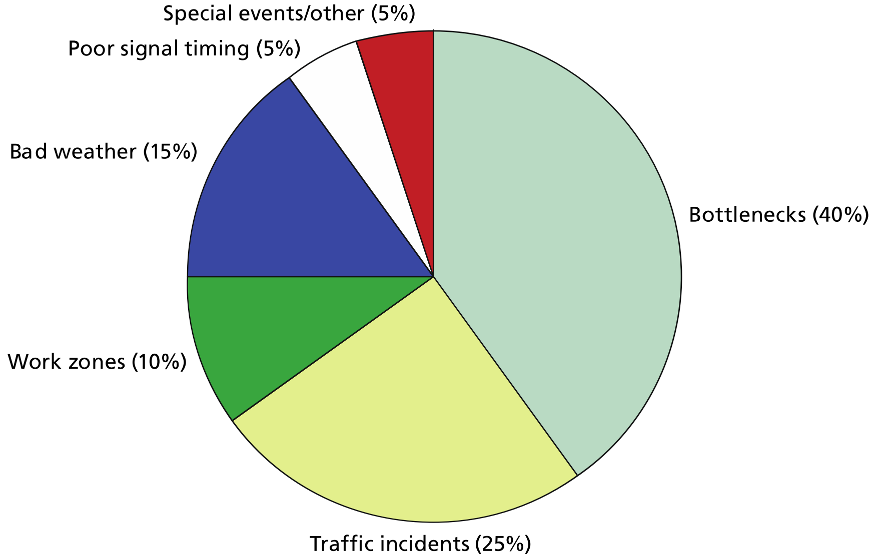


Figure 3.9: Sources of congestions in U.S.

Source: (Cambridge Systematics 2005)

Four major approaches can be taken to decrease traffic congestions that can be implemented through a diversity of mechanisms such as user fees, regulations, and new information technology (IT):

- Adding physical capacity, such as increasing the number of lanes, or permitting larger trucks to travel on existing highways;
- Disseminate the demand through time and space;
- Encourage shift of mode to rail or waterway; and
- Reducing total demand.

Increasing the capacity of highways by adding new lanes has proven ineffective, as described in a RAND report on improving the traffic conditions in Los Angeles. Triple convergence is a phenomenon that weakens the effectiveness of adding lanes to improve

capacity. The situation described by this phenomenon is: when the traffic conditions on a roadway are improved during peak hours, the newly freed capacity tends to attract additional users from other times, routes, and modes of travel eventually returning to the former levels of congestion is a matter of years (Sorensen et al. 2008).

Another alternative for increasing the physical capacity of highways is by creating special truck-only lanes. One of the advantages of creating lane specifically for truck usage is that regulations limiting the size and weight of trucks on highways could be reduced, therefore increasing the capacity significantly. For instance, allowing triple-trailer trucks would increase the capacity of a highway by 50 percent. However, changing this kind of regulation would only be possible on truck-only lanes, or highways that would not rejoin truck-size limiting traffic lanes (Hillestad et al. 2009).

Another alternative discussed by Hillestad et al. is disseminating the demand by using congestion pricing for peak periods. Congestion pricing for peak periods is implemented in order to shift rush hour highway traffic to other modes of transportation or off-peak periods. Pricing strategies can involve pricing separated lanes within a highway such as High Occupancy Toll (HOT) lanes, pricing entire roads, highways, and bridges during rush hour, cordon charges which charges to drive within or into a congested area (Congestion Pricing: A Primer 2006). Other alternatives for disseminating demand includes increasing the number of High Occupancy Vehicle (HOV) lanes, signal timing and priority control, placing limits on curbside parking for major corridors, and increasing public-transit capacity to shift people from automobiles to public transportation (Hillestad et al. 2009).

Congestion reduction can also be achieved by shifting freight mode transportation from road to rail or water transportation. Some factors that increase the shift of goods from truck to train are speeding the transition of goods by improving intermodal facilities; increase the number of short-haul rail to decrease the need of road transportation, and reducing truck movement on highways connecting to ports. Also, freight shifting from truck to vessels is achievable by using short-sea solutions moving freight from highly used ports to nearby ports via less-congested waterways, reducing the need for roadway transportation (Hillestad et al. 2009).

Finally, enhancing freight-related IT infrastructure can also help decrease traffic jams in several ways, including using Radio Frequency Identification (RFID) tracking to avoid losses, and coordinate and accelerate the movement of goods between modes, identifying real-time traffic breaks and routing to avoid traffic congestions, thus not incrementing the size of the already present congestion, and coordinating logistics to avoid empty trucks return tips (Hillestad et al. 2009).

3.1.7 Highway Infrastructure Financing

3.1.7.1 Highway Trust Fund

The Highway Trust Fund (HTF) was established in 1956 to finance U.S. Interstate System. Since its establishment, surface transportation programs have been largely funded by taxes on motor fuel that flow into the HTF, and it continues to be the major funding source to this day. The HTF is composed of two separate accounts: the highway and mass transit accounts. The major source of revenue for these two accounts comes from an 18.4-cents-per-gallon and a 24.4-cent-per-gallon federal tax imposed on gasoline and diesel fuel respectively. Although 90

percent of the income for the fund comes from fuel taxes, the HTF also has other sources for revenue such as truck registration fees, taxes imposed to truck tires, and interest credited to the fund balances by U.S. Treasury. The transit account receives 2.86-cents-per-gallon of fuel taxes, while the highway account receives the remainder of the tax revenue. Independently, there is a 0.1-cent-per-gallon from the tax revenue going into the leaking underground storage tank fund (LUST), which has no relation to transportation (Kirk 2013).

According to the Congressional Budget Office (CBO), the HTF revenues are inadequate and insufficient to support the standard spending on surface transportation programs after the fiscal year (FY) 2014, with the balances in both accounts (highway and mass transit) of the HTF approaching zero by FY2015. “If congress were to pass a six-year reauthorization bill to follow MAP-21 that increases spending on surface transportation programs in line with inflation”, there would still be a difference of nearly $80 million between the projected HTF revenue and the planned spending (obligation limitation) form FY2015 through FY2020, as detailed in Table 3.11. The difference between the estimated HTF revenues and the outlays is even greater, reaching $85 millions. Therefore, to fund baseline spending over the FY2015-2020 period, the HTF would require finding approximately $85 million in revenue, which is a 33% increase from the level of revenues estimated by the CBO (Kirk 2013).

Table 3.11: HTF sufficiency under a baseline six-year surface transportation act from FY2015 to FY2020

Billions of Dollars

		Obligation Limitations		Outlays	
Fiscal Year	**HTF Revenue**	**Amount**	**Difference**	**Amount**	**Difference**
2015	39	51	-12	53	-14
2016	40	52	-12	53	-13
2017	40	53	-13	55	-15
2018	41	54	-13	55	-14
2019	41	56	-15	55	-14
2020	41	56	-15	56	-15
Six-Year Total	242	322	-80	327	-85
Annual Average	40	54	-13	55	-14

Source: (Kirk 2013)

One of the main causes for the depletion of the HTF is a decrease of annual VMT that had an average increase of about 2% per year from 1960 to 2008. Due to the constant increase in VMT, the HTF used to have an automatic growth, which is currently nonexistent. The decrease in VMT is mainly due to a slow-moving economy causing a decrease in personal income, thus reducing the amount of leisure travel, work-related driving, and also weakened the demand for freight shipments. Other main reasons for the depletion of the HTF are the ever-increasing fuel efficiency of vehicles, and the improvement of fuel economy (Kirk 2013).

As mentioned before, the amount of VMT has decreased over the years, while the motor fuel taxes are based on cents-per-gallon at a time when drivers are consuming less fuel, thus the HTF revenues are not rising. All these problems added to the political difficulty of increasing fuel taxes has led U.S. to take interest in alternative sources of revenue for the HTF, including

taxes to the price of fuel rather than a fixed amount per gallon, and charging driver according to the distance traveled, and not by the amount of fuel consumed (Kirk 2013).

<u>3.1.7.2 Sales Taxes</u>

The sales tax concept proposes that the federal tax on motor fuels should be calculated based on the retail price of fuels, in contrast to the current state of taxation based on a fixed amount per gallon of motor fuel. Some states in U.S. are already implementing this way of taxation; some of them are implementing the sales tax system instead, while others are implementing it along with the cents-per-gallon system (Kirk 2013).

As estimated by the American Association of State Highway and Transportation Officials (AASHTO) in 2011, a tax of 8.4% on gasoline sales and 10.6% on diesel fuel sales would produce an equivalent amount of revenues as the current state of motor fuel tax collection. According to forecasts performed by the Energy Information Administration of U.S. Department of Energy, fuel prices are estimated to rise in the future; therefore sale tax revenues could rise every year without the need of an increase in fuel consumption (Kirk 2013).

On the contrary, however, a motor fuel prices decline could lead to a decrease of sale tax revenues. This situation has happened before in the 1970s when fuel prices fell dramatically, and some states experienced a drop in revenue from price related fuel taxes in the 1980s. However, recently some states like Virginia have favored a sales tax on fuels (implementing a 3.5 percent on gas and a 6 percent on diesel fuel), eliminating their 17.5 cents per gallon system completely (Kirk 2013). As economists Michael Madowitz from UC San Diego and Kevin Novan from UC Davis pointed out in a study, the sale tax imposed in fuels have proven more volatile in California, where a tax of 8.25 percent was imposed to fuels until 2010. When the price of oil

rises, sale taxes imposed on gas and diesel would rise too, intensifying the pain of prices rises. On the six-month study period sale taxes on gas range from 13.2 to 32.5 cents per gallon, and over the last decade revenue from the sales tax fluctuated by approximately 13.5 percent while revenue from the per-gallon tax fluctuated by only 1.2 percent (Madowitz 2013).

The sales tax concept, however, is only considered to be a possible temporary solution, because as the current system, it still relies on fuel consumption to fund transportation programs. Federal tax tied to fuel consumption creates an inefficient system for revenue creation, mainly due to the improvement of vehicles efficiency, and the adoption of hybrid and electric vehicles that would decrease the amount of fuel usage (Kirk 2013).

3.1.7.3 Distance-Based Charges

Fees bases on vehicle miles traveled (VMT) have been subject to extensive research by the Transportation Research Board and other groups, which concluded that a conversion into a VMT system for financing highways is desirable and possible. Federal VMT charges have been considered to provide revenue to the HTF either replacing or alongside the existing motor fuel taxes. Distance-based are viewed by economist as a superior form of user charge because it is directly related to the quantity (miles) of infrastructure consumed, while fuel tax is not. For example, considering an electric vehicle, a hybrid vehicle, and a regular gasoline-powered vehicle travel the same distance on a highway; all vehicles would consume the same quantity of infrastructure, however, they would all pay different amounts of taxes according to the efficiency of the vehicle. In contrast, with a VMT system, the amount paid by all three vehicles would be directly related to the amount of road miles used or consumed. In addition to VMT, adding the weight of the vehicle to the tax calculation would better incorporate infrastructure usage,

accounting for the pavement wear attributable to different vehicles according to weight and type (Kirk 2013).

The most prominent advantages of VMT system implementation include:

- All users of road are required to pay, whereas currently some drivers of vehicles powered by batteries, fuel cells, and other alternative technologies are able to use the public roads without paying fuel taxes used to maintain and restore them.
- VMT costs can be adjusted accordingly to reflect the usage of a particular segment of infrastructure. This can be achieved by assigning different cost to road segments depending on the type of road (urban highway or rural roadway), and how heavily the road is used. For example, assigning higher cost to a heavily used interstate highway in contrast to a small rural highway scarcely traveled. It can also be modified according to the time, traffic level, and other measures to account for congestion to encourage driver to change their driving patterns and choose an alternative route to avoid crowded road at rush hours (Kirk 2013).

Furthermore, according to Vavrová (2012), a distance-based tolling system is a feasible idea at state level. Vavrová points out that while it ensures a more stable source of revenues, a distance-based model would be unaffected by changes in vehicle fuel efficiency and the development of alternative fuels. Also, differentiating the toll in time and space would provide assistance in congestion management, effectively reducing travel time and energy consumption. Finally, lower energy consumption is implied by driver’s awareness of usage-based fees (Vavrová 2012).

3.1.8 Major Logistics Hubs/Centers

Congestions, bottlenecks, and other inefficiencies in the transportation network can drive up the cost of goods; however, warehouses, distribution centers, and logistics providers help alleviate congestions, support, and enhance the mobility of goods across U.S. The warehouse and logistics industry helps to improve U.S. economy and global competitiveness by optimizing the movement of goods across all modes of transportation (House Committee on Transportation and Infrastructure 2013).

Easy access to multiple modes of transportation is a great advantage for businesses involved in the shipment of goods to a wide variety of destinations. Since intermodal access has become essential to cope with modern supply chain management strategies, all major logistics hubs in U.S. are intermodal facilities.

However, excellent highway connections are essential for an effective supply chain system, and the timely delivery of goods to the marketplace. Often, highway transportation by trucks is the first stage of shipping goods, and interstate and state highways are essential for cross-country and international shipment of products. Therefore the fast delivery of goods to their destination is more efficiently accomplished by logistics facilities close to interstate and state highways. Some major intermodal sites in U.S. include:

- Alliance Intermodal Terminal North of Dallas/Forth Worth, which connects the BNSF railway with 4 interstate highways (I-20, I-30, I-35, and I-635);
- San Antonio Intermodal Terminal, which connects the Union Pacific railway with interstate highways I-35 and I-410, and;

- CenterPoint Intermodal Center outside Chicago, which connects BNSF and Union Pacific railways with interstate highways I-55 and I-80.

Some eastern states like Florida, Virginia, Maryland, and South Carolina with strong connections between highways and deep-water ports are forecasted to increase their warehousing and logistics activity with the Panama Canal expansion in 2014 (Crawford 2013).

According to USDOT (2009), the top U.S. freight transportation gateways/hubs include all three transportation modes (air, water, and land transportation). The ranking performed in America's Freight Transportation Gateways 2009 is based on total value of freight handled, allowing for comparison between different transportation modes. A ranking based on tonnage would be inaccurate due to lack of complete data, and because of the nature of transportation modes (e.g. waterborne transportation handles more freight by weight than airports can handle), therefore value of merchandise was used as the ranking criteria. Figure 3.10 shows the top 25 ports for international import and export of freight shipments by value (USDOT 2009).

The top U.S. freight hubs usually handle both imports and exports; however, some of the gateways primarily serve as either import or export hubs. For example, the maritime port of Long Angeles exports accounted for only 14 percent of the total value of cargo handled by the port; meanwhile, the land border crossing of Detroit, and the JFK International Airport handled more exports than imports based on cargo value. The top 50 freight hubs by value in U.S. are shown in Table 3.12 (USDOT 2009).

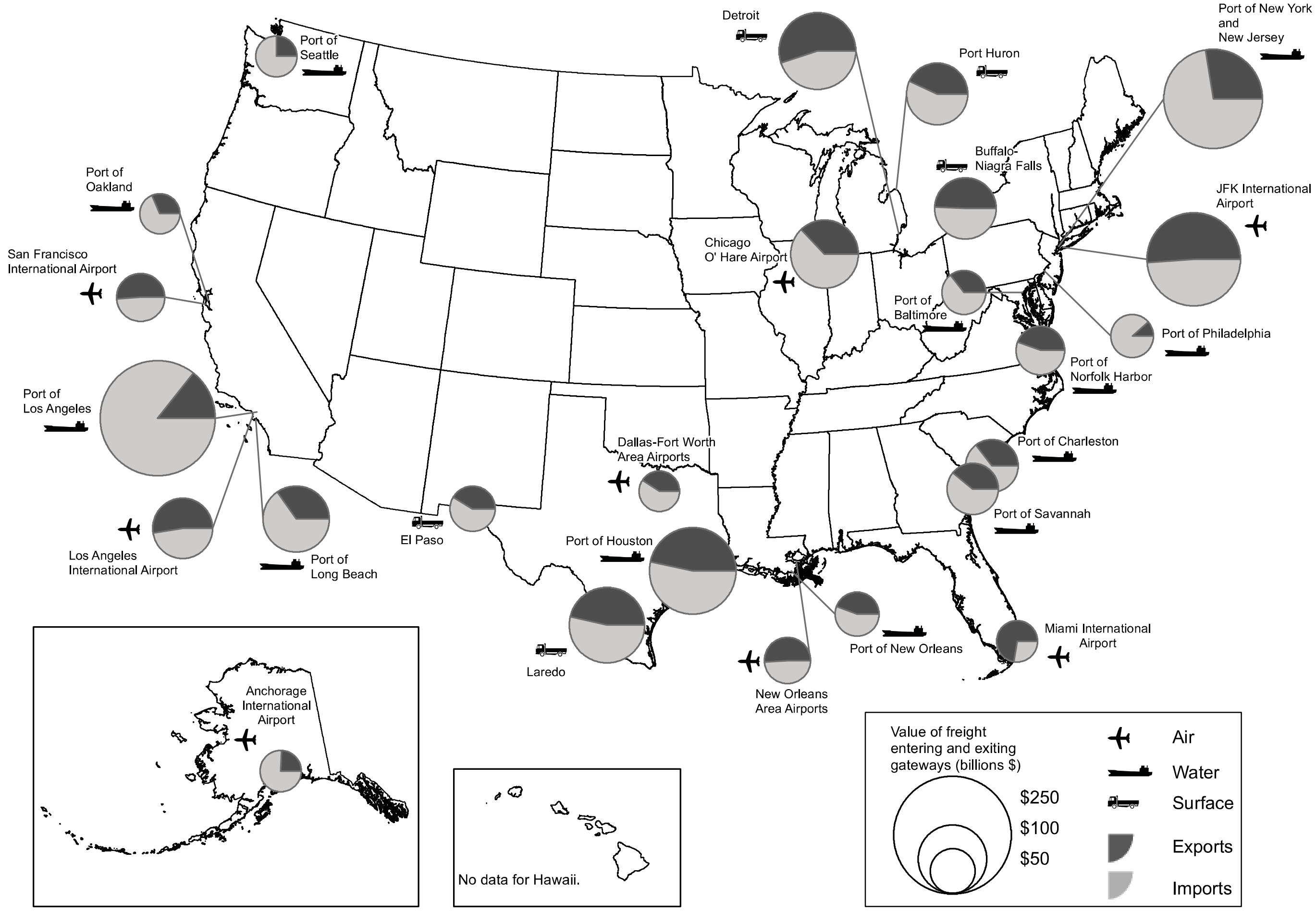


Figure 3.10: Top 25 U.S. freight gateways by value of shipments in 2008

Source: (USDOT 2009)

Table 3.12: Top 50 U.S. freight gateways by value of shipment in 2008

Rank	Port name	Mode	Total U.S. trade	Exports	Imports	Exports as % of total	Rank	Port name	Mode	Total U.S. trade	Exports	Imports	Exports as % of total
1	Port of Los Angeles, CA	Water	243.9	34.8	209.1	14.3	26	Port of Morgan City, LA	Water	39	0.2	38	0.6
2	Port of New York/New Jersey, NY/NJ	Water	185.4	50.6	134.8	27.3	27	Port of Tacoma, WA	Water	35	8	27	23.3
3	JFK Intl. Airport, NY	Air	168.0	85.5	82.5	50.9	28	Hartsfield-Jackson Atlanta Intl. Airport, GA	Air	32	12	20	38.1
4	Port of Houston, TX	Water	147.7	68.8	78.9	46.6	29	Otay Mesa Station, CA	Land	32	11	21	33.2
5	Detroit, MI	Land	120.2	66.5	53.7	55.3	30	Cleveland Hopkins Intl. Airport, OH	Air	31	18	13	57.0
6	Laredo, TX	Land	115.8	53.9	61.8	46.6	31	Port of Corpus Christi, TX	Water	30	5	25	16.7
7	Chicago, IL	Air	97.2	35.8	61.4	36.9	32	Port of Gramercy, LA	Water	24	9	15	36.2
8	Port of Long Beach, CA	Water	91.5	31.6	59.9	34.5	33	Champlain–Rouses Point, NY	Land	24	9	14	39.9
9	Port Huron, MI	Land	81.2	35.2	46.0	43.4	34	Port of Jacksonville, FL	Water	23	11	12	48.6
10	Buffalo–Niagara Falls, NY	Land	80.8	40.3	40.5	49.9	35	Port of Texas City, TX	Water	23	3	19	14.4
11	Los Angeles Intl. Airport, CA	Air	78.3	41.3	37.0	52.8	36	Port Everglades, FL	Water	23	12	11	53.2
12	Port of Charleston, SC	Water	62.3	22.3	40.1	35.7	37	Port of Miami, FL	Water	22	11	11	50.0
13	Port of Savannah, GA	Water	59.0	22.8	36.1	38.7	38	Hidalgo, TX	Land	22	10	12	44.5
14	Port of Norfolk, VA	Water	54.0	23.9	30.0	44.4	39	Port of Beaumont, TX	Water	21	3	18	13.3
15	San Francisco Intl. Airport, CA	Air	52.8	26.6	26.2	50.4	40	San Juan Intl. Airport, PR	Air	21	12	9	58.0
16	Port of New Orleans, LA	Water	49.8	25.3	24.4	50.9	41	Pembina, ND	Land	20	11	9	56.7
17	New Orleans Customs District, LA	Air	49.6	22.3	27.3	44.9	42	Nogales, AZ	Land	19	7	12	36.1
18	El Paso, TX	Land	48.2	20.2	28.0	41.8	43	Christiansted, VI	Water	19	3	17	13.5
19	Port of Baltimore, MD	Water	45.3	16.1	29.2	35.6	44	Blaine, WA	Land	18	11	7	59.9
20	Port of Philadelphia, PA	Water	43.2	5.0	38.1	11.7	45	Washington, DC	Air	17	6	12	32.1
21	Anchorage Intl. Airport, AK	Air	41.4	10.2	31.2	24.6	46	Port Arthur, TX	Water	17	2	15	14.1
22	Miami Intl. Airport, FL	Air	40.0	29.2	10.8	73.0	47	Port of Portland, OR	Water	17	5	12	30.6
23	Port of Seattle, WA	Water	40.0	9.9	30.0	24.9	48	Portal, ND	Land	17	10	7	58.4
24	Dallas–Fort Worth Intl. Airport, TX	Air	39.5	16.4	23.1	41.5	49	Sweetgrass, MT	Land	16	8	8	49.6
25	Port of Oakland, CA	Water	38.7	12.4	26.3	32.0	50	Freeport, TX	Water	16	2	14	12.6
								Top 50 gateways		**2,651**	**1,006**	**1,645**	**37.9**
								Total U.S. merchandise trade by all modes		**3,401**	**1,301**	**2,100**	**38.2**
								Top 50 gateways as share of U.S. total (percent)		**78.0**	**77.4**	**78.3**	

Notes: $ Billions

Source: (USDOT 2009)

A brief description of the top ten freight transportation hubs by value of shipments is provided below:

<u>1. Port of Los Angeles, California – Water Gateway</u>

The Port of Los Angeles is a self-supporting department of the City of Los Angeles encompassing 7,500 acres and 43 miles of waterfront. In 2013, the port handled approximately 7.9 million Twenty-Foot Equivalent Units (TEU) of cargo. Combining the Los Angeles International Airport, the other four major commercial airports in the area (Burbank Airport, John Wayne Airport: Orange County, Long Beach Airport, and Ontario International Airport), the extensive highway system including 8 interstate highways (I-5, I-10, I-105, I-110, I-210, I-405, I-605, and I-710), and the rail system including a Class 1 railroad, the Union Pacific Railroad (The Port of Los Angeles 2014). Class 1 railroads as defined by the Association of American Railroads (2013) are freight railroads with operating revenue of $433.2 million or more (Association of American Railroads 2013). Los Angeles is the leading logistics hub in Western U.S. (The Port of Los Angeles 2014).

