TRUCKING AND SIZE AND WEIGHT REGULATIONS IN COSTA RICA

By

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ABSTRACT

The purpose of this research is to increase transportation engineering knowledge about trucking operations and truck size and weight regulations in Costa Rica. This is done to reveal issues that should be considered in defining, evaluating, and choosing among alternative courses of action to improve truck operations and safety in the country. The research analyzes truck operations in Costa Rica with respect to the transportation system, truck size, weight and safety regulations, trucking activity and operating weights of trucks, and future transportation developments that may impact truck operations. This is done through the analysis of available data related to truck operations including an analysis of weight data to determine compliance with weight regulations and the associated operations of the trucking industry in Costa Rica. A series of interviews and site visits were used to understand the transportation system, regulations, enforcement, and associated issues.

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1. INTRODUCTION

1.1 THE RESEARCH

The purpose of this research is to increase transportation engineering knowledge about trucking operations and truck size and weight regulations in Costa Rica. This is done to reveal issues that should be considered in defining, evaluating, and choosing among alternative courses of action to improve truck operations and safety in the country. The research analyzes truck operations from the transportation engineering perspective in Costa Rica, with particular focus on the Pan-American Corridor and major connecting links. The research: (1) characterizes the transportation system and operations in the region as they relate to trucks; (2) describes the truck size, weight, and safety regulations in Costa Rica and the associated enforcement practices; (3) analyzes truck activity and the operating weights of trucks in the country; and (4) identifies transportation system developments to determine their likely impact on truck flows and characteristics in the region.

1.2 BACKGROUND AND RESEARCH NEED

The safe and efficient movement of goods is essential for the economic development of a region. In Costa Rica, similar to other Central American countries, the Pan-American Corridor (i.e., the Pan-American highway and major connecting links) plays a key role in the movement of freight into, out of, and through the country.

Like the rest of the world, Cost Rica faces economic, social, and environmental pressures to create a more sustainable and livable place for its people and businesses. The technical productivity, safety, and efficiency of the trucking sector and its highways are fundamental to achievement of this goal.

The truck size and weight (TS&W) regulation regime under which trucks operate has a direct impact on vehicle handling and stability, that in turn impacts geometric design elements of the road, traffic operations, and the condition of the infrastructure (e.g., pavements and bridges). Furthermore, the way in which these regulations are enforced has an impact on the safety of the system, as well as on the condition of available infrastructure, among others.

The implementation of two recent regional trade agreements in Central America: (1) Dominican Republic – Central America Free Trade Agreement (DR-CAFTA); and (2) the Association Agreement between the European Union and Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama are expected to see significant growth in freight movement activity along the Pan-American Corridor. This will likely lead to increased regional economic integration as it is essential to keep this freight moving safely and efficiently. From an engineering perspective, it is necessary to understand the characteristics and issues associated with each of the elements that impact truck safety and efficiency to be able to implement measures to improve them throughout the region.

This research is directed at increasing knowledge about trucking operations and truck size and weight regulations in Costa Rica and their respective impact on truck transportation in the country– to help engineers, planners, and decision-makers make more informed choices about the sector, its development, and its infrastructure.

1.3 OBJECTIVES AND SCOPE

The objectives of this research are to:

1. Understand Costa Rica’s transportation system with respect to: (a) the road network and its characteristics; (b) international trade; (c) current status of the railway network (d) available infrastructure, including border crossings with

Nicaragua and Panama; (e) major marine ports, and (f) transportation system constraints.

2. Identify truck size, weight, and safety regulations in the country and associated enforcement practices.

3. Determine trucking activity in terms of truck fleet characteristics, and operating weights