<u>2. Port of New York and New Jersey, New York/New Jersey – Water Gateway</u>

Operated by the Port Authority of New York/ New Jersey, the Port of New York/ New Jersey is considered the largest port in U.S. East Coast, with cargo volumes increasing by 16 percent from 2009 to 2010 and reaching approximately 5.3 million TEUs. The port contains 1,500 square miles and manages more than two-dozen facilities including 6 airports (John F. Kennedy International Airport, LaGuardia Airport, Newark Liberty International Airport, Stewart International Airport, Teterboro Airport, and Atlantic City International Airport), 4 bridges (The George Washington Bridge, Bayonne Bridge, Goethals Bridge, and the Outerbridge

Crossing), two tunnels (The Lincoln Tunnel and the Holland Tunnel), as well as three bus terminals and four distinct marine terminals (Port Jersey, Brooklyn, Elizabeth, Howland Hook, and Port Newark Marine Terminals). Additionally, an investment of $283 million is planed to improve maritime facilities. The port is served by three of Class 1 railroads (Canadian Pacific Railway, CSX Transportation, and Norfolk Southern Railways), as well a by 8 interstate highways within the port district: I-78, I-80, I-87, I-278, I-280, I-287, I-495, and I-684 (The Port Authority of New York & New Jersey 2014).

3. John F. Kennedy International Airport, New York – Air Freight Gateway

The John F. Kennedy International Airport is operated by the Port Authority of New York and New Jersey under lease of the City of New York. The airport covers a total of 4,930 acres, with about 1,000 cargo companies operating the airport, and more than 30 miles of runway. John F. Kennedy International Airport also offers 4 million square feet of warehousing area, and the interstate highway I-678 directly serves it (The Port Authority of New York & New Jersey 2014).

4. Port of Houston, Texas – Water Gateway

Operated by The Port of Houston Authority, The Port of Houston has been the number one port handling foreign waterborne tonnage for 14 consecutive years, and is currently first port in U.S. imports, U.S. exports by tonnage, and only second in U.S. in total tonnage behind the Port of South Carolina. The port is a 25 miles complex of public and private facilities located in the 45 feet deep Houston Ship Channel centrally located in the Gulf Coast, and carries more than 200 million tons of cargo every year. Approximately 200 million TEUs were handled at the port in 2013. The Port of Houston has easy access to two interstate highways (I-10, and I-45), as well

as two Class 1 railroads (BNSF, and Union Pacific). Additionally, three airports including the George Bush Intercontinental Airport serve the city, and Houston is also located in the proposed Interstate 69 NAFTA superhighway linking, Canada, U.S., and Mexico (Port of Houston Authority 2012).

5. Detroit, Michigan – Land Gateway

Detroit was the busiest land border hub by value of imports and exports across U.S. border by trucks, rail, and pipelines in 2008. Trucking is considered by far the most used mode of cargo transportation across the border with approximately 84 percent of the value of total land cargo in 2008. In 2012 a total of 1,397,518 truck containers passed through the border, including empty and loaded containers (USDOT 2013). There are 6 interstate highways passing though the Detroit metropolitan area including I-75, I-94, I-95, I-275, I-375, and I-696, and the city is also served by 4 Class 1 Railroads (CSX Transportation, Canadian National Railway, Canadian Pacific Railway, Norfolk Southern Railway) (USDOT 2009).

6. Laredo, Texas – Land Gateway

Laredo is located in the Mexico-U.S. Border, and thousands of trucks cross the international border everyday through this gateway via the World Trade Bridge (which is the most important truck crossing on U.S.-Mexico border) and the Columbia Bridge (USDOT 2009). In 2011, Laredo’s international bridges handled about 1.3 million northbound truck crossings (Prozzi 2013). Also, interstate highway I-35, and two Class 1 railroads (Union Pacific Railroad, and Kansas City Southern Railway) directly serve the City of Laredo (The State of Texas 2013).

7. Chicago, Illinois – Air Freight Gateway

The Chicago air freight hub comprises Midway International Airport and O'Hare International Airport, which together provide international passenger and freight services, with as much as 1.6 million tons of cargo processed annually. Additionally, after Hong Kong and Singapore, Chicago is considered the third-largest intermodal port in the world. Operated by the Illinois International Port District, the Port of Chicago is the largest inland cargo port in U.S., and it is a critical link between the Illinois and Michigan canals, the Great Lakes, and the Mississippi River. According to Logistics List, a third party logistics directory for logistics and supply chain decision makers, there are approximately 1.3 billion square feet of warehousing and distribution area in the city, and on its suburbs (Logistics List 2013). Furthermore, the city of Chicago is served by six of the seven Class 1 railroads including the BNSF, Canadian National Railway, Canadian Pacific Railway, CSX Transportation, Norfolk Southern Railway, and Union Pacific Railroad, and is also served by nine interstate highways (I-55, I-57, I-80, I-88, I-90, I-94, I-190, I-290, I-355). Midway International Airport and O'Hare International Airport provide international passenger and freight services, with as much as 1.6 million tons of cargo processed annually (Illinois International Port District 2013).

8. Port of Long Beach, California – Water Gateway

Governed by the City of Long Beach, the Port of Long Beach is the second busiest port in U.S., the 18th busiest container port in the world, and if combined with the Port of Los Angeles, they would be the eight-busiest port complex by container volume in the world. The port has 3,200 acres of land, 10 piers, 80 berths, and 22 shipping terminals. In 2013, the Port of Long Beach handled 6,730,573 containers. The port is also served by 2 Class 1 railroads (Union Pacific Railroad, and BNSF Railway), and is also directly served by interstate highway I-710 that provides a link to other interstate highways such as I-110, and I-405 (Port of Long Beach 2013).

9. Port Huron, Michigan – Land Gateway

Port Huron was the third busiest U.S. import and export land border gateway in 2008. The city is connected by the Blue Water Bridge spanning over the St. Clair River with the Canadian city of Point Edward. According to U.S. DOT (2009), trucking was the major form of freight transportation passing trough Port Huron, averaging from 52 to 57 percent of land trade since 2000. The Blue Water Bridge handled 738,000 truck crossings in 2008, while in 2006, 1.7 million (the highest number for the port) container crossings were recorded (USDOT 2009). The city of Port Huron is served by two interstate highways (I-69 and I-94) as well as by two Class 1 railroads (Canadian National Railway, and CSX Transportation) with international connections via the St. Claire Tunnel.

10.Buffalo-Niagara Falls, New York – Land Gateway

Buffalo-Niagara Falls was the fourth busiest U.S. import and export land border gateway in 2008. According to U.S. DOT (2009), trucking was the most used mode of transport for freight passing through the Buffalo-Niagara Falls Metropolitan Area, with 73 percent of the value of land trade in 2008, and keeping an average between 75 and 79 percent since 2000. Closely to 1 million trucks transport freight through the Peace Bridge, and the Lewiston-Queenston Bridge from Canada into U.S., with 981,000 trucks crossings in 2008 (USDOT 2009). The metropolitan area of Buffalo-Niagara Falls is served by 4 intestate highways (I-90, I-190, I-290, and I-990), as well as by 4 Class 1 railroads including the Canadian National Railway, Canadian Pacific Railway, CSX Transportation, and Norfolk Southern Railways.

U.S. inland waterway system is mainly composed of the Mississippi River and its branches (among which is the Illinois River that connects to the Great Lakes), the Hudson River

and the Saint Lawrence Seaway, the Great Lakes (Lakes Superior, Huron, Michigan, Erie, and Ontario), the Chesapeake Bay, the Delaware River, and the Columbia River (see Figure 3.11).

Figure 3.11: U.S. waterway system

Source: (House Committee on Transportation and Infrastructure 2013)

The waterway system connects the ports of Mobile, AL and New Orleans, LA in the Gulf of Mexico to the Mississippi River, which in turn connects to the Illinois, Ohio, and Tennessee Rivers. Likewise, the Illinois River provides access from the Mississippi River to the Great Lakes area through Chicago, IL. Industrial areas such as Detroit, MA, Chicago, IL, and Cleveland, OH surround the Great Lakes (Figure 3.12), which are all interconnected, and provide access between U.S. and the Canadian Province of Ontario (House Committee on Transportation

and Infrastructure 2013). Lake Superior and Lake Huron are connected by the St. Marys River (including the Soo Locks), and the Strait of Mackinac connects Lake Huron to Lake Michigan (which are considered to be a single mass of water). Then Lake Huron connects via the St. Claire River to Lake St. Claire, which in turn connects to Lake Erie via the Detroit River. Subsequently, Lake Erie and Lake Ontario are naturally connected through the Niagara River; however, vessels are transported through the Welland Canal bypassing the Niagara Falls. Finally Lake Ontario is connected to the Atlantic Ocean, and thus to European, African, and Asian markets via the St. Lawrence River (Taylor and Roach 2005).

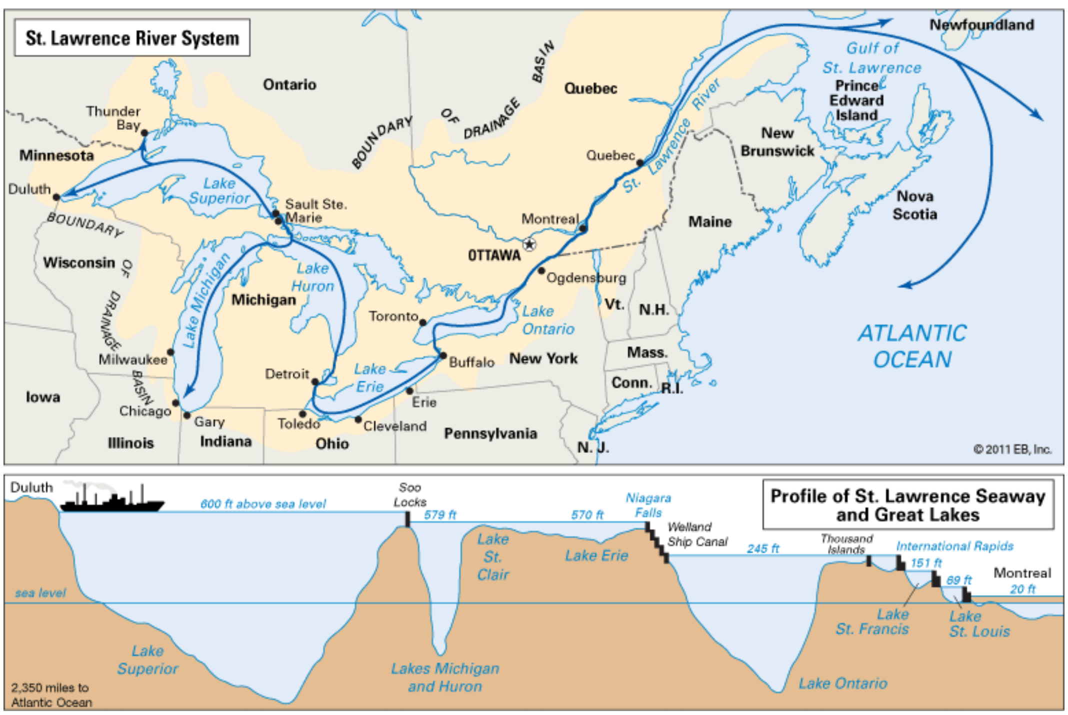


Figure 3.12: St. Lawrence Seaway and Great Lakes

Source: (House Committee on Transportation and Infrastructure 2013)

3.2 Current State of Highway Freight Transportation in EU

3.2.1 Authorities of Highway Freight Transportation

Authorities on highway freight transportation in EU can be divided in two separate categories: authorities on EU level, and authorities on member state level. Authorities on EU level are organizations that focus on enforcing and proposing new laws to represent EU interests as a whole, while state level authorities are organizations that focus on individual country interests. The most important EU authorities on highway freight transportation are the following:

European Commission

Composed of 28 commissioners (one for each EU country), is one of the main institutions of EU in charge of drafting proposals for new EU laws, and managing the implementation of EU policies and the spending of EU funds. The main purpose of the European Commission is to represent the interest of EU as a whole by doing the following:

1. Proposing new laws to European Parliament and the Council of EU (represents individual member states governments);
2. Managing EU budget and allocation of funds;
3. Enforcing EU law;
4. Representing EU internationally.

Possessing the "right of initiative", the European Commission proposes new laws to protect the interest of EU on issues that are hard to deal with on national or regional levels. The Commission is also in charge of composing a budget that need to be passed by the Parliament

and the Council, and supervising how agencies, national, and regional authorities are spending EU funds. It is also in charge of ensuring that all countries are applying EU laws, and has the power of referring the issue to the Court of Justice of EU to be imposed penalties in case of failure to comply according to EU laws. Finally, the Commission also represents EU and speaks on its behalf on international organizations such as the World Trade Organization (European Commission 2014b).

The European Commission is divided into several departments and services. The departments are called Directorates-General (DGs), and they are classified according to the policies the DGs where created to handle. Some of the DGs significant in this study include the Directorate-General for Mobility and Transport, and Eurostat (European Commission 2014b).

Directorate-General for Mobility and Transport

The Directorate-General for Mobility and Transport (DG MOVE) is a department under European Commission with the goal of promoting an efficient, safe, secure, and environmental friendly mobility, and to generate economic growth and jobs by creating the conditions for a competitive industry. Since the challenges and issues to achieve this goal cannot be addressed by national governments alone, the DG for Mobility and Transport works closely with EU member states, European industry, citizens, and stakeholders (European Commission 2014b).

DG MOVE’s objectives on road transportation are to encourage efficient freight and passenger road transportation services, to produce fair competitive conditions, to promote more environmental friendly and secure standards, and to ensure that road transportation rules are effectively applied, and with no discrimination (European Commission 2014b). Current legislation on road transportation regulates the following:

- Access to the profession and to the market;
- Minimal standards for working time, driving time, and rest periods;
- Minimum annual vehicle taxes, common rules for tolls, and user charges for heavy good vehicles;
- Maximum weight and dimension of road vehicles; and
- Promote more and safer parking (rest) areas in the TEN-T.

Eurostat

Eurostat is a Directorate-General under the European Commission, and the statistical office of EU. The main goal of Eurostat is to provide EU and other DGs with European level data and statistics that allow comparisons between member countries and regions. Eurostat offers a wide range of data that governments, businesses, the education sector, journalists, and the public can use for their work, and to define, implement, and analyze policies (Eurostat 2014b).

For authorities on highway freight transportation on member state level, every member country on EU owns a Ministry of Transport (or equivalent government department). In this case, the Czech Republic will serve as an example for highway freight transportation at state level in EU.

Ministry of Transport

The Ministry of Transport in the Czech Republic is a central state administration authority for all matters involved in transportation, and it is responsible for developing the

country's transportation policy and ensuring its implementation within the scope of its power. Some of the main tasks of the Ministry of Transportation are the following (RSS 2005):

- Ensuring the preparation, creation, and monitoring of the Czech Transportation Policy;
- Creating documents supporting the development of transportation networks in the Czech Republic, the use of innovative technologies in transportation;
- Develop priority proposals for the construction of transportation networks based on economic efficiency, risk, and benefit analyses;
- Planning and coordinating statistics; and
- Assigning, managing, and analyzing research and development projects.

<u>Department of Road Transport</u>

Under the Ministry of Transport, there is a Department of Road Transport. The main mission and responsibilities of the Department of Road Transport is providing state administration in the field of cargo and international passenger traffic (RSS 2005).

Under the Department of Road Transport, there is a Department of Freight and SOD (State Professional Supervision). Some of the main activities of the Department of Freight and SOD concerning freight transportation are the following (RSS 2005):

- Issuing permits for road transportation of goods, including annual foreign entry permits, and supporting the exchange of such permits;
- Issuing European Conference of Ministers of Transport (CEMT) permits for road haulage;

- Issuing Eurolicense (license for international road transportation of goods) according EU specifications;
- Application of ADR (European agreement concerning the international carriage of dangerous goods) in the Czech Republic, and its integration into the Czech national legislation;
- Supervising the training of drivers involved in the transportation of goods, and issuing of certificates according to ADR regulations.

Road and Motorway Directorate of the Czech Republic

The Road and Motorway Directorate of the Czech Republic (RSD CR) is a national organization created by the Ministry of Transport. Some of the main tasks and responsibilities of this organization are the following (RSD CR 2012):

- Management and maintenance of 1st class motorways (highways) and roads, including its components and facilities;
- Ensures the implementation of the approved transportation policy;
- Management of acquisition and optimal allocation of funds for roads and motorways;
- Administration of road and motorways statistics and documents, and the edition of road maps; and
- Supervised the working of the Centre of Bridges makeshifts.

RSD CR headquarters are located in Prague, and the organization is divided into sections of internal affairs, construction, operations, and commercial and economic sections. There are two motorway division located in Prague and Brno, and 13 regional investment road

administrations in Prague, České Budějovice, Plzeň, Karlovy Vary, Chomutov, Liberec, Hradec Králové, Pardubice, Jihlava, Brno, Olomouc, Zlín and Ostrava (RSD CR 2012).

3.2.2 Associations of Highway Freight Transportation

Associations of highway freight transportation on EU level are scarce, since most countries have specific organizations focused on highway freight transportation on a state level. However, there is a global road transportation organization that was funded by 7 European countries, and nowadays it encompasses most of the world. This worldwide road transport organization is called International Road Transport Union.

International Road Transport Union

The International Road Transport Union (IRU) is a world road transport organization that supports the interest of bus, coach, taxi, and truck operators, and seeks to ensure economic growth and prosperity through worldwide sustainable mobility of people and goods by road. Some of the activities that the IRU is involved in are the following (IRU 2014):

- Partnership of all active members and related organizations to define, develop, and support policies of common interest;
- Monitoring all activities, legislation, policies, and events that impact the road transport industry;
- Cooperation with policy makers, legislators, and opinion-makers for the development of more informed and effective legislation; and

- Training to promote professional competence in the sector, improve the quality of services, and ensure compliance of rod transport training standards with international legislation.

On the other hand, there are road freight organizations that are focused specifically on each country of EU. As an example, the Czech Republic has Česmad Bohemia.

Česmad Bohemia

Česmad Bohemia is an association of road transport operators, and it is the largest organization for domestic and international freight and passenger road transport operators in the Czech Republic. The organization is composed of approximately 2,000 operators of approximately 20,000 vehicles. The organization is involved in the process of developing and amending legislations concerning road transportation, and inter-governmental agreements and treaties in the area. Česmad Bohemia is part of the IRU; therefore, it reacts and complies with important international standards, and influences legislation in EU. The organization provides quality, and reliable services through its regional offices located in economic hubs through the Czech Republic, such as Prague, Brno, Ostrava, Hradec Králové, Ústí nad Labem, České Budějovice and Plzeň (Česmad Bohemia 2011).

The mission of this organization according to its website is "to support the development and prosperity of road transport and, at the same time, protect and promote the interests of companies operating domestic and international road freight transport and bus transport" (Česmad Bohemia 2011).

3.2.3 Volume, Weight and VMT Transported

According to Eurostat, total road freight transport in EU-28 fell by 4% in 2012 when approximately 1,675 billion ton-kilometers of freight where moved by road, compared to the approximately 1,736 billion ton-kilometers in 2011. As can be seen in Table 3.13, in 2012 the majority of EU countries reported a decrease in their total road freight transport compared to 2011. The biggest decrease in road freight transport was observed in Belgium (24%), Italy (13%), and Portugal (10%), while the highest increase in freight road transport was obtained by Bulgaria (15%), and Romania (13%). The Czech Republic reported a decrease in road freight transport of 7% between 2011, and 2012 (Eurostat 2013).

As can be observed in Table 3.13, the member states with highest increase of road freight transport from 2008 to 2012 are Bulgaria (59%), Poland (35%), and Lithuania (15%), while the countries with the most important decrease in road freight transport were Romania (47%), Ireland (43%), and Belgium (35%) (Eurostat 2013).

On the other hand, national road freight transport in EU-28 decreased by 5% from the 1,166 billion ton-kilometers of road freight movement in 2011, to 1,105 billion ton-kilometers in 2012. Only five Member States recorded an increase in national road freight transport (Denmark, Estonia, Lithuania, Romania, and Slovakia), twenty member states reported a decrease in national road freight transport, and two member states remained the same (Luxembourg, and the United Kingdom). The Member States with the highest decrease in national road freight movement were Belgium (18%), Slovenia (15%), Hungary (13%), Italy (12%) and Portugal (12%), while the countries with the highest increase in national road freight were Romania (7%) and Lithuania (5%), although the increase in not highly significant (Eurostat 2013). The Czech

Republic reported a decrease of 4% on national road freight transport from 2011 to 2012. Table 3.14 shows the national road freight transport in EU.

Table 3.13: Total road freight transport in EU (million ton-kilometers)

	2008	2009	2010	2011	2012	Change 2011-2012
EU-28 (1)	1 890 876	1 699 507	1 755 061	1 736 470	1 675 145	-4%
BE	38 356	36 174	35 002	33 107	25 008	-24%
BG	15 322	17 742	19 433	21 214	24 372	15%
CZ	50 877	44 955	51 832	54 830	51 228	-7%
DK	19 480	16 876	15 018	16 120	16 679	3%
DE	341 532	307 547	313 104	323 833	307 009	-5%
EE	7 354	5 340	5 614	5 912	5 791	-2%
IE	17 402	11 687	10 939	10 108	9 976	-1%
EL	28 850	28 585	29 815	20 597	20 839	1%
ES	242 983	211 895	210 068	206 843	199 209	-4%
FR	206 304	173 621	182 193	185 685	172 060	-7%
HR	11 042	9 426	8 780	8 926	8 649	-3%
IT	180 461	167 627	175 775	142 843	124 015	-13%
CY	1 308	963	1 087	941	896	-5%
LV	12 344	8 115	10 590	12 131	12 178	0%
LT	20 419	17 757	19 398	21 512	23 449	9%
LU (2)	8 965	8 400	8 694	8 835	8 835	0%
HU	35 759	35 373	33 721	34 529	33 736	-2%
NL	78 159	72 675	75 783	73 411	68 991	-6%
AT	34 313	29 075	28 659	28 542	26 089	-9%
PL	164 930	180 742	202 308	207 651	222 332	7%
PT	39 091	35 808	35 368	36 453	32 935	-10%
RO	56 386	34 269	25 889	26 349	29 662	13%
SI	16 261	14 762	15 931	16 439	15 888	-3%
SK	29 276	27 705	27 575	29 179	29 693	2%
FI	31 036	27 805	29 532	26 863	25 460	-5%
SE	42 370	35 047	36 268	36 932	33 481	-9%
UK (3)	160 296	139 536	146 685	146 685	146 685	0%
LI	328	263	303	312	280	-10%
NO	20 595	18 447	19 751	19 188	20 171	5%
CH	13 911	13 174	13 237	13 567	12 957	-4%

(1) EU-28: provisional data for reference year 2011 and 2012.
(2) LU: 2011 data was used for reference year 2011.
(3) UK: 2010 data was used for reference year 2011 and 2012.

Source: (Eurostat 2013)

Table 3.14: National road freight transport in EU (million ton-kilometers)

	2008	2009	2010	2011	2012	Change 2011-2012
EU-28 (1)	1 275 582	1 158 491	1 176 691	1 166 140	1 105 258	-5%
BE	18 207	17 603	17 755	17 750	14 521	-18%
BG	7 122	6 306	6 120	6 518	6 286	-4%
CZ	15 748	13 480	14 762	14 985	14 403	-4%
DK	10 718	10 002	10 573	12 025	12 292	2%
DE	264 545	245 568	252 462	265 025	254 499	-4%
EE	1 832	1 326	1 388	1 561	1 599	2%
IE	13 265	8 469	8 221	7 470	7 419	-1%
EL	24 346	24 228	25 256	16 809	16 486	-2%
ES	175 184	151 060	146 194	142 323	133 368	-6%
FR	181 879	156 021	164 325	168 242	156 079	-7%
HR	6 445	5 125	4 547	4 375	4 145	-5%
IT	151 823	145 610	149 248	127 681	111 785	-12%
CY	1 296	944	1 066	923	880	-5%
LV	2 536	2 149	2 561	2 646	2 616	-1%
LT	2 560	2 633	2 292	2 320	2 438	5%
LU (2)	555	530	574	650	650	0%
HU	13 043	12 171	11 329	10 534	9 181	-13%
NL	32 009	31 337	33 782	33 593	32 654	-3%
AT	14 581	13 491	13 914	14 475	14 118	-2%
PL	71 917	79 207	82 218	89 734	89 013	-1%
PT	17 114	14 424	12 881	12 673	11 180	-12%
RO	23 190	20 879	12 096	11 858	12 673	7%
SI	2 636	2 276	2 288	2 177	1 849	-15%
SK	6 319	5 519	5 198	4 906	5 073	3%
FI	27 615	24 394	25 156	23 732	21 928	-8%
SE	37 952	32 123	32 732	33 402	30 370	-9%
UK (3)	151 145	131 616	137 753	137 753	137 753	0%
LI	:	:	:	:	:	-
NO	16 658	15 277	16 344	16 131	16 983	5%
CH	9 813	9 697	9 550	9 912	9 986	1%

(1) EU-28: provisional data for reference year 2011 and 2012.
(2) LU: 2011 data was used for reference year 2011.
(3) UK: 2010 data was used for reference year 2011 and 2012.

Source: (Eurostat 2013)

According to Eurostat, the importance of national road freight transport greatly varies from one member state to another, mainly due to the size of the country, and its geographical location. For example, in 2012 national road freight transport accounted for more than 90% in countries like France, Italy, Cyprus, Sweden, and the United Kingdom, while it accounted for less than 25% in countries like Latvia, Lithuania, Luxembourg, Slovenia, and Slovakia. The

highest percentage of national road freight was obtained by Cyprus with 98%, clearly a result of its geographical location as an island. On the other hand, the lowest percentage of national road freight was obtained by Luxembourg with only 7% of the total road freight haulage moved inside the country, mainly due to the size of the country, and the geographical location between bigger countries like France, Germany, and Belgium (Eurostat 2013).

Table 3.15: Share of international transport on total road freight transport in EU, (% in ton-kilometers)

	2008	2009	2010	2011	2012
EU-28 (1)	33%	32%	33%	33%	34%
BE	53%	51%	49%	46%	42%
BG	54%	64%	69%	69%	74%
CZ	69%	70%	72%	73%	72%
DK	45%	41%	30%	25%	26%
DE	23%	20%	19%	18%	17%
EE	75%	75%	75%	74%	72%
IE	24%	28%	25%	26%	26%
EL	16%	15%	15%	18%	21%
ES	28%	29%	30%	31%	33%
FR	12%	10%	10%	9%	9%
HR	42%	46%	48%	51%	52%
IT	16%	13%	15%	11%	10%
CY	1%	2%	2%	2%	2%
LV	79%	74%	76%	78%	79%
LT	87%	85%	88%	89%	90%
LU (2)	94%	94%	93%	93%	93%
HU	64%	66%	66%	69%	73%
NL	59%	57%	55%	54%	53%
AT	58%	54%	51%	49%	46%
PL	56%	56%	59%	57%	60%
PT	56%	60%	64%	65%	66%
RO	59%	39%	53%	55%	57%
SI	84%	85%	86%	87%	88%
SK	78%	80%	81%	83%	83%
FI	11%	12%	15%	12%	14%
SE	10%	8%	10%	10%	9%
UK (3)	6%	6%	6%	6%	6%
LI	100%	100%	100%	100%	100%
NO	19%	17%	17%	16%	16%
CH	29%	26%	28%	27%	23%

(1) EU-28: provisional data for reference year 2011 and 2012.
(2) LU: 2011 data was used for reference year 2011.
(3) UK: 2010 data was used for reference year 2011 and 2012.

Source: (Eurostat 2013)

According to Eurostat, the increase of total road freight transport from 2008 to 2012 is mainly due to an increase in international road freight transport. Increasing international road freight transports indicates the use of heavier vehicles, carrying heavier loads across longer distances; however, travelling empty trucks are avoided as much as possible. As can be seen in Table 3.15, an increase in the share of international freight transport on the total freight transport is reported for all member states that joined EU in 2004 (including the Czech Republic), except for Estonia, Latvia, and Romania. The countries with the highest increase from 2008 to 2012 were Cyprus (107%), and Bulgaria (39%). On the other hand, most of the remaining member states of EU reported decreases for the same time period, particularly four countries experienced a decrease of the share of international freight transport of more than 20%: Denmark (42%), Italy (38%), Germany (24%), and France (22%) (Eurostat 2013).

Poland is the member state with higher share in the total EU international freight transport (see Figure 3.13) with 23%, and its own share of international freight transport increased from 56% to 60% from 2008 to 2012. The Czech Republic saw an increase of 69% to 72% of its international freight transport share, and has 6.5% share of the total international freight transport (Eurostat 2013).

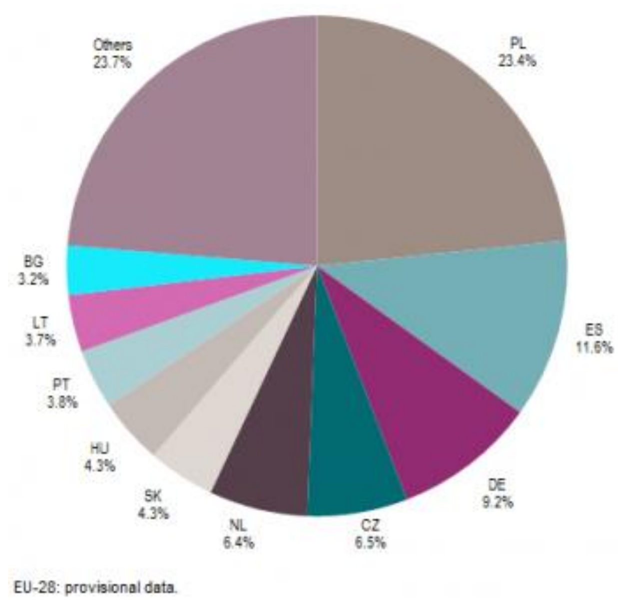


Figure 3.13: Share of each member state in EU-28 total international transport in 2012 (% in ton-kilometers)

Source: (Eurostat 2013)

3.2.4 Major Truck Routes and Truck Volume

European Commission established the Trans-European Network (TEN-T) program to support the construction and improvement of European Union transportation infrastructure. The TEN-T program provides economic support for the implementation of important transport infrastructure projects, in accordance to the overwhelming goal of European competitiveness, the creation of jobs, and cohesion between member states. The TEN-T Executive Agency (TEN-T EA) was created in 2006 to manage all programs under the 2000-2006 and 2007-2013 TEN-T program funding schemes. The projects covered in the program encompass all transportation modes (air, rail, road, and maritime/in-land waterways), logistics, and intelligent transportation systems for all member states. However, on January 2013, the Innovation and Networks

Executive Agency (INEA) succeeded the TEN-T EA. The TEN-T program consists of hundreds of projects with the purpose of ensuring the cohesion, interconnection, and interoperability of the Trans-European Transport Network in all member states, and all modes of transportation. In general TEN-T projects aim to (TEN-T 2014):

- Create and develop the key links and interconnections needed to eliminate the existing bottlenecks to mobility;
- Complete the main routes, and fill in the missing sections, specially at cross-border sections;
- Cross natural barriers; and
- Improve the interoperability on major routes.

However, of the 30 priority projects (chosen by their European added value and their contribution to the sustainable development of transportation) plan to be completed by 2020 on this program, only three of them involved road transportation. The trans-European road network's (composed of highways and high-quality roads) goal is to provide the users with a high, continuous and uniform level of service, comfort, and safety. TEN-T projects involve the adaptation of existing roads, or construction of new roads to meet the program objectives (TEN-T 2014). The trans-European road network can be seen in Figure 3.14.

The TEN-T networks consist of two planning layers, a comprehensive network, and a core network. The comprehensive network is a multi-modal network that provides all European regions with the accessibility to support the movement of their citizens, and further economic, social, and territorial development. The total length of roads that are part of the comprehensive network is 84,945.2 miles (136,706 kilometers). On the other hand, the core network is a part of

the comprehensive network, but it represents the strategically most important nodes and links for global transport flow. The total length of roads in the TEN-T core network is 37,052.4 miles (59,630 kilometers) (European Commission 2014c).

Under the INEA, the Connecting Europe Facility fund (CEF) finances projects to complete the missing links in European energy, transport, digital networks. At the transport sector level, CEF will provide 26.25 billion Euros for EU 2014-2020 budget to co-fund TEN-T projects in the Member States. CEF sets the rules for the awarding of EU funds, priority projects, and the maximum limits for EU co-financing per project type (TEN-T 2014).

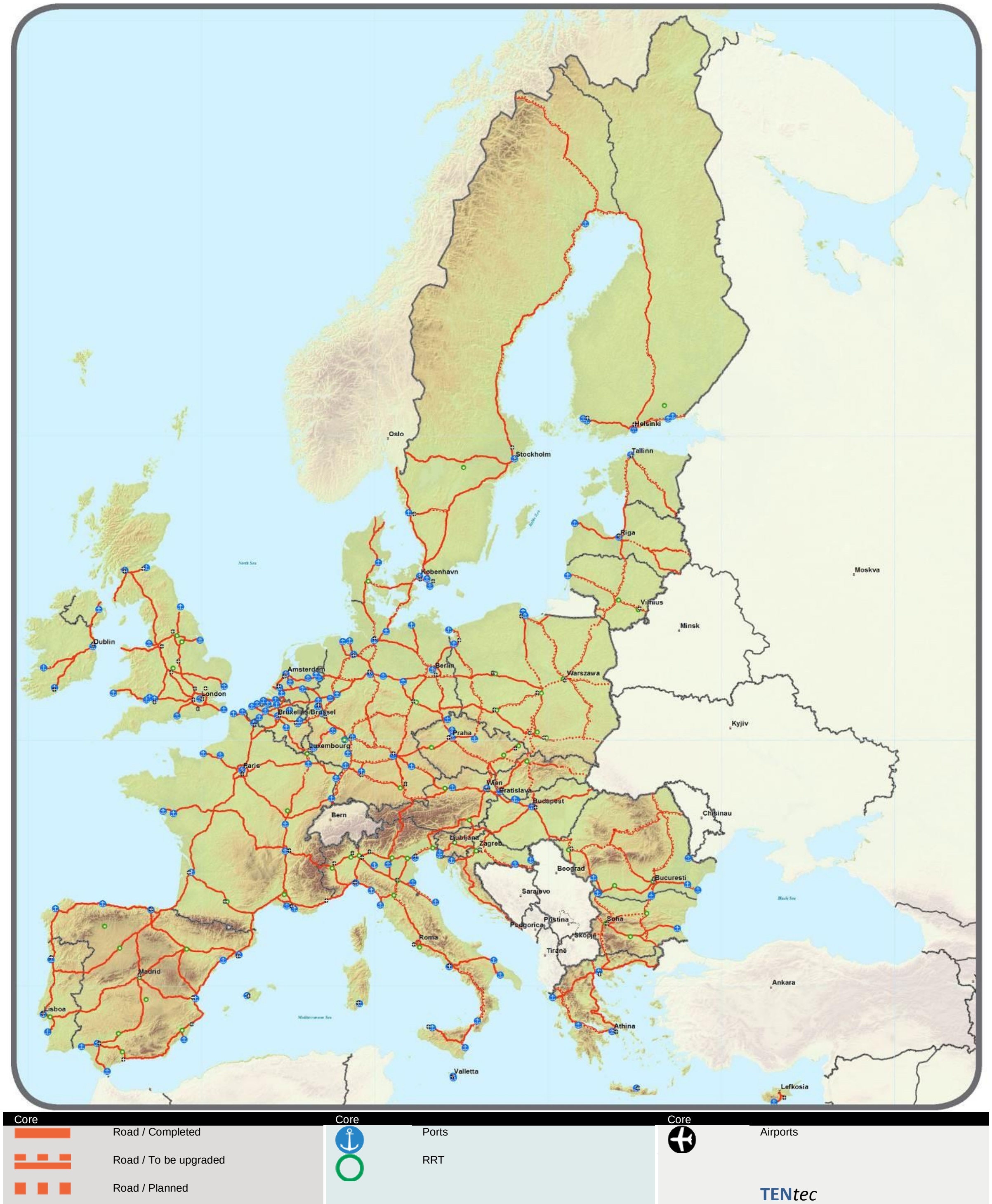


Figure 3.14: TEN-T road network

Source: (*TEN-T 2014)*

Besides the TEN-T road network, there is another European road network called the Pan-European Road Network (see Figure 3.15). These corridors where defined in the Pan-European Transport Conference, in Crete in March 1994, as Central and Eastern European routes that require major investments over the next 15 years. Additions to the Pan-European network were made in the third conference in Helsinki in 1997, and a tenth corridor was added when hostilities between the former Yugoslavian states ended. The objective for developing the Pan-European corridors was to increase the development of transport routes, and to facilitate economic exchange between European countries.

Figure 3.15: Pan-European Road Network

Source: (European Commission 2009)

From Table 3.16, it can be seen that the length of highways in most states of EU have increased from 2005 to 2012; although, some of the data is not readily available, and in some of the states the total length of highways has decreased such as in Cyprus.

Table 3.16: Length of highways in EU

State	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	1,747	1,763	1,763	1,763	1,763	1,763	:	:
Bulgaria	331	394	418	418	418	437	458	541
Czech Republic	564*(r)*	633	657	691	729	734	745	751
Denmark	:	1,071	1,111	1,128	:	:	:	:
Germany (until 1990 former territory of the FRG)	12,363	12,531	12,594	12,645	12,813	12,819	12,845	12,879
Estonia	99	99	96	104	100	115	115	124
Ireland	247	:	269	423	663	:	:	:
Greece	:	:	:	:	:	:	:	:
Spain	11,432	12,073	13,013	13,518	14,021	14,262	14,531	14,701
France	10,800	10,848	10,958	11,042	11,163	11,392	11,412	:
Italy	6,542	6,554	6,588	6,629	6,661	6,668	6,668	:
Cyprus	276	257	257	257	257	257	257	257
Latvia	0	0	0	0	0	0	0	0
Lithuania	417	309	309	309	309	309	309	:
Luxembourg	147*(r)*	147	147	147	152	:	:	:
Hungary	636	785	858	1,273.70	1,273	:	:	:
Netherlands	2,600*(r)*	2,604*(r)*	2,582*(r)*	2,637*(r)*	2,631	:	:	:
Austria	1,677	1,678	1,696	1,696	1,696	1,719	1,719	1,719
Poland	552	663	663	765	849	857	1,070	1,365
Portugal	:	2,545	2,613	2,673	2,705	2,737	2,737	2,988
Romania	228	228	281	281	321	332	350	550
Slovenia	569	579	579	696	747*(p)*	771*(p)*	768*(p)*	769*(p)*
Slovakia	327.5	327.5	364.5	384	391	415.7	419.2	419.2
Finland	693	700	700	739	765	779	790	:
Sweden	1,677	1,744	1,806*(r)*	1,855	1,891	:	:	:
United Kingdom	3,629	3,665*(r)*	3,669	3,673*(r)*	3,673.90	3,673	3,685.70	:
Croatia	1,016*(r)*	1,081*(r)*	1,156*(r)*	1,199*(r)*	1,244*(r)*	1,244*(r)*	1,254	1,254
Former Yugoslav Republic of Macedonia, the	216	216	221	237	251	251	259	:
Turkey	1,667	1,908	1,908	1,922	2,036	2,080	2,119	2,127
Iceland	11*(e)*	:	:	:	:	:	:	:
Liechtenstein	:*(z)*	:*(z)*	:*(z)*	:*(z)*	:*(z)*	:	:	:
Norway	264*(r)*	271	239	253	344	381	393	392

Notes: b: break in time series; c: confidential; d: definition differs, see metadata; e: estimated; f: forecast; i: see meta data; n: not significant; p: provisional; r: revised; s: Eurostat estimate; u: low reliability; z: not applicable; : - not available.

Source: (Eurostat 2014a)

The total annual road freight transportation for EU in 2012 was almost 137 billion vehicle-kilometers. From Table 3.17 it can be seen that Poland had the maximum annual road freight transportation from all Member States, with approximately 20 billion vehicle-kilometers, while Liechtenstein had the minimum with only 21 million vehicle-kilometers.

Table 3.17: Summary of annual road freight transport (million vehicle-kilometers)

State	2005	2006	2007	2008	2009	2010	2011	2012
European Union (27 Countries)	:	:	:	:	:	:	:	136,825
European Union (25 Countries)	:	:	:	:	:	:	:	132,600
European Union (15 Countries)	:	:	:	:	:	:	:	96,390
Belgium	3,355	3,419	3,173	2,678	2,584	2,478	2,392	1,722
Bulgaria	:	1,581	1,658	1,774	1,902	1,944	2,060	2,204
Czech Republic	5,222	5,463	5,279	5,364	4,550	4,876	5,028	4,788
Denmark	2,267	2,210	2,246	2,163	1,863	1,692	1,697	1,691
Germany (until 1990 former territory of the FRG)	28,853	30,243	31,460	31,787	29,142	29,295	30,347	29,106
Estonia	493	497	537	603	433	429	451	438
Ireland	2,522	2,481	2,635	2,373	1,514	1,437	1,337	1,307
Greece	2,491	3,048	2,893	3,068	3,040	3,109	2,208	2,142
Spain	20,160	20,903	22,270	20,637	18,206	17,581	17,200	16,468
France	21,367	21,588	22,053	20,794	18,276	18,966	19,672	18,022
Croatia	:	:	:	1,120	951	879	890	860
Italy	13,864	11,648	11,419	11,196	10,646	11,254	9,027	7,975
Cyprus	196	155	161	210	136	150	151	137
Latvia	840	1,464	1,657	1,030	685	846	966	963
Lithuania	1,413	1,575	1,709	1,645	1,424	1,449	1,626	1,789
Luxembourg	670	682	742	680	531	532	528	525
Hungary	2,491	2,898	3,334	3,295	3,206	3,016	3,058	2,937
Netherlands	9,700	9,769	9,204	9,386	8,994	8,171	8,176	7,645
Austria	3,137	3,391	3,327	3,154	2,778	2,709	2,690	2,512
Poland	13,010	14,276	15,904	16,901	18,099	19,298	19,639	20,480
Portugal	3,986	4,084	4,136	3,633	3,286	3,228	3,163	2,691
Romania	:	3,482	3,529	3,320	2,241	1,647	1,739	2,021
Slovenia	1,104	1,123	1,258	1,423	1,296	1,385	1,389	1,313
Slovakia	3,158	3,010	3,004	3,576	3,438	3,420	3,498	3,365
Finland	2,650	2,541	2,539	2,694	2,420	2,521	2,452	2,138
Sweden	2,683	2,704	2,826	2,929	2,642	2,738	2,669	2,445
United Kingdom	22,271	22,392	22,579	21,212	18,854	18,776	20,347	:
Liechtenstein	30	24	23	22	19	20	21	21
Norway	1,784	1,837	1,887	2,016	1,864	1,958	1,940	2,084
Turkey	:	:	:	1,980	1,925	1,968	1,968	1,918

Notes: b: break in time series; c: confidential; d: definition differs, see metadata; e: estimated; f: forecast; i: see meta data; n: not significant; p: provisional; r: revised; s: Eurostat estimate; u: low reliability; z: not applicable; : - not available.

Source: (Eurostat 2014a)

3.2.5 Accident Rates

According to European Commission, the number of fatalities related to accidents involving Heavy Goods Vehicles (HGV), defined as vehicles over 3.5 tons of Gross Vehicle Weight (GVW), in most EU countries have been decreasing in the last decades except for some special cases like Luxembourg where the number of fatalities increased from 2001 to 2010. As can be seen in Table 3.18, the total number of persons killed in accidents involving heavy good vehicles decreased by 42% from 7,867 persons in 2001 to 4,576 persons in 2010. Although the overall number of fatalities in accidents involving HGV has decreased over the years, still more than 4,800 persons died in HGV related accidents in 2010, which accounts for about one sixth of the total 2010 road accident fatalities in EU (European Commission 2012b).

The scope of injuries caused by accidents involving HGV not only includes the drivers, but also passenger vehicle occupants, motorcycle riders, cyclists, and pedestrians. In 2010, 15% of people killed in HGV accidents in EU were occupants of the HGV; however, 50% of the fatalities are attributed to car occupants, and 15% to pedestrians. More detailed information on the type of casualties on HGV accidents in EU can be seen on Table 3.19 (European Commission 2012b).

Table 3.18: Fatalities in accidents involving heavy goods vehicles in EU-19

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BE	193	178	136	143	161	133	156	122	117	111
CZ	222	234	241	257	240	215	220	169	163	175
DK	78	80	69	65	79	49	66	62	35	36
DE	824	836	815	738	684	719	687	625	536	534
IE	70	42	54	55	51	57	40	44	22	13
EL	220	219	217	181	158	167	141	138	113	127
ES	803	860	834	766	714	659	528	452	353	333
FR	1.057	988	758	727	726	683	658	596	502	552
IT	1.412	1.438	1.312	1.244	1.174	1.140	1.017	977	785	835
LU	6	12	9	6	4	7	7	2	2	9
NL	169	129	158	137	103	129	123	107	95	-
AT	122	143	140	144	126	120	89	107	81	97
PL	1.443	1.474	1.462	1.487	1.425	1.374	1.246	1.155	952	947
PT	197	214	213	187	163	130	145	112	120	95
RO	193	191	224	207	297	263	271	292	252	191
SI	15	19	11	21	21	4	20	7	12	7
FI	118	105	97	107	92	82	97	106	70	92
SE	118	135	92	59	61	83	92	72	45	-
UK	607	561	548	478	510	434	449	380	287	282
EU-19[2]	7.867	7.858	7.390	7.009	6.789	6.448	6.052	5.525	4.542	4.576
Yearly reduction		0,1%	6,0%	5,2%	3,1%	5,0%	6,1%	8,7%	17,8%	-0,7%
EE	-	-	-	-	50	37	35	32	21	-
LV	-	-	-	85	81	81	97	46	38	41
HU	-	-	115	264	251	239	218	173	118	144
MT	-	-	-	-	0	1	0	1	0	1
SK	-	-	-	-	134	122	144	141	69	106
CH	-	-	-	56	-	-	-	39	45	29
IS	-	3	2	4	3	2	4	4	3	1
NO	-	-	-	-	-	-	-	-	-	71

Source: (European Commission 2012b)

Table 3.19: Fatalities in accidents involving HGV in EU-24 by road user type in 2010

	HGVs	
	fatalities	%
HGV occupant	**722**	**15%**
Bus or Coach occupant	23	0%
Car occupant	2.453	50%
Light GV occupant	175	4%
Moped rider	104	2%
Motorcycle rider	328	7%
Pedal cyclist	296	6%
Pedestrian	754	15%
Other/unknown	52	1%
All	4.907	100%

Source: (European Commission 2012b)

As can be seen in Table 3.20, traffic accidents involving HGV can occur in highways, rural and urban roadways, and sometimes the exact location were the accidents happen is unknown. On average, 55% of all fatalities in HGV accidents in 2010 happened on rural areas, while the percentage for countries like Finland, Latvia, Sweden and Spain exceeds 68%. In comparison, only about 15% of fatalities in HGV accidents in 2010 occurred in highways (European Commission 2012b).

Table 3.20: Distribution of fatalities in accidents involving HGV by road type in EU-24 in 2010

	Motorway	Non-motorway		Not known	Total
		Rural	Urban		
BE	31%	47%	23%	0%	111
CZ	7%	62%	30%	0%	175
DK	14%	50%	36%	0%	36
DE	35%	46%	19%	0%	534
EE	0%	0%	0%	100%	21
IE	8%	0%	0%	92%	13
EL	14%	20%	0%	66%	127
ES	25%	69%	5%	0%	333
FR	17%	62%	21%	0%	552
IT	19%	54%	28%	0%	835
LV	0%	78%	22%	0%	41
LU	44%	44%	11%	0%	9
HU	14%	67%	19%	0%	144
MT	0%	0%	100%	0%	1
NL	19%	49%	31%	1%	95
AT	21%	45%	34%	0%	97
PL	1%	58%	30%	11%	947
PT	19%	44%	37%	0%	95
RO	1%	56%	43%	0%	191
SI	29%	29%	43%	0%	7
SK	8%	56%	36%	0%	106
FI	3%	86%	11%	0%	92
SE	9%	76%	11%	4%	45
UK	16%	52%	24%	8%	282
EU-24	15%	55%	24%	5%	4.889
CH	14%	66%	21%	0%	29
IS	0%	100%	0%	0%	1
NO	0%	0%	0%	100%	71

Source: (European Commission 2012b)

According to European Commission SafetyNet Accident Causation Database, the most common specific criteria and events causing accidents are “timing” related, with the higher frequency assigned to drivers that take no action at all. Approximately 52% of timing-related specific criteria are recorded for HGV and bus drivers. Considering the timing of the drivers’ actions, premature and late action are both more frequent for HGV and bus drivers, while no action is more frequent for other drivers and riders involved in the accident. Considering the incorrect direction and surplus speed criteria, other drivers and riders involved in the accident have higher frequencies. Incorrect direction refers to maneuvers performed in the wrong direction (e.g. turning right instead of left), while surplus speed refers to traveling speeds to high for the maneuver being carried out, travelling above speed limit, and at speed unexpected by the other drivers. This two criteria account for approximately 24% for HGV and bus drivers (European Commission 2012b).

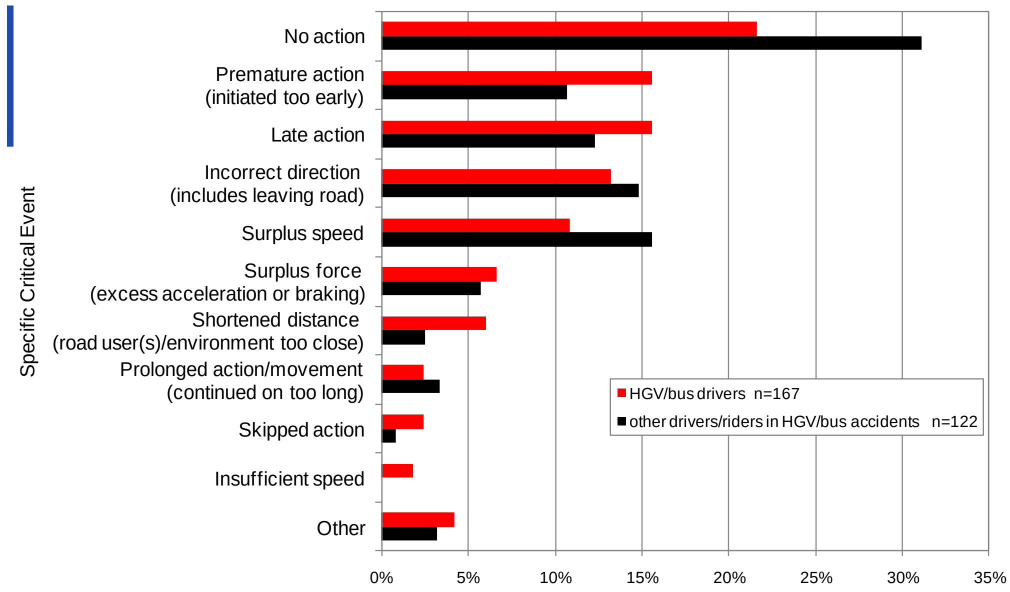


Figure 3.16: Distribution of specific critical events for HGV/bus drivers, and other drivers/riders in HGV/bus accidents in EU

Source: (European Commission 2012b)

Another study performed by the private company Volvo in 2013, on average 7,200 people are killed, and more than 100,000 people are injured in accidents involving heavy trucks (GVW greater than 3.5 tons) each year in EU-27. In Figure 3.16, it can bee seen that approximately 15 to 20% of road user fatalities/injuries that occur in heavy truck accidents are truck occupants. Two main groups of accidents that cause truck occupants fatalities and injuries can be identified: about 50% of the accidents are single vehicle accidents with only one truck involved (type A1 and A2), and about 30% are collisions between two trucks (type A3 and A4) (Volvo 2013).

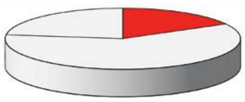
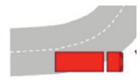
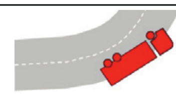
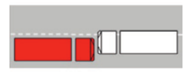
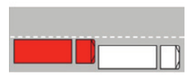
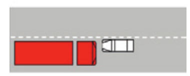
	Road user Group	Type Accident			Frequency
17%	A. Truck Occupants 15-20% 	A1	Truck single Driving off road (with or without rollover)		35%
		A2	Truck single Roll or yaw instability on road		15%
		A3	Truck- truck collision, oncoming traffic Front vs. front		10%
		A4	Truck- truck collision, traffic ahead in same direction Front vs. rear		20%
		A5	Truck-car collision, all collision types (if they cause injuries also to the truck occupants)		5%

Figure 3.17: Traffic accidents involving heavy trucks causing serious to fatal injuries to truck occupants in EU

Source: (Volvo 2013)

However, as seen in Figure 3.17, the largest population of injured people in accidents involving heavy trucks is by far car occupants, accounting for 55 to 65% of the people with serious to fatal injuries. About 65% of the accidents (car and truck collisions) causing car occupant injuries involve the front of the truck (types B1, B3, B4, and B5). The most common accidents resulting in sever to fatal injuries to car occupants is a front-to-front collision between a car and a truck (type B1), mainly due to the relative high speeds, and de high differences of the masses involved. The most common accidents between trucks and cars inside urban areas are changing lane, and merging accident (type B8), although it only accounts for 5% of the total accidents causing injuries to car occupants (Volvo 2013).

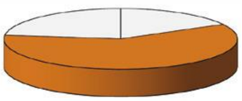
	Road user Group	Type Accident			Frequency
60%	**B. Car Occupants** 55–65% 	B1	Truck- car collision, oncoming traffic Truck front vs. car front,		35%
		B2	Truck- car collision, oncoming traffic, Truck side vs. car front/ side (Sideswipe)		10%
		B3	Truck- car collision, oncoming traffic Truck front vs. car side		5%
		B4	Truck- car collision, traffic ahead in same direction Truck front vs. car rear		10%
		B5	Truck- car collision, intersection Truck front vs. car side		15%
		B6	Truck- car collision, traffic ahead in same direction Car front vs. truck rear		10%
		B7	Truck- car collision, intersection Car front vs. truck side		10%
		B8	Truck- car collision, lane change accident Truck side vs. car side		5%

Figure 3.18: Traffic accidents involving heavy trucks causing serious to fatal injuries to car occupants in EU

Source: (Volvo 2013)

Finally, 15 to 20% of people severely injured in accidents involving heavy trucks are unprotected road users, such as pedestrians, cyclists, and motorcyclists. 60% of accidents between trucks and cyclists occur in urban areas, while 75% between trucks and motorcyclist occur on rural areas. This information can be seen in more detail on Figure 3.18 (Volvo 2013).

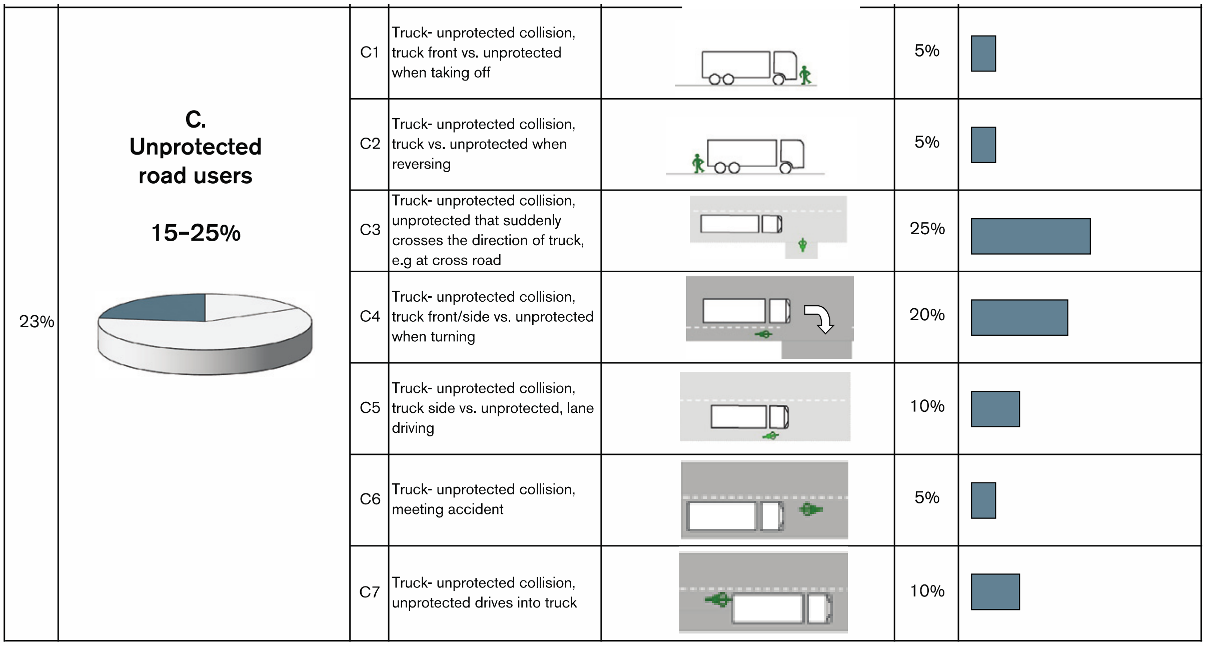


Figure 3.19: Traffic accidents involving heavy trucks causing serious to fatal injuries to unprotected road users in EU

Source: (Volvo 2013)

3.2.6 Major Issues/Concerns in Highway Freight Transportation

According to European Commission (2012a), road transportation in EU generates close to 2 percent of their GDP. Approximately 44 percent of EU goods are transported by road (45.9 percent in 2010), while people also travel mainly by road, as private cars account for 73 percent of passenger traffic. As seen from this statistics, EU road transport sector is facing several challenges, and with one out of four heavy goods vehicles running empty, congestion is one of the main issues EU are facing nowadays. Figure 3.19 shows the intra-EU goods transportation modal split for 2010.

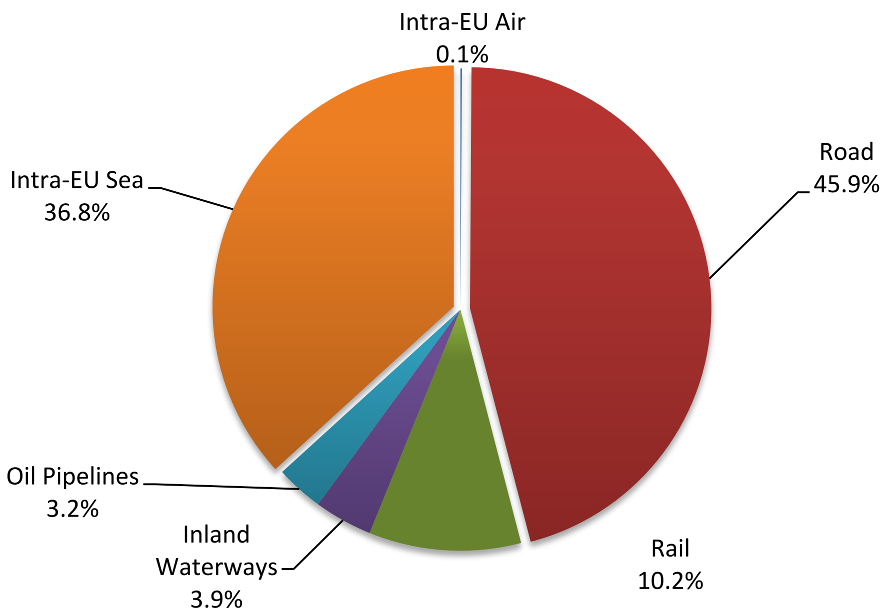


Figure 3.20: Modal split of intra-EU goods transportation in 2010

Source: (European Commission 2012a)

Congestion in EU is not only bothersome for road users, but it also represents inefficiency in the system with huge wastes of fuel and productivity, and increase environmental and noise pollution. Efficiency of the manufacturing processes has decreased, since many manufacturing processes depend on just-in-time deliveries. Therefore, congestions cost EU economy more than 1 percent of GDP, which is more than EU budget (European Commission 2012a). According to European Commission (2013a) data, road freight transportation in EU accounted for 1,734 billion ton-kilometers in 2011, or 45.3 percent of the total goods moved in EU, and has never accounted for less than 42 percent since 1995 (European Commission 2013a). Table 3.21 and 3.22 show EU goods transportation billion ton-kilometers per mode, and modal split respectively.

Table 3.21: Freight transportation in EU by mode

billion tonne-kilometres	ROAD	RAIL	INLAND WATER-WAYS	PIPE-LINES	SEA	AIR	TOTAL
1995	1 289	386	122	115	1 146	2	3 060
1997	1 352	410	128	118	1 193	2	3 202
1998	1 414	393	131	125	1 232	2	3 297
1999	1 470	384	129	124	1 268	2	3 377
2000	1 519	404	134	127	1 314	2	3 499
2001	1 556	386	133	133	1 334	2	3 544
2002	1 606	384	133	128	1 355	2	3 608
2003	1 625	392	124	130	1 378	2	3 652
2004	1 742	417	137	132	1 427	3	3 857
2005	1 794	413	139	136	1 461	3	3 946
2006	1 848	435	138	136	1 505	3	4 064
2007	1 914	448	145	130	1 532	3	4 173
2008	1 881	440	145	125	1 498	3	4 091
2009	1 690	361	130	119	1 336	2	3 639
2010	1 756	391	148	121	1 415	3	3 833
2011	1 734	420	141	119	1 408	3	3 824
1995–2011	34.6 %	8.8 %	15.6 %	3.2 %	22.8 %	25.9 %	25.0 %
per year	1.9 %	0.5 %	0.9 %	0.2 %	1.3 %	1.4 %	1.4 %
2000–2011	14.2 %	4.0 %	5.4 %	– 6.4 %	7.1 %	2.8 %	9.3 %
per year	1.2 %	0.4 %	0.5 %	– 0.6 %	0.6 %	0.2 %	0.8 %
2010–2011	– 1.2 %	7.3 %	– 4.8 %	– 1.7 %	– 0.5 %	– 1.2 %	– 0.2 %

Source: (European Commission 2013a)

Table 3.22: Freight transportation modal split in EU

(%)	ROAD	RAIL	INLAND WATER-WAYS	PIPE-LINES	SEA	AIR
1995	42.1	12.6	4.0	3.8	37.5	0.1
1997	42.2	12.8	4.0	3.7	37.3	0.1
1998	42.9	11.9	4.0	3.8	37.4	0.1
1999	43.5	11.4	3.8	3.7	37.6	0.1
2000	43.4	11.5	3.8	3.6	37.5	0.1
2001	43.9	10.9	3.7	3.8	37.6	0.1
2002	44.5	10.6	3.7	3.6	37.6	0.1
2003	44.5	10.7	3.4	3.6	37.7	0.1
2004	45.2	10.8	3.5	3.4	37.0	0.1
2005	45.5	10.5	3.5	3.5	37.0	0.1
2006	45.5	10.7	3.4	3.3	37.0	0.1
2007	45.9	10.7	3.5	3.1	36.7	0.1
2008	46.0	10.7	3.6	3.1	36.6	0.1
2009	46.5	9.9	3.6	3.3	36.7	0.1
2010	45.8	10.2	3.8	3.1	36.9	0.1
2011	45.3	11.0	3.7	3.1	36.8	0.1

Source: (European Commission 2013a)

According to European Commission (2008), long-distance freight traffic, especially international freight movement between EU members' states, and between EU states and third countries are contributors to the increasing road congestion. European road system has taken the biggest toll of increasing freight traffic due to the failure of alternative modes (rail and shipping) to cope with the rising demand. Thus, what EU needs and is working to achieve is a sustainable transport system that shifts freight off the roads and into alternative and more environmental friendly modes of transportation. There have been attempts to tackle the congestion issue, like the currently running Marco Polo Programme, which aims at shifting or avoiding the increasing international freight traffic (estimated at 20 billion ton-kilometers per year) from roads to short sea shipping, rail, and inland waterway transportation modes (European Commission 2008).

There is also an existing regulation, Regulation (EU) No 913/2010 of European Parliament and of the Council, which main goal is the establishment of international market oriented Rail Freight Corridors (RFCs) as an essential factor towards sustainable mobility. The goal is to create efficient RFCs in order to reduce the freight traffic on EU roads, and shift a percentage into rail transportation. This regulation encourages member states to establish RFC to meet the following challenges (European Parliament and Council 2013):

1. Strengthen the co-operation of infrastructure managers in aspects such as allocation of paths, and infrastructure development;
2. Finding the right balance between passenger and freight traffic along RFCs, ensuring adequate capacity for freight market needs, and time targets;
3. Promoting intermodality by integrating terminals in the RFCs management system.

According to the mentioned Regulation (EU) No 913/2010, there are a total of 9 RFCs, as shown in the dimension and time schedule scheme of RFCs in Figure 3.20. As an example, one of the 9 RFCs to be implemented, and that would help reduce congestion and pollution on Eastern Europe is the Czech-Slovak Rail Freight Corridor (RFC9 – CS Corridor). The CS corridor is define by the regulation as follows: Praha – Horní Lideč / Bohumín / Havířov / Žilina – Košice – Čierna nad Tisou (alternatively Maťovce) – Slovak-Ukrainian border (CZDC 2014). The CS route is shown in Figure 3.21 (European Parliament and Council 2013).

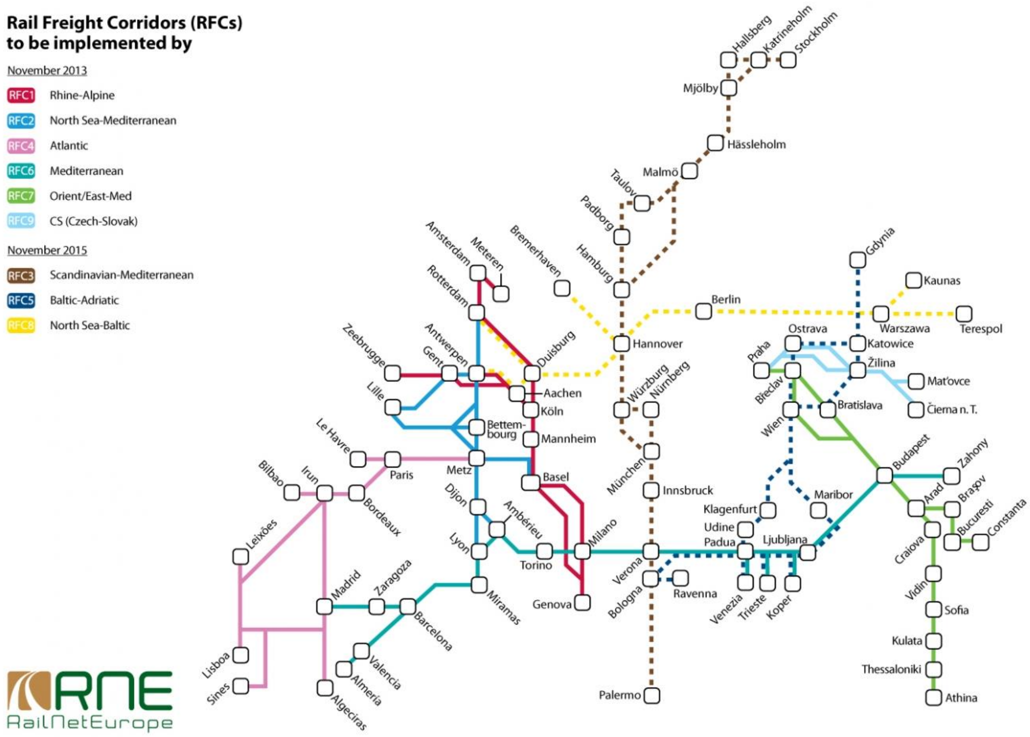


Figure 3.21: Rail freight corridors

Source: (RNE 2014)

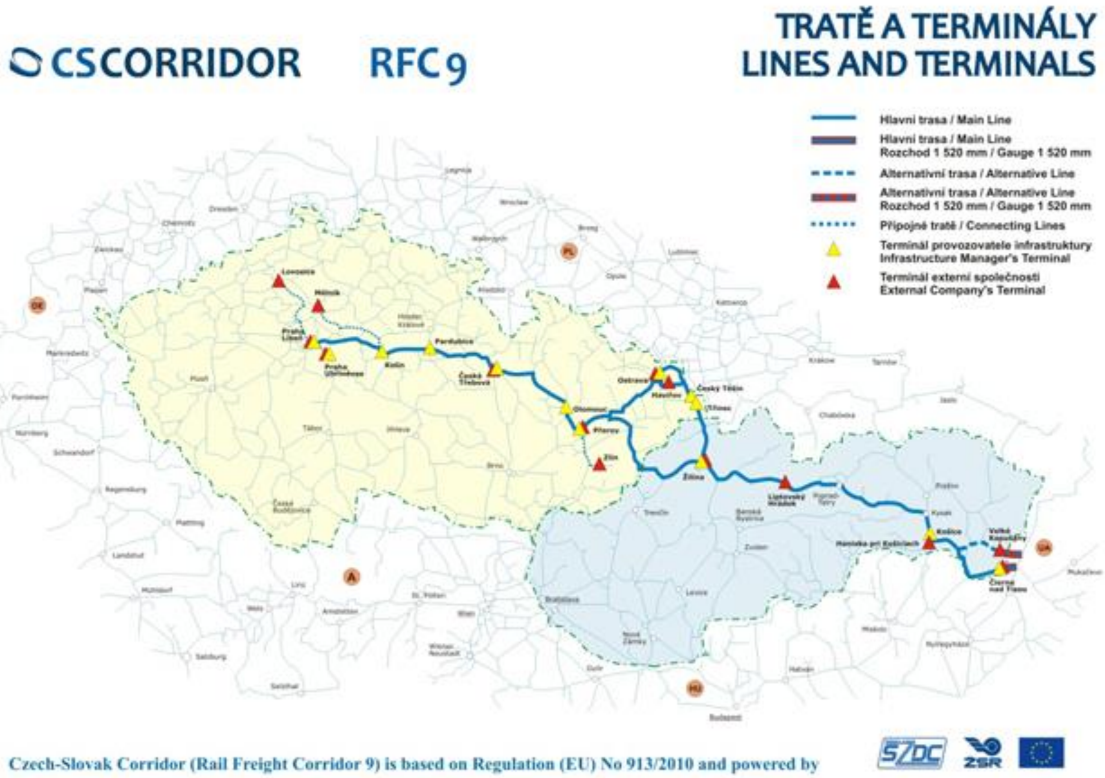


Figure 3.22: Czech-Slovak Rail Freight Corridor

Source: (SZDC 2014)

3.2.7 Highway Infrastructure Financing

European Union has created a framework to encourage EU member states to implement, where taxation and infrastructure charging are used in the most efficient and reasonable way in order to maintain and develop the trans-European infrastructure network through two basic ideologies: the “user pays” and “polluter pays” principles. The framework also contributes to the incorporation of the road transport related external costs, such as the usage of the infrastructure network, and its environmental and social impacts. Road usage is also used as a tool for

generating new sources of revenue, and helps develop Europe's infrastructure, as well as less energy consuming and cleaner modes of transportation. As mentioned before, to help achieve these goals, EU uses several instruments such as vehicle and fuel taxation, and road infrastructure charging (European Commission 2013b).

European Commission provides minimum rates for the annual vehicle taxation on heavy goods vehicles, according to the numbers of axels, and the maximum permissible Gross Vehicle Weight (GVW). However, the structure of taxes, and the procedures for imposing and collecting them falls under the competence of each member state national authorities (European Commission 2013b).

EU has a harmonized structure for charging fuel taxes. However, the rate still differs form one member state to another. Fuels such as petrol (gasoline), gas oil, kerosene, natural gas, etc. are subject to two types of taxes: a Value Added Tax (VAT), and excise duties (indirect tax on the consumption of energy products) which differs depending on EU member state (European Commission 2013b).

EU has a set of common rules on distance-related (toll), and time-based (vignettes) user charges for heavy goods vehicles above 3 tons for the use of certain infrastructure (see Figure 3.22). These rules dictate that the cost of construction, operating, and developing infrastructure can be covered by the implementation of tolls and vignettes to road users. The regulatory structure aims at reducing the differences in levels and systems of tolls and vignettes applied in Member States. Although the application of tolls and vignettes is not required by EU, there are certain rules that member states are required to follow if they decide to implement this kind of road user charges, this set of rule is the following (European Commission 2013b):

- Tolls must be imposed according to the distance traveled, and type of vehicle; vignettes are adjusted according to the time spent using a specific infrastructure, and the vehicle's emission class;
- EU does not allow for tolls and vignettes to be imposed at the same time for the same single road section. The only exception is for tolls applied to bridges, tunnels, and mountain passes in vignette zones;
- National tolls and vignettes must be non-discriminatory, excessive discounts on tolls are forbidden;
- Charging systems should minimize the disruption of traffic free flow, avoiding mandatory checks at EU's internal borders;
- The maximum average tolls must be set in accordance to the cost of constructing, operating, and developing the infrastructure concerned. New tolling systems must be notified to EU;
- Tolls may include an "external cost charge" to account for the cost of air pollution, and noise pollution;
- The revenues collected from these systems should preferably be used to develop the trans-European network.

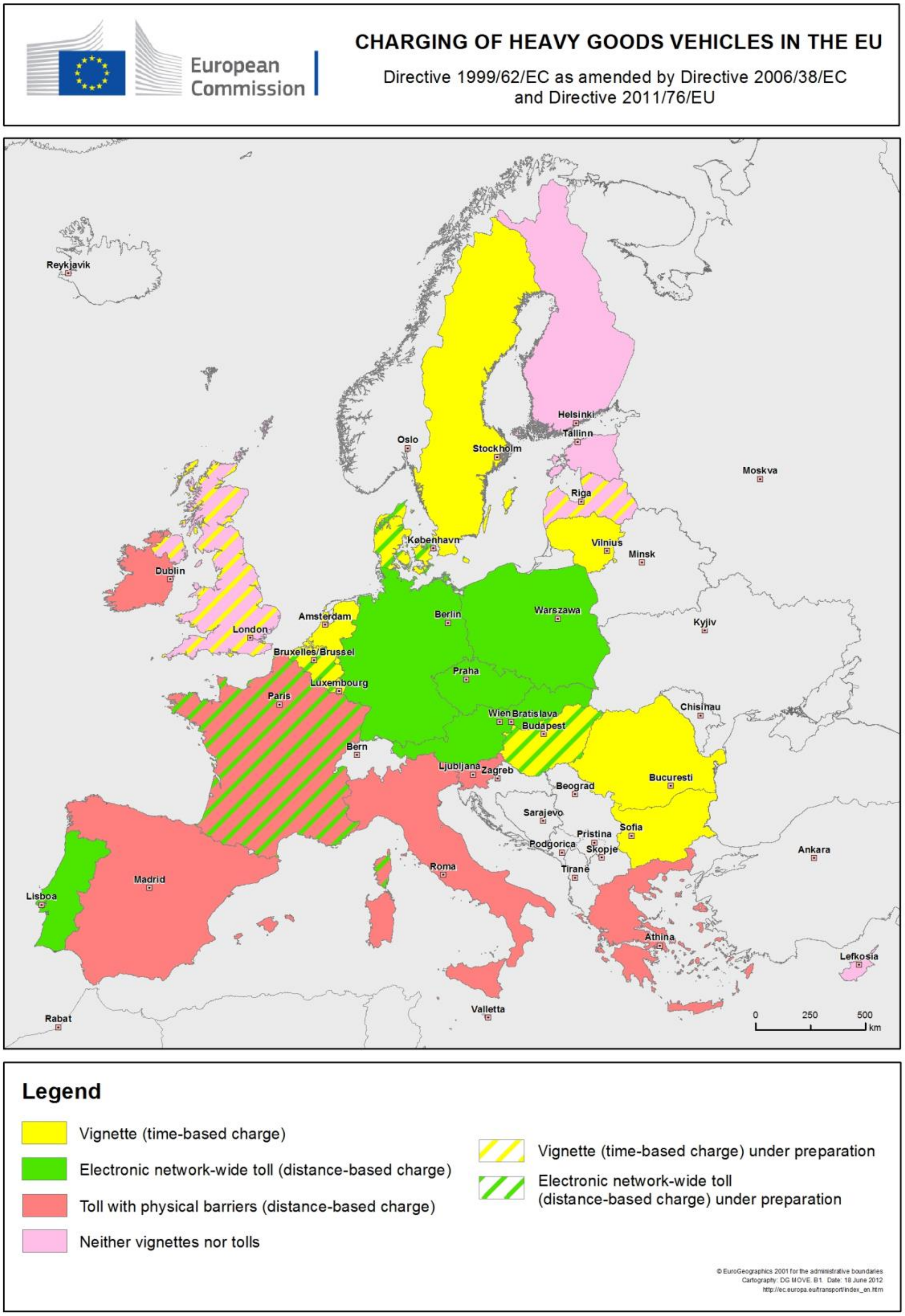


Figure 3.23: Charging of heavy goods vehicles in EU

Source: (European Commission 2013b)

EU allows member states to cooperate for the purpose of introducing a common system of electronic vignettes. For example, Belgium, Denmark, Luxemburg, the Netherlands, and Sweden have a common system for charging heavy good vehicles above 12 tons called the "Eurovignette" system. This system allows truckers to use roads from the specified member states after paying a specified amount; however, each country is responsible for charging Eurovignette in their own territory (European Commission 2013b).

The Czech Republic will serve as an example of highway infrastructure financing in individual member states. The Státní Fond Dopravní Infrastruktury (SFDI), or the State Fund for Transport Infrastructure's goal is the development, construction, maintenance, and modernization of roads, highways, railways, and waterways in the Czech Republic. The fund not only finances the construction and maintenance of roads, but it also contributes to research, project works, and education related to transport infrastructure. The income for the fund comes from the revenue of road taxes, a percentage of the excise duties on hydrocarbon fuels and lubricants, and revenue raised by fees on highways (vignettes and toll). The purpose of this system is to return some of the revenue acquired from transport to develop transport infrastructure. Another source of funding comes from European Commission, and at the end of each fiscal year, the remaining (if any) income is carried over to the next fiscal year (SFDI 2014).

According to the State Fund for Transport Infrastructure, road-use fees have been in effect in the Czech Republic since 1995, currently the fee pricing is determined by the type of vehicle, distance traveled on a toll road, or by time period for the use of toll roads. The largest permissible weight allowed on toll roads is 3.5 tons, and motorcycles can travel through the toll roads free of charge. The time-based fees can be purchased for a calendar year, a month, or ten

days, with the available annual, monthly, and ten-days vignettes. A map of toll roads and highways in the Czech Republic is presented in Figure 3.23 (SFDI 2014).

Figure 3.24: Map of toll and time-fee sections in the Czech Republic

Source: (SFDI 2014)

Fees for the annual, monthly, and ten-day vignettes are 1500 Kč ($75), 440 Kč ($22), and 310 Kč ($15.5) respectively. However there are exceptions for the fees on toll roads and highways, that are mainly for official vehicle of the Czech Republic government (police, military, customs, fire department, etc.), or every vehicle in the case of detours due to the closing

of other roads, and finally in the case of a warning or regulation signal for PM 10 particles until the signal stops (SFDI 2014).

Furthermore, the Czech Government Regulation Nr. 26/2010 Coll. stipulates toll rates according to the length of the section of road, and vehicle category depending on number of axels, and emission class. Vehicles with at least four wheels, and a GVW exceeding 3.5 tons are liable to toll payment in the Czech Republic. The operation of the electronic toll system in the Czech Republic is based on microwaves; the tolling system is installed in tolling stations that communicate with an on-board electronic device in the vehicles. Passing under a tolling station automatically charges the on-board unit for the specific tolled section. When passing through a toll gantry, an acoustic signal is triggered in the on-board unit that alerts the driver that a transaction has taken place; the tolling process is fully automatic and requires no intervention on the part of the driver. A map of the tolled roads and highways in the Czech Republic is shown in Figure 3.24 (MYTO CZ 2014).

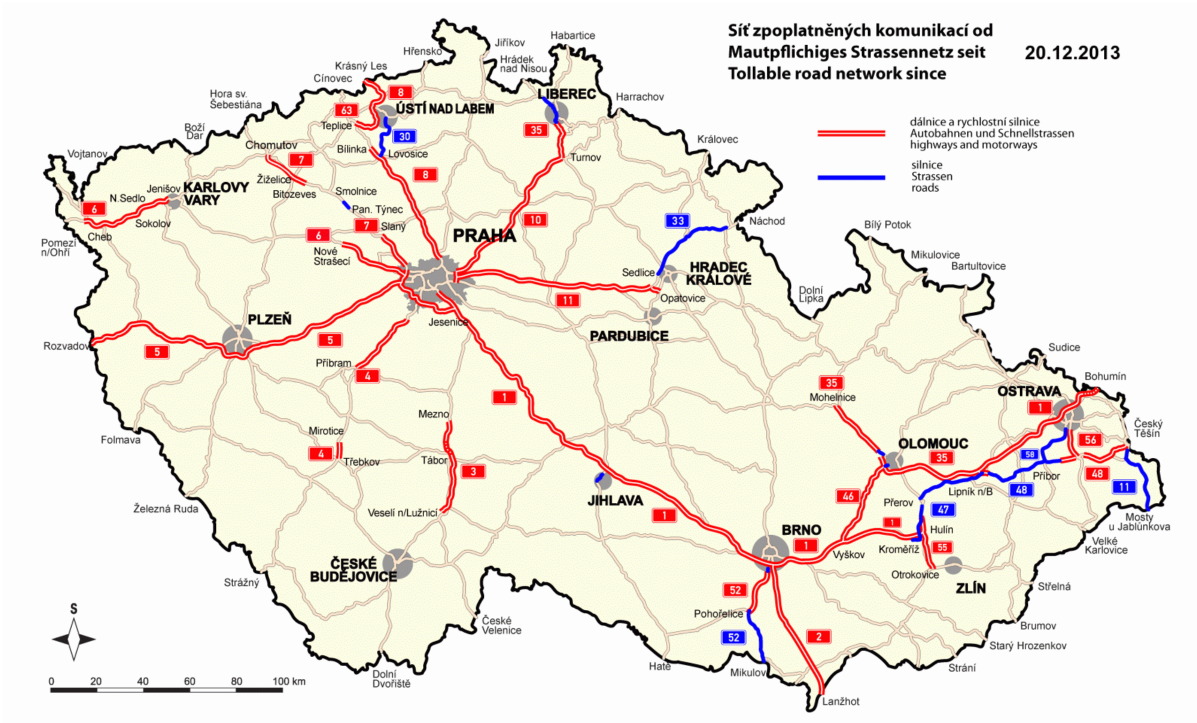


Figure 3.25: Tollable road network in the Czech Republic

Source: (MYTO CZ 2014)

The toll rates imposed by MYTO CZ for trucks on toll rods for most weekdays and Fridays are shown in Tables 3.23 and 3.24 (MYTO CZ 2014). Average currency exchange rate according to the Czech National Bank is 19.798 and 27.445 per 1 US Dollar, and 1 Euro respectively.

Table 3.23: Toll rates for trucks in most weekdays in the Czech Republic

Toll Rates for Trucks [CZK/km] in most of weekdays									
	Emission Class EURO 0-II			Emission Class EURO III-IV			Emission Class EURO V+		
	Axles								
	2	3	4+	2	3	4+	2	3	4+
Highways	3,34	5,67	8,24	2,61	4,45	6,44	1,67	2,85	4,12
Roads	1,58	2,74	3,92	1,23	2,14	3,06	0,79	1,37	1,96

Source: (MYTO CZ 2014)

Table 3.24: Toll rates for trucks on Fridays from 3:00 p.m. to 8:00 p.m.

Toll Rates for Trucks [CZK/km] in most of weekdays									
	Emission Class EURO 0-II			Emission Class EURO III-IV			Emission Class EURO V+		
	Axles								
	2	3	4+	2	3	4+	2	3	4+
Highways	4,24	8,10	11,76	3,31	6,35	9,19	2,12	4,06	5,88
Roads	2,00	3,92	5,60	1,56	3,06	4,38	1,—	1,96	2,80

Source: (MYTO CZ 2014)

3.2.8 Major Logistics Hubs/Centers

The global commercial real state services organization Colliers International conducted a study on the top European logistic hubs considering the following factors (Colliers 2013):

1. **Infrastructure and Accessibility** – each location is scored in terms of its accessibility to European ports (market entry points), and the quality of the existing transportation infrastructure.
2. **Market Access** – the size of the surrounding catchment area in terms of population, and current and forecasted GDP.
3. **Operational Base Costs** – basic operational costs including labor, rental, and land costs.
4. **Labor Market Capacity** – the size of the working and unemployed populations.

5. **Logistics Competence** – specialized workforce, and logistics indices.
6. **Business Environment** – simplicity of doing business.

Additionally, in order to determine the relative attractiveness of the cities, different weights were applied to each of the past categories depending on 3 scenarios: Balanced, Distribution, and Manufacturing scenarios (Colliers 2013).

The distribution scenario was considered of most relevance for this study; hence the results of the Colliers International study presented here are only based on the weights assigned to the mentioned criteria focusing on a distribution perspective.

The proximity to final consumer markets, and the presence of a reliable and well-developed transportation infrastructure for the movement of goods is essential for companies active in the distribution business. Therefore, in the distribution scenario, the highest weight was assigned to the "Market Access" (45%), and the "Infrastructure and Accessibility" (25%) factors. The results from the study indicate that cities from the "Blue Banana" (an economically advantageous region due to it population density, urbanization, and good transportation infrastructure) dominate the top logistics hubs positions (see Figure 3.25). Antwerp occupied the first place on the list, closely followed by other Belgian-Dutch-German cities like Rotterdam, Brussels, Dusseldorf, and Hamburg; the top logistics hubs can be seen in Table 3.25. The top hub cities are strategically located at the economic core of Europe, which spans the region stretching from the Netherlands, Belgium, Western and Southern Germany, Switzerland, and the North of Italy. Distribution companies seeking to reach a large number of customers as quickly as possible, logically choose to operate in the more rich and densely populated area in Europe (Colliers 2013).

Figure 3.26: Blue Banana Region and logistics hubs considered in Europe

Source: (Colliers 2013)

Table 3.25: Top European Logistics Hubs

1	Antwerp
2	Rotterdam
3	Dusseldorf
4	Brussels
5	Hamburg
6	Amsterdam
7	Liege
8	Venlo
9	Lille
10	Frankfurt
11	Paris
12	Munich
13	Lyon
14	Prague
15	Milan
16	Le Havre
17	Bratislava
18	Rijeka/Koper
19	Bologna
20	Istanbul

Source: (Colliers 2013)

From Antwerp, for example, approximately 143 million people can be reached by truck in 9 hours. The population that can be reached in 9 hours by truck increases in other cities like Liege (153 million), Dusseldorf (163 million), and Frankfurt (190 million), which has the highest population within its catchment area from all the cities considered, approximately equal to three times the population of the United Kingdom. In terms of Gross Domestic Product (GDP), this amount to approximately 6,000 billion Euros, or about three times France's nominal GDP (Colliers 2013).

The high score obtained by cities located within the "Blue Banana" region can also be attributed to its privileged location near Europe largest freight seaport and airports, which provides the continent with gateways to non-European markets, and through which most goods

entering and exiting Europe transit. Consequently, having their distribution centers located neat this entry points is a decisive factor deciding location for many companies. However, some cities such as Dusseldorf (4th place), and Liege (7th place) benefit from their location not exactly close to the entry points, but along the corridors through which a large volume of freight unloaded in Antwerp, Rotterdam, and Amsterdam transit toward inland Europe (Colliers 2013).

Not considering Western Europe, the city the obtained the highest rank on the distribution-driven scenario is Prague (14th place), followed by Bratislava (17th place). From Prague, there is a consumer population of approximately 150 million people reachable in 9 hours by truck, equivalent to a GDP of about 4,000 billion Euros, against a national GDP for the Czech Republic of 130 billion Euros. The potential appeal of these two cities roots from the lower cost of inputs, like labor and real state, with rents for top distribution space in Bratislava averaging 25% less than Western European countries, and employee remuneration amounting only a third of the compensation paid in the Netherlands (Colliers 2013).

The cost/market access trade-off is illustrated in Figure 3.26. Some of the cities that offer an especially good compromise between cost and access to market include, from highest to least expensive, Venlo, Lille, Liege, Prague, Bratislava, Upper Silesia (Katowice), and Poznan (Colliers 2013).

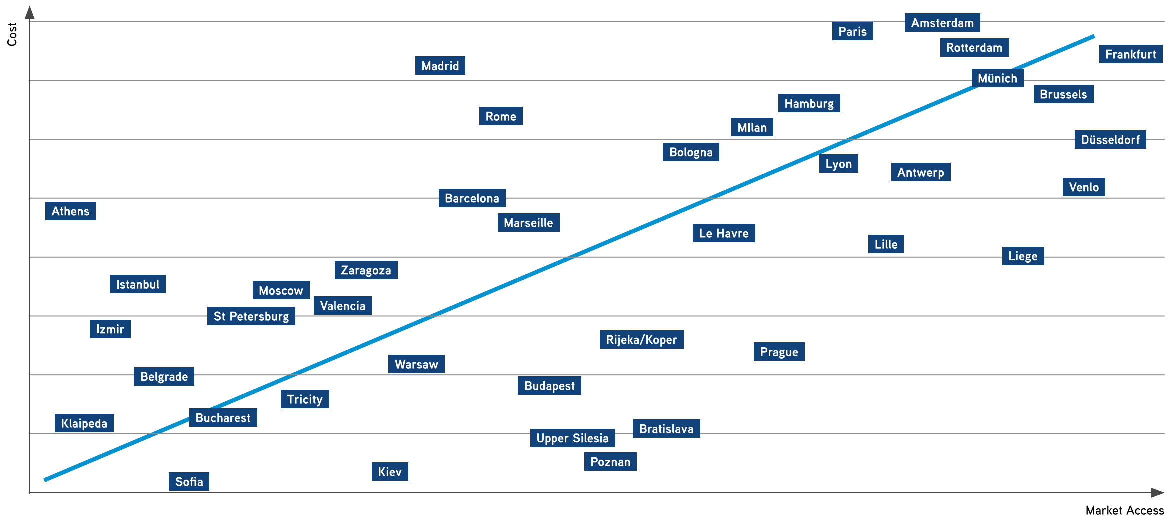


Figure 3.27: Correlation between cost and market access in European hubs

Source: (Colliers 2013)

Finally, the analysis performed by Colliers International showed that a further shift eastward towards a further reduction in total costs would also mean a reduction in market accessibility, which it assumes as an essential factor in the distribution-driven scenario. There is already a need for certain goods to be distributed to Central and Eastern Europe markets, and for the finished products to be distributed back into the production lines of Western European companies; however, infrastructure and market access are still a limiting constraint for Central and Eastern European hubs to act as competitors to the already more stable Western European hubs within the "Blue Banana" region. Figure 3.25 shows the 15 cities with the largest consumer population catchments (Colliers 2013).

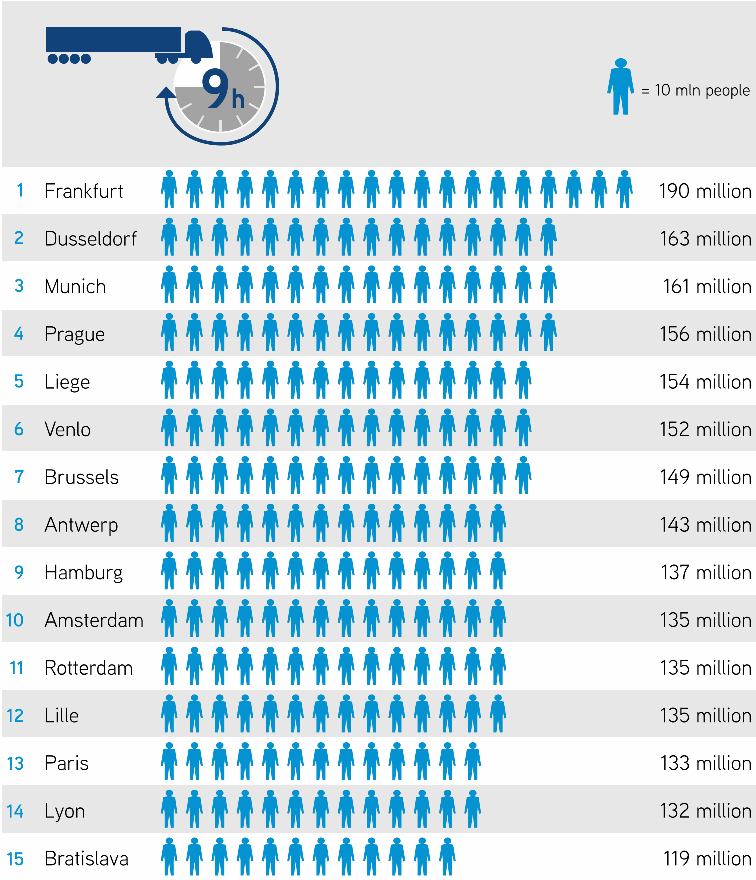


Figure 3.28: Top 15 Population catchments per city in Europe

Source: (Colliers 2013)

Chapter 4: Analysis of Truck Trip Generation Rate and Accident Frequency

This chapter analyzes inbound and outbound truck volume flow generated by several warehousing areas in El Paso, Texas, and truck-related traffic accidents occurring in close vicinity of the warehousing complexes. Truck volume data from El Paso was collected at four selected sites, and then correlated with parcel areas of the warehousing complexes, and traffic accidents involving trucks obtained and filtered from the Texas Department of Transportation (TxDOT) crash records. The purpose of this correlation analysis is to determine the relationship between these three variables, and how they influence freight traffic movement in El Paso.

4.1 El Paso Site Descriptions

Video recording of truck movements (in both directions) along the main road was performed at four site locations. Traffic movements were recorded during three days (Monday, Wednesday, and Friday), and two times a day (from 6:00 a.m. to 10:00 a.m., and from 12:00 p.m. to 3:00 p.m., except for site 4 which lasted until 4:00 p.m.). Time and days of the recordings were chosen as per recommendations of Kuehne and Nagel, which coincide with the opening hours of the commercial lanes on the El Paso international bridges. Detailed tables containing morning and afternoon truck volume flow for all four locations are available in Appendix A. There are six international bridges located in a 45-mile stretch of U.S.-Mexico border, comprising two U.S. states (Texas and New Mexico) and one Mexican state (Chihuahua). The six international bridges in the El-Paso Juarez region are (see Figure 4.1):

- **Santa Teresa**, located in Dona Ana County, New Mexico. Non-tolled facility.

- **Paso del Norte Bridge (PDN)**, handles northbound automobile traffic and northbound and southbound pedestrian traffic. Tolled facility.
- **Stanton St. Bridge**, handles mostly southbound vehicular traffic. Tolled facility.
- **Bridge of the Americas (BOTA)**, handles more than half of all international passenger and commercial crossings in the region. Non-tolled facility.
- **Ysleta-Zaragoza Bridge**, located in Eastern El Paso. Tolled facility.
- **Fabens-Caseta Bridge**, is a small, light-duty bridge.

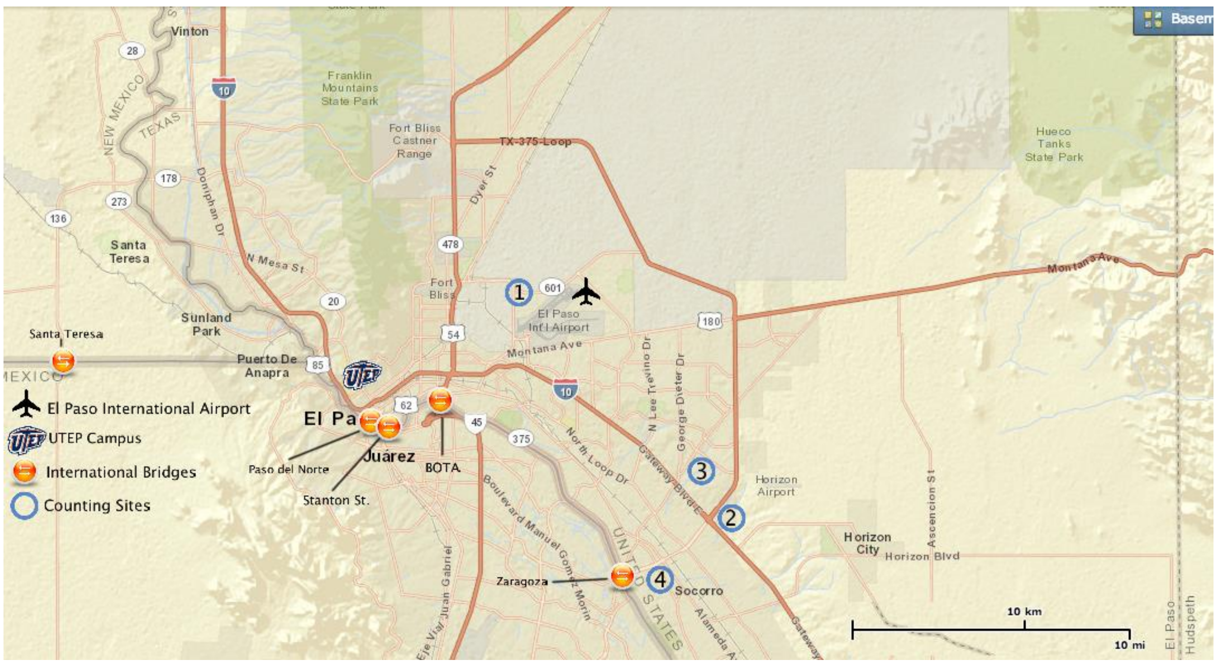


Figure 4.1: El Paso international bridges, counting sites and important landmarks

Only four of the mentioned international bridges have operating commercial lanes, which are the following:

- Santa Teresa – one Commercial Lane;

- BOTA – six Commercial Lanes; and
- Ysleta-Zaragoza – eight Commercial Lanes.

Industrial zones in the El Paso region are shown in Figure 4.2, along with the location of the four counting sites, important landmarks in El Paso such as the international bridges, UTEP campus, and El Paso International Airport.

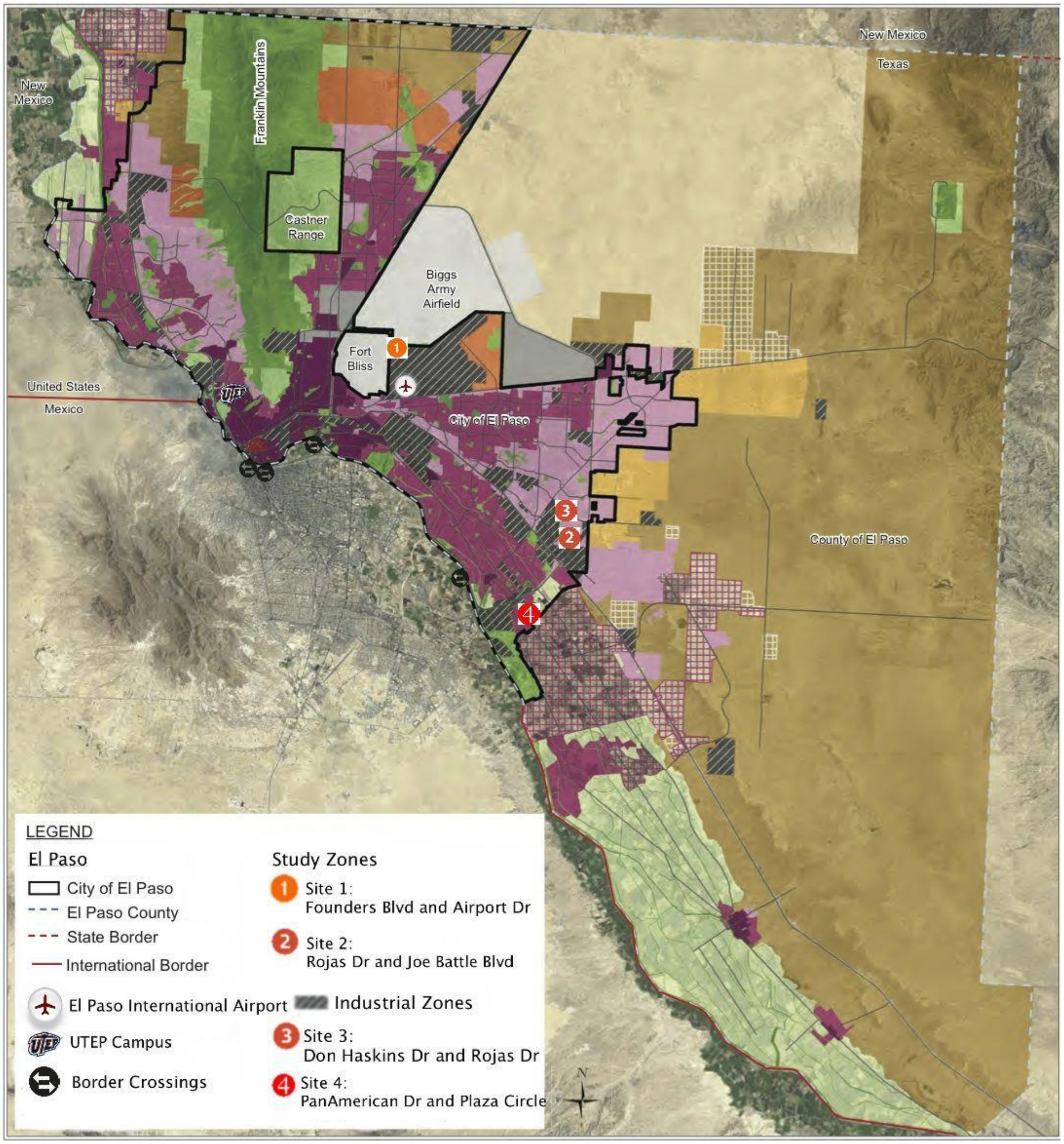


Figure 4.2: El Paso site locations, industrial zones and important landmarks

4.1.1 Site 1: Founders Blvd and Airport Dr

Site 1 is located in the intersection of Founders Boulevard, and Airport Drive. This site was chosen because at the time of the study, this intersection was the main entrance/exit for

trucks heading to warehouses located near the airport (approximately 2.5 miles from the airport). Another two intersections near the catchment area considered could be used as entrance/exit points; however, at the time of the study both intersections where closed due to constructions activities (lane closures). Founders Boulevard, Airport Drive, and El Paso International Airport serve as boundaries for the catchment area. An aerial picture of site 1 and the catchment area is shown in Figure 4.3.

Figure 4.3: Aerial picture of site 1

4.1.2 Site 2: Rojas Dr and Joe Battle Blvd

Site 2 is located in the intersection of Rojas Drive, and Joe Battle Boulevard. This site is located near a warehouse complex (right side of Figure 4.2) on the east side of El Paso, and it was chosen because of its easy access to the interstate highway I-10 (El Paso's main highway), and the Texas State Highway Loop 375 which runs directly into the Ysleta-Zaragoza International Bridge. Rojas Drive, Mercantile Avenue, and empty land serve as boundaries of the catchment area. Figure 4.4 shows an aerial view of site 2 and the catchment area.

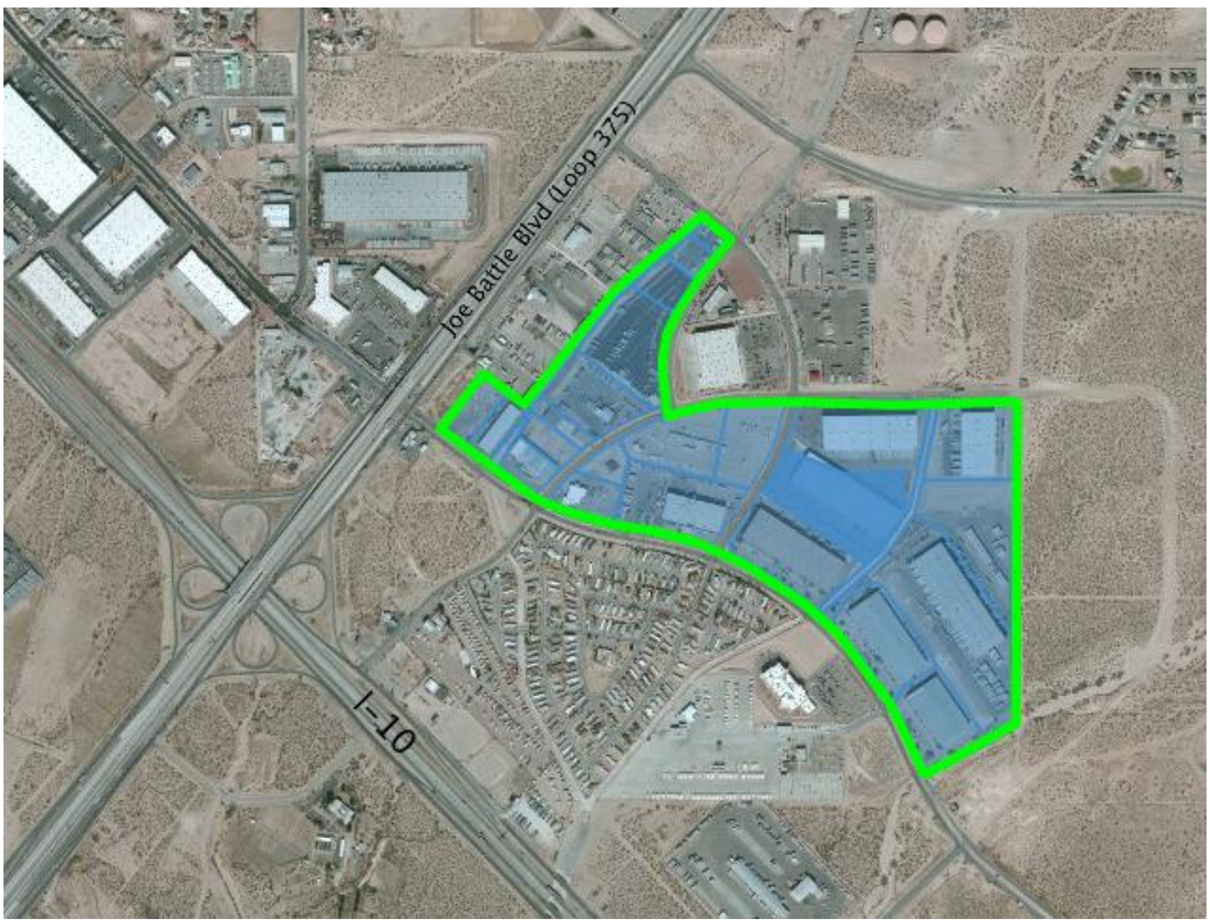


Figure 4.4: Aerial picture of site 2

4.1.3 Site 3: Don Haskins Dr and Rojas Dr

Site 3 is located in the intersection of Don Haskins Drive, and Rojas Drive. This site was chosen near a warehouse complex located along Don Haskins Boulevard, on the east side of El Paso. The site was chosen because from previous site reconnaissance, it was observed that Don Haskins Boulevard provides access between the warehouses near the zone, and the interstate highway I-10 (which is the major highway in the city). Figure 4.5 shows an aerial picture of Site 2, and part of the catchment area (center of the picture).

Figure 4.5: Aerial picture of site 3

4.1.4 Site 4: Pan American Dr and Plaza Circle

Site 4 is located on the intersection of Pan American Drive, and Plaza Circle. Plaza Circle serves as the boundary for site 4. The site was chosen near a warehouse complex with easy access to the Texas State Highway Loop 375 through Pan American Drive (the only access to the warehouse complex). This site was chosen because it is located approximately 2.5 miles from the Ysleta-Zaragoza International Bridge. Figure 4.6 shows an aerial view of site 4, and the catchment area.

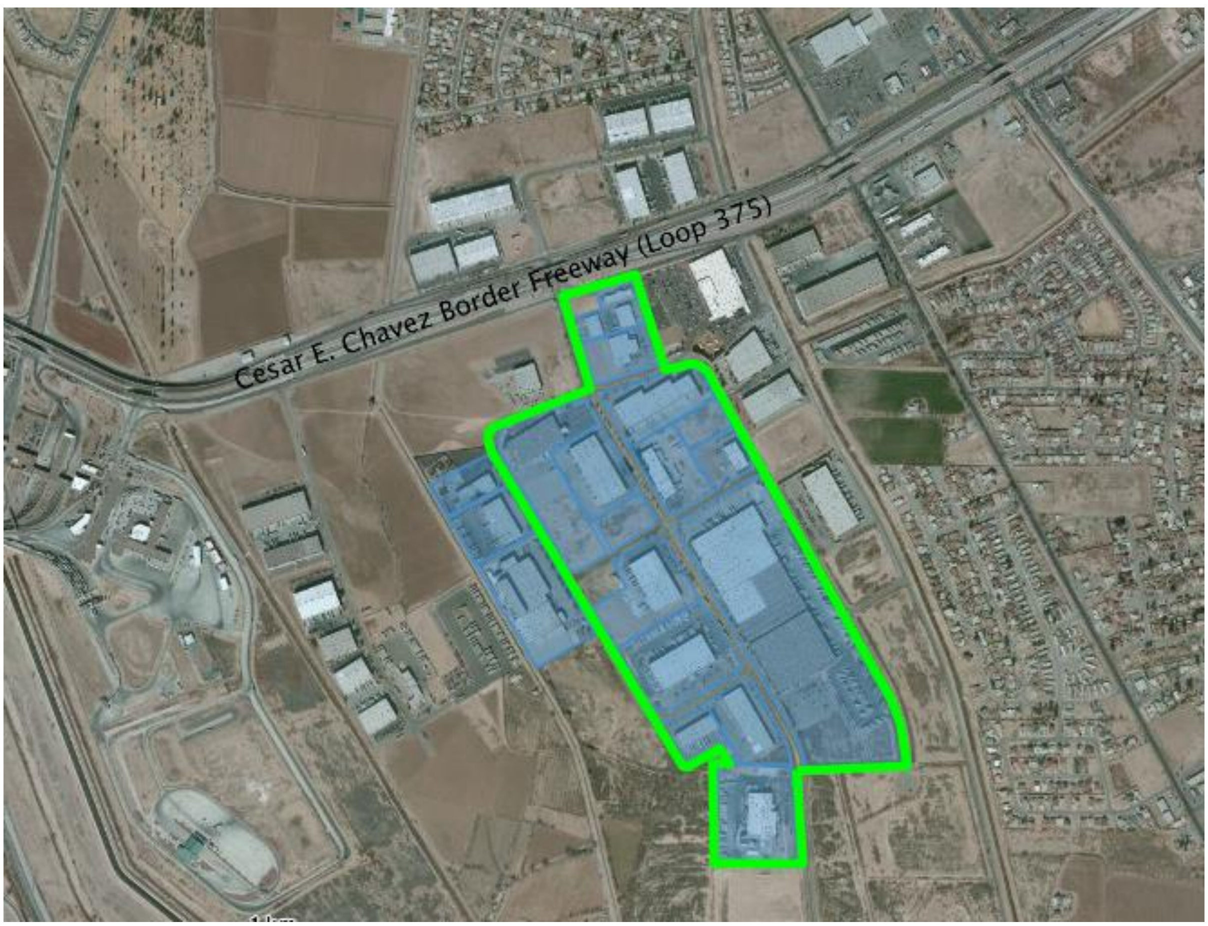


Figure 4.6: Aerial picture of site 4

4.2 Analysis of Truck Volume, Accident Rate and Freight Generation Attributes in El Paso

Since the amount of data collected regarding truck volume in El Paso was too extensive, the data was summarized into a table containing the average and maximum inbound, outbound, and total flow for each of the four sites. This data is shown in Table 4.1 along with warehousing area for each site determined by the sum of all parcels inside the selected site, and the number of traffic accidents involving trucks within a 1-mile radius of the sites.

Table 4.1: Average and maximum truck volumes, total parcel area, and truck-related accidents in El Paso

Site	Day	Total Parcel Area (acre)	Truck-Related Accidents within 1 Mile	a.m. average inbound volume (veh/hr)	a.m. maxinum inbound volume (veh/hr)	a.m. average outbound volume (veh/hr)	a.m. maxinum outbound volume (veh/hr)	a.m. average total volume (veh/hr)	a.m. maxinum total volume (veh/hr)	p.m. average inbound volume (veh/hr)	p.m. maxinum inbound volume (veh/hr)	p.m. average oitbound volume (veh/hr)	p.m. maxinum outbound volume (veh/hr)	p.m. average total volume (veh/hr)	p.m. maxinum total volume (veh/hr)
Site 1	M	492	43	46	60	60	108	106	168	53	59	76	82	128	141
	W	492	43	28	34	43	93	71	125	51	53	63	74	114	125
	F	492	43	38	47	60	110	98	157	42	49	67	71	117	119
Site 2	M	81	199	65	83	48	64	113	141	56	62	38	43	94	105
	W	81	199	33	43	33	44	66	82	72	85	44	51	116	121
	F	81	199	49	67	34	50	82	116	62	66	49	51	110	117
Site 3	M	118	79	35	55	26	44	61	99	53	57	62	71	115	128
	W	118	79	28	51	24	44	52	95	57	68	65	68	122	133
	F	118	79	30	45	25	50	55	95	69	75	69	79	138	154
Site 4	M	121	188	39	60	27	53	66	113	38	43	38	42	74	85
	W	121	188	26	41	20	40	46	76	50	58	49	60	99	117
	F	121	188	33	50	26	42	58	91	50	52	49	54	99	105

Notes: M: Monday, W: Wednesday, F: Friday.

Figure 4.7 shows all the traffic accidents involving trucks in El Paso. This data was filtered using ArcGIS to isolate all truck-related accidents within a 1-mile radius of the traffic count locations. Figure 4.8 is a map showing counting site locations, and their respective truck-related accidents.

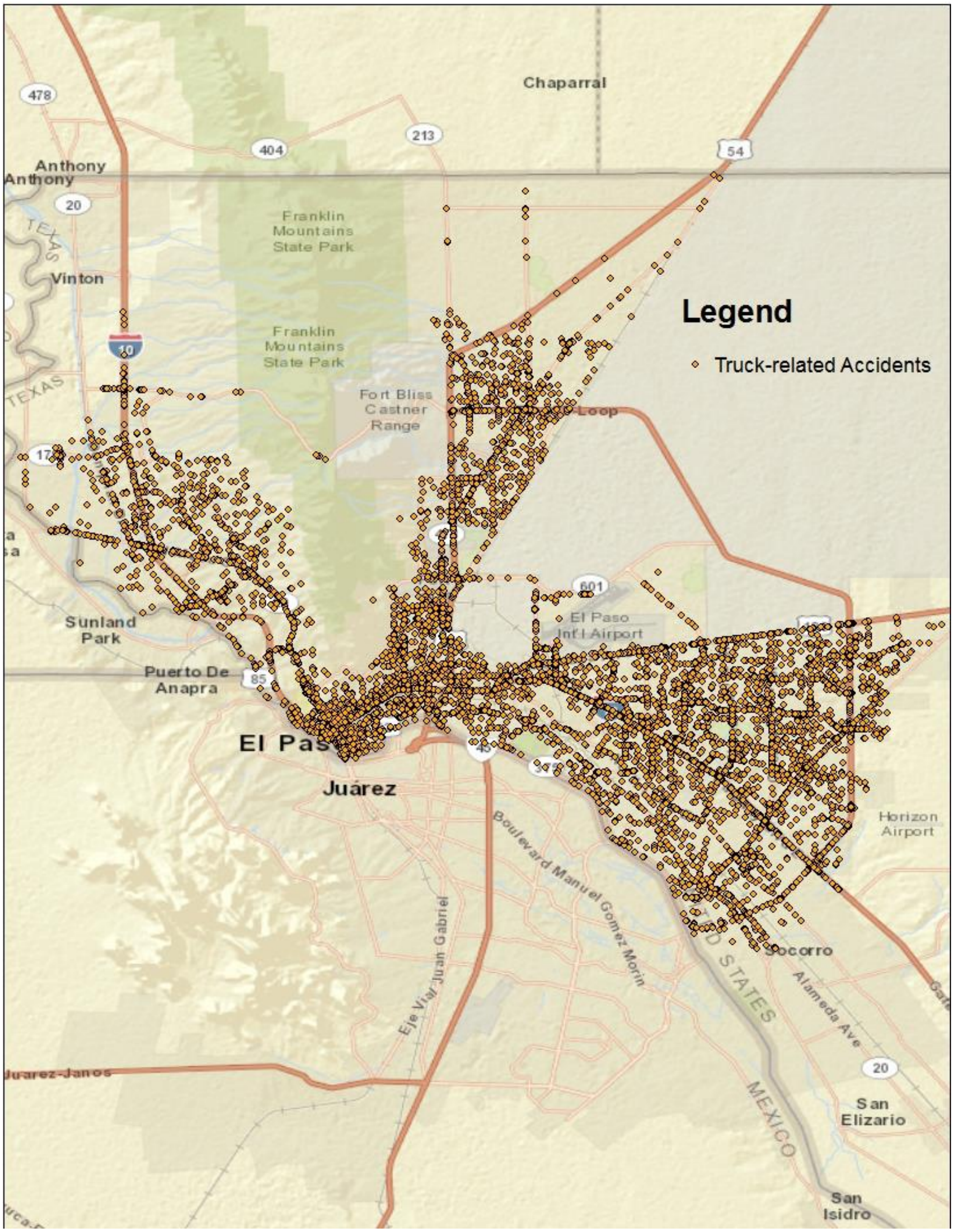


Figure 4.7: Traffic accidents involving trucks in El Paso, TX

Figure 4.8: Truck-related traffic accidents within a 1-mile radius of chosen warehousing complexes

The correlation analysis was conducted by calculating Pearson's correlation coefficient to determine the relationship between the three variables: truck volume flow, parcel area, and truck accidents. The Pearson's correlation coefficient is obtained by dividing the covariance of two variables by the product of their standard deviations. The formula for calculating the correlation coefficients is the following:

$$Correl\ (X, Y) = \rho = \frac{\sum(x-\bar{x})\sum(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2(y-\bar{y})^2}} \qquad (4.1)$$

where $\bar{x}$ and $\bar{y}$ are the sample means. Pearson's correlation coefficient is +1 when there is a prefect increasing linear relationship (correlation), -1 when there is a perfect decreasing linear relationship and all other cases fall in-between representing the degree of linear dependence between the variables. The results from the correlation analysis show that total parcel area has a significant correlation with most outbound volumes, except with the afternoon total volume. The strongest coefficient was found to be with the morning maximum outbound volume with a coefficient of 0.944 (p-value of 0.018), while all values for the morning outbound volume were higher than the afternoon counterparts. This could be due to inbound volume dependency on third parties, and external factors for freight to be delivered to the warehousing complexes, while the morning outbound volume depends more on the existing area, size, and capacity of the warehouses, and their logistics systems that appear to arrange outbound shipment to depart on mornings.

On the other hand, traffic accidents involving trucks were found to be not highly significant to truck volume in most of the cases. The most significant influence exerted by traffic accidents was again on outbound volume; however, this time the average afternoon volume

obtained higher coefficients than their morning counterparts, with a coefficient of -0.923 (p-value 0.005) obtained by the afternoon average outbound volume.

Finally, total parcel area, and truck-related traffic accidents obtained a correlation coefficient of -0.750 (p-value 0.185), which is not a highly significant coefficient, as confirmed by its p-value that shows there is no significant relationship between these two variables. A negative sign would infer an inverse linear relationship, where the number of truck-related traffic accidents decreases as the total parcel area increases, and vice versa..

The detailed results from the correlation analysis are shown in Table 4.2 and 4.3 respectively.

Table 4.2: Correlation coefficients between morning truck volume flow, total parcel area, and truck-related traffic accidents

	Total Parcel Area (acre)	**Truck-Related Accidents within 1 Mile**	**a.m. average inbound volume (veh/hr)**	**a.m. maxinum inbound volume (veh/hr)**	**a.m. average outbound volume (veh/hr)**	**a.m. maxinum outbound volume (veh/hr)**	**a.m. average total volume (veh/hr)**	**a.m. maxinum total volume (veh/hr)**
Total Parcel Area	1.000	-0.750	-0.070	-0.315	0.768	0.944	0.457	0.725
Truck-Related Accidents	-0.750	1.000	0.297	0.376	-0.429	-0.652	-0.130	-0.460

Table 4.3: Correlation coefficients between afternoon truck volume flow, total parcel area, and truck-related traffic accidents

	Total Parcel Area (acre)	**Truck-Related Accidents within 1 Mile**	**p.m. average inbound volume (veh/hr)**	**p.m. maxinum inbound volume (veh/hr)**	**p.m. average oitbound volume (veh/hr)**	**p.m. maxinum outbound volume (veh/hr)**	**p.m. average total volume (veh/hr)**	**p.m. maxinum total volume (veh/hr)**
Total Parcel Area	1.000	-0.750	-0.397	-0.403	0.640	0.623	0.322	0.259
Truck-Related Accidents	-0.750	1.000	0.141	0.151	-0.923	-0.910	-0.672	-0.660

A hypothesis testing was performed to determine the significance of the correlation coefficients obtained. The null hypothesis H_0 and the alternative hypothesis H_1 were defined as follows:

$$H_0 : \rho = 0 \tag{4.2}$$

$$H_1 : \rho \neq 0 \tag{4.3}$$

In order to determine the p-values a t-statistic was calculated using the formula:

$$T_0 = \frac{\rho \sqrt{n-2}}{\sqrt{1-\rho^2}} \tag{4.4}$$

which has a t-distribution with n-2 degrees of freedom if H_0: $\rho = 0$ is found to be true. Otherwise, the null hypothesis would be rejected if $|t_0| > t_{\alpha/2,n-2}$. A level of significance $\alpha = 0.05$ was assumed. The calculated t-statistics, and p-values are shown in Table 4.4, while Figures 4.9 and 4.10 are graphical representations of the most significant relationships found during the correlation analysis, which were between the total parcel area and morning maximum outbound volume (p-value = 0.018), and between truck-related accidents and afternoon average outbound volume (p-value = 0.005). As can be seen in Table 4.4, most p-values are smaller than $\alpha = 0.05$. The most significant coefficients represented in Figures 4.9, and 4.10 show a very strong presumption against the null hypothesis. and therefore the null hypothesis is rejected for this two relationships.

Table 4.4: t-statistic and p-values for correlation coefficients

	Total Parcel Area (acre)	Truck-Related Accidents within 1 Mile	a.m. average inbound volume (veh/hr)	a.m. maxinum inbound volume (veh/hr)	a.m. average outbound volume (veh/hr)	a.m. maxinum outbound volume (veh/hr)	a.m. average total volume (veh/hr)	a.m. maxinum total volume (veh/hr)	p.m. average inbound volume (veh/hr)	p.m. maxinum inbound volume (veh/hr)	p.m. average outbound volume (veh/hr)	p.m. maxinum outbound volume (veh/hr)	p.m. average total volume (veh/hr)	p.m. maxinum total volume (veh/hr)
Total Parcel Area	1.000	-0.750	-0.070	-0.315	0.768	0.944	0.457	0.725	-0.397	-0.403	0.640	0.623	0.322	0.259
p-value	-	0.185	0.007	0.013	0.007	0.018	0.026	0.106	0.013	0.017	0.014	0.018	0.095	0.133
t-stat	-	0.595	0.023	0.040	0.022	0.056	0.082	0.336	0.042	0.053	0.044	0.056	0.301	0.425
Truck-Related Accidents	-0.750	1.000	0.297	0.376	-0.429	-0.652	-0.130	-0.460	0.141	0.151	-0.923	-0.910	-0.672	-0.660
p-value	0.185	-	0.001	0.004	0.001	0.009	0.024	0.533	0.004	0.008	0.005	0.009	0.439	0.765
t-stat	3.583	-	0.982	1.284	1.502	2.722	0.413	1.638	0.451	0.483	7.582	6.929	2.870	2.781

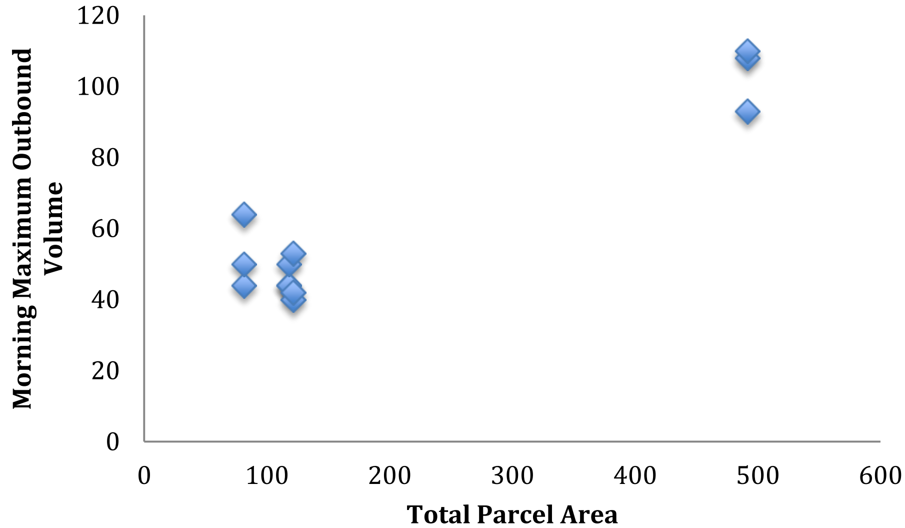


Figure 4.9: Relationship between total parcel area and morning maximum outbound volume

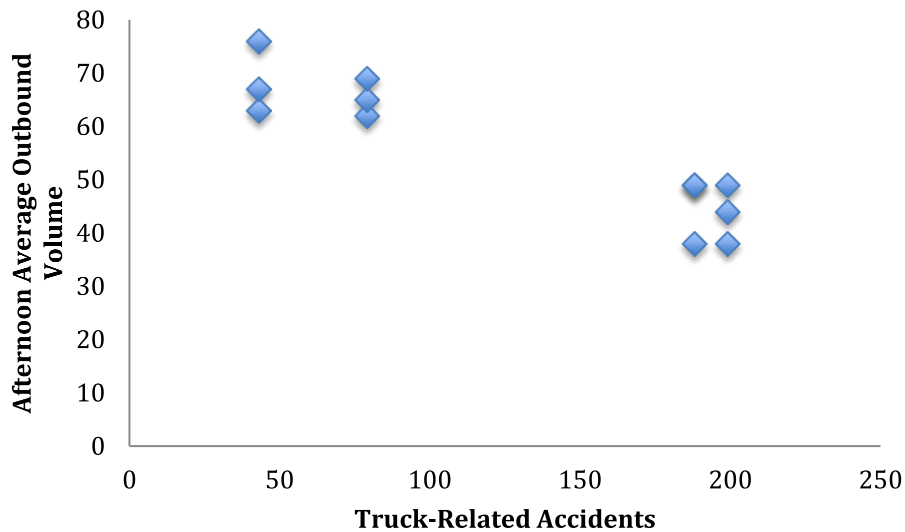


Figure 4.10: Relationship between truck-related accidents and afternoon average outbound volume

Chapter 5: Conclusion and Recommendations for Future Research

5.1 Summary of Research

The highway freight transportation comparison, and contrast analysis in U.S. and EU was done based on the information found, presented, and discusses in Chapter 3.

Authorities on Highways Freight Transportation

The major authorities on highway freight transportation in U.S. and EU are both official government departments, and organizations created by these departments for the management of issues related to road and highway freight transportation. Since EU is composed of individual member states with their own ministries of transportation, similar to individual U.S. states department of transportation, it can be inferred that the United State Department of Transportation (USDOT) serves a similar role in U.S. as the Directorate-General for Mobility and Transport (DG MOVE) does for EU. Both are departments under a larger governmental body (U.S. Government, and European Commission respectively), with the purpose of creating and administering policies and programs regarding the safety, capability and efficiency of the transportation system and services.

DG MOVE works closely with the governmental authorities (Ministries of Transport) for road transportation in EU Member States, while USDOT works with State's Departments of Transportation, such as the Texas Department of Transportation (TxDOT). Considering the Czech Republic as an example for a EU member state, a difference between U.S. and EU road transportation authorities could be that the Federal Highway Administration (FHWA) in U.S. has the same responsibilities and tasks assigned as the Department of Road Transport under the

Ministry of Transport of the Czech Republic, plus the Road and Motorway Directorate of the Czech Republic.

A similarity between U.S. and EU could be the Office of Freight Management and Operations under the FHWA in U.S, and the Department of Freight under the Department of Road Transport in the Czech Republic. Both of these departments have the purpose of promoting the efficient, smooth, and secure flow of freight through their transportation systems and across the borders as a mean to improve the economy and global connectivity of the region. Also, the Bureau of Transportation Statistics serves a similar purpose in U.S. as Eurostat does for EU.

Finally, another difference could be that U.S. still has more specialized departments such as the Federal Motor Carrier and Safety Administration (FMCSA) that focuses on safety measures to reducing and prevent freight truck-related accidents, fatalities and injuries, and the Research and Innovative Technology Administration (RITA) that focuses on performing USDOT research, and expanding the utilization of interlinked technologies to improve U.S. transportation system.

<u>Associations on Highways Freight Transportation</u>

The major difference between associations on highway freight transportation in U.S. and EU is that EU is composed of several countries; therefore, it harder to find trucking associations at the European level, while U.S. has several trucking organizations at the national level such as the American Trucking Associations (35,000 operators). Although there are trucking associations at national level in Member States of EU, such as Česmad Bohemia (2,000 operators) in the Czech Republic, the difference in size compared to U.S. associations is significant. Hence, EU

relies on international associations, such as the International Road Transport Union (IRU), while ATA is also a member of this organization.

Volume, Weight and VMT Transported

Data obtained regarding volume, weight, and VMT transported in U.S. and EU is hard to compare since U.S. data focuses more on weight and value of freight transported, and VMT for the whole country, while EU data focuses on ton-kilometers of freight transported per member state. However, one noticeable difference is that freight movement through roads in U.S. account for about 50% for distances below 100 miles, and continues to be the major mode for freight transportation for distances up to 750 miles, and over 2,000 miles. On the other hand, in EU, trucks move most of the freight causing congestions and bottlenecks, while U.S. truck traffic accounts for approximately only 10% of the total highway VMT, with light-duty vehicles (cars) accounting for 89%.

Major Truck Routes and Truck Volume

The road transportation networks in U.S. and EU have both similarities and differences. One of the similarities is that there are at least two major road transportation networks in both regions (U.S. and EU). As discussed in Chapter 3, U.S. road transportation network is composed of the NHS, and the National Network, both of them combined to approximately 200,000 miles long. In the case of EU, the road transportation network is composed of the Trans-European Road Network (TEN-T), which is about 84,946 miles long (136,307 km), as well as by the Pan-European road network; although, most of the Pan-European corridors in member countries of EU have already been added to the TEN-T road network.

Another similarity between the NHS in U.S., and the TEN-T road network in EU is that both are composed of a basic core network that helps to accelerate commerce and freight flow, and to improve the competitiveness by linking the strategically more important nodes. In U.S., the Interstate Highway System, which is about 47,714 miles long (76,788 kilometers), is the core part of the NHS, while in EU the TEN-T core network, which is about 37,052 miles long (59,630 kilometers), is the core part of the TEN-T comprehensive network.

A difference between U.S. and EU road networks could be that the NHS in U.S. is a high quality road network currently under operation, while EU TEN-T road network is not yet completed, and is currently under construction mainly in the corridors within the newest member states of EU (Central and Eastern Europe); although there are still some improvements under construction in the Western side of EU.

Accident Rates

Most of the accident rate data from U.S. was obtained in terms of number of accidents involving trucks, while EU data was more fatalities and injuries oriented. Hence, a comparison between both data sets is not easily achievable. However, a similarity observed for both regions concerning fatal to serious injuries was that the percentage of injured people according to the vehicle occupied. In EU, approximately 15% to 20% of road user fatalities/injuries resulting from truck accidents were truck occupants, while in U.S. about 15 to 25% of fatalities was attributed to truck occupants. Similarly, car occupants in EU accounted for 55% to 65% of fatalities and injuries, while in U.S. 57% to 75% of fatalities is attributed to other vehicle occupants (cars). Finally, 15% to 20% of people severely injured in accidents involving heavy

trucks are unprotected road users, such as pedestrians, cyclists, and motorcyclists, while in U.S. they account for approximately 10% of the fatalities.

Major Issues/Concerns in Highway Freight Transportation

Road traffic congestions were found to be the mutually shared major issue in highway freight transportation in U.S. and EU. Most future projections indicate that the capacity of major highway corridors is getting close to their limits, and would become a constraining factor for the movement of goods, and economic growth in the future. However, it was found that trucks carry approximately 79 percent of U.S. and 44 percent of EU freight by weight. Although U.S. road system carries a much larger share of freight transportation than its EU counterpart, trucks only represents about 10 percent of U.S. highway VMT, and are not a main contributor highway congestions and bottlenecks as in EU. Some of the approaches to tackle the road congestion issue were found to be similar in U.S. and EU. For example: supporting and encouraging mode shifting in freight transportation. There have been attempts to improve intermodal facilities, increase the number of shot-haul rail, and move freight from highly used ports to nearby port via waterways with the purpose of reducing the need for roadway freight transportation, much like the Marco Polo programme implemented in EU whose main goal is to avoid and shift the increasing international freight traffic from roads to short sea shipping, rail, and inland waterway transportation modes. Finally, a difference was found to be another approach at counteracting traffic congestion in U.S. and EU; while both regions have considered infrastructure pricing as an alternative for alleviating congestions, U.S. has focused on the pricing of separated lanes (such as HOT lanes), entire roads, highways, and bridges during rush hour, and not on cordon

charges, which are commonly used in EU for avoid downtown congestions in major cities such as in London, and Berlin.

Highway Infrastructure Financing

Sources for funding of highway infrastructure construction and maintenance differ in U.S. and EU. Since its establishment, road infrastructure in U.S. has been largely funded by taxes on motor fuels that flow into a Highway Trust Fund (HTF). Although approximately 90 percent of the income for the HTF comes from a federal tax imposed on hydrocarbon fuels, other sources for revenue include: truck registration fees, taxes imposed to truck tires, and interest credited to the fund balances by U.S. Treasury. On the other hand, EU funding for road infrastructure comes mainly from vehicle and fuel taxation, and road infrastructure charging. The road infrastructure charges in U.S. do not normally contribute to HTF in U.S. While both U.S. and EU impose taxes on fuel, there is a difference in the methods used by both region; for example: U.S. normally imposes a fixed amount-per-gallon tax on fuels, while EU imposes a value added tax, or sales tax based on the retail price on motor fuels. U.S. has also implemented the sales tax concept instead of a fixed amount; however, it is not widely spread and utilized like in the member states of EU. Both U.S. and EU impose some type of excise duties on motor fuels. The main difference between sourced of income for funding of road infrastructure is income generated by time, and distance related infrastructure charging. Although U.S. has considered, and performed some research on the matter, only EU uses road tolling, and time vignettes system to generate and collect funds to be invested in road infrastructure, while U.S. does not.

Major Logistics Hubs/Centers

A similarity between all major logistics hubs in both U.S. and EU is that they are intermodal facilities. Most of the major hubs in the U.S. include al three transportation modes (air, water, and land transportation) in logistics hubs such as Chicago and Port of Los Angeles. Chicago offers connection between all Class 1 railways, several interstate highways, and inland waterway ports, while the Port of Los Angeles offers connection between a large international port with one of the largest, and more complex highway networks in U.S. In EU, major hubs such as Rotterdam and Hamburg offer connection between EU major ports, highway, and inland waterway networks. However, a difference is that logistics hubs in EU are all mainly located in a small and highly dense populated area (Blue Banana), while major logistics hubs in U.S. are not located close to each other. Finally, the major similarity is that the major logistics hubs are strategically located with large consumers catchment areas, easily reachable within hours by truck.

5.2 Recommendations

After analyzing the state of highway freight transportation in U.S. and EU, their strengths and weaknesses have been identified. Both regions can learn and optimize its highway freight transportation by adopting similar practices.

First of all, the statistics organizations in both regions such as the Bureau of Transportation Statistics (in U.S.) and Eurostat (in EU) should focus on the collection of important, and meaningful transportation data, and make it readily available to the public and researchers on the subject. Also, some standardization on data collection should be developed, since data differences between regions create complications in terms of comparison.

Second, EU should focus on finishing the construction of TEN-T. In this case, EU should follow U.S. example of the Interstate Highway System, creating the core network of the TEN-T to provide road connections between all member states of the EU, which does not exist for the newest members of EU, mainly on central and eastern Europe. Unfortunately, most of the TEN-T funds are allocated for other modes of transportation, while road transportation is only considered in three of their 30 priority projects.

Third, in terms of road traffic congestion, EU should continue its modal shift efforts to shift freight transportation traffic from roads to short-sea shipping, railways, and inland waterway transportation. Although trucks are not the main cause of congestions in the NHS, U.S. should increase their efforts for modal shift to account for the increasing freight volume demand in future years, which will exceed road capacity. Finally, U.S. should adopt EU practices of cordon charging (area) as a mean to dissipate downtown congestion in major cities, besides their already present entire road, road segment, lanes, and bridges charging.

In terms of highway infrastructure funding, U.S. should follow EU example, and implement infrastructure usage charges such as VMT, toll roads, and vignettes systems to increase income generation for the HTF. This way, U.S. would also account for vehicle type (weight, number of axels, etc.), amount of infrastructure used (distance, time, etc.), and the increasing fuel efficiency of vehicles, which is decreasing the amount of income available for the HTF, while not really decreasing infrastructure usage.

Finally, EU should invest in developing new transportation hubs on eastern European countries as the EU's center gradually shifts to the east. More centrally located countries such as Czech Republic, and Slovakia could serve as transportation hubs with connection to both eastern

and western Europe, and not serve mainly western European countries like the currently major hubs in the Blue Banana do.

5.3 Future Research

Future research should be performed including the collection of European traffic flow data, since this kind of data is not readily available, and hard to collect. This way, a comparison and contrast analysis on the influence and correlation between warehousing area, truck volume flow rate, and accident rate data could be implemented. Also, with more data available, not only correlation analysis could be performed, but also more sophisticated regression analysis to test the sensitivity of independent variables on a critical dependent variable.

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Appendix – Truck Counting Forms

Site 1			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	14	14	28
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	29	23	52
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	23	19	42
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	28	32	60
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	7	10	17
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	21	8	29
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	17	17	34
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	13	19	32
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	14	11	25
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	33	11	44
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	19	15	34
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	26	21	47

Site 1			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	6	7	13
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	31	23	54
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	45	19	64
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	79	29	108
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	3	5	8
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	14	8	22
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	37	11	48
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	70	23	93
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	21	5	26
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	30	15	45
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	41	18	59
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	81	29	110

Site 1 P.M.

Site 1			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	30	21	51
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	22	25	47
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	25	34	59
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	19	32	51
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	16	37	53
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	17	32	49
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	9	22	31
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	12	34	46
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	11	38	49

Site 1			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	22	55	77
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	23	44	67
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	31	51	82
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	28	46	74
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	21	40	61
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	20	33	53
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	12	47	59
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	17	54	71
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	11	59	70

Site 2 A.M.

Site 2			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	12	10	22
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	57	25	82
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	47	26	73
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	34	52	86
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	9	1	10
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	17	26	43
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	19	22	41
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	14	24	38
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	5	10	15
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	13	32	45
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	24	43	67
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	22	44	66

Site 2			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	8	10	18
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	26	29	55
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	28	36	64
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	14	40	54
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	10	3	13
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	13	22	35
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	15	23	38
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	20	24	44
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	4	8	12
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	4	29	33
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	12	28	40
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	11	39	50

Site 2 P.M.

Site 2			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	10	49	59
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	20	42	62
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	8	39	47
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	10	53	63
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	13	34	47
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	9	63	72
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	7	51	58
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	12	48	60
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	7	59	66

Site 2			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	8	25	33
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	13	30	43
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	8	30	38
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	9	29	38
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	9	38	47
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	10	41	51
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	10	36	46
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	8	41	49
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	10	41	51

Site 3 A.M.

Site 3			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	0	5	5
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	5	26	31
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	12	31	43
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	13	4	17
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	0	11	11
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	1	17	18
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	4	28	32
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	6	45	51
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	1	9	10
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	10	19	29
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	7	29	36
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	10	35	45

Site 3			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	3	2	5
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	4	8	12
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	7	36	43
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	5	39	44
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	1	4	5
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	4	11	15
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	5	27	32
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	10	34	44
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	1	3	4
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	4	10	14
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	2	23	25
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	11	39	50

Site 3 P.M.

Site 3			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	22	35	57
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	10	41	51
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	14	36	50
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	11	39	50
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	14	54	68
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	5	47	52
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	15	60	75
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	12	55	67
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	7	57	64

Site 3			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	12	59	71
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	12	40	52
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	14	48	62
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	15	53	68
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	9	56	65
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	13	48	61
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	15	64	79
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	8	55	63
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	7	58	65

Site 4 A.M.

Site 4			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	1	12	13
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	4	17	22
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	11	48	59
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	14	46	60
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	2	10	12
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	6	9	15
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	8	33	41
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	9	27	36
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	3	14	17
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	5	18	23
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	9	31	40
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	8	42	50

Site 4			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	6:00 a.m.-7:00 a.m.	**Mon 6-7am**	0	9	9
	7:00 a.m.-8:00a.m.	**Mon 7-8am**	6	9	15
	8:00 a.m.-9:00 a.m.	**Mon 8-9am**	14	17	31
	9:00 a.m.-10:00 a.m.	**Mon 9-10am**	13	40	53
Wednesday	6:00 a.m.-7:00 a.m.	**Wed 6-7am**	0	10	10
	7:00 a.m.-8:00a.m.	**Wed 7-8am**	6	9	15
	8:00 a.m.-9:00 a.m.	**Wed 8-9am**	10	33	43
	9:00 a.m.-10:00 a.m.	**Wed 9-10am**	16	27	43
Friday	6:00 a.m.-7:00 a.m.	**Fri 6-7am**	1	6	7
	7:00 a.m.-8:00a.m.	**Fri 7-8am**	4	7	11
	8:00 a.m.-9:00 a.m.	**Fri 8-9am**	13	29	42
	9:00 a.m.-10:00 a.m.	**Fri 9-10am**	7	34	41

Site 4 P.M.

Site 4			Inbound (vph) medium truck	Inbound (vph) heavy truck	Inbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	7	33	40
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	4	25	29
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	6	34	40
	3:00 p.m.-4:00 p.m.	**Mon 3-4pm**	6	37	43
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	12	46	58
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	8	32	40
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	10	35	45
	3:00 p.m.-4:00 p.m.	**Wed 3-4pm**	11	46	57
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	10	37	46
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	8	40	48
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	11	41	52
	3:00 p.m.-4:00 p.m.	**Wed 3-4pm**	10	42	52

Site 4			Outbound (vph) medium truck	Outbound (vph) heavy truck	Outbound (vph) total
Monday	12:00 p.m.-1:00 p.m.	**Mon 12-1pm**	7	29	36
	1:00 p.m.-2:00 p.m.	**Mon 1-2pm**	4	30	34
	2:00 p.m.-3:00 p.m.	**Mon 2-3pm**	9	28	37
	3:00 p.m.-4:00 p.m.	**Mon 3-4pm**	9	33	42
Wednesday	12:00 p.m.-1:00 p.m.	**Wed 12-1pm**	10	38	48
	1:00 p.m.-2:00 p.m.	**Wed 1-2pm**	8	39	47
	2:00 p.m.-3:00 p.m.	**Wed 2-3pm**	8	32	40
	3:00 p.m.-4:00 p.m.	**Wed 3-4pm**	10	50	60
Friday	12:00 p.m.-1:00 p.m.	**Fri 12-1pm**	12	42	54
	1:00 p.m.-2:00 p.m.	**Fri 1-2pm**	6	40	46
	2:00 p.m.-3:00 p.m.	**Fri 2-3pm**	9	33	42
	3:00 p.m.-4:00 p.m.	**Wed 3-4pm**	10	43	53

Vita

Luis Hernandez was born in Ciudad Juarez, in the state of Chihuahua, Mexico on July 29, 1988. He obtained his Bachelor Degree in Civil Engineering at The University of Texas at El Paso (UTEP), in El Paso, Texas in 2012. He then continued his graduate education at UTEP, where he became part of the Transatlantic Dual Master Degree Program in Transportation and Logistics Systems. As part of this program, operated by The University of Texas at El Paso, the Czech Technical University (CTU), and the University of Zilina, Luis Hernandez continued his studies and culminated his Master Degree in the Czech Technical University in Prague.

Permanent address: 7339 Corona del Sol

El Paso, Texas 79911

This thesis was typed by Luis Hernandez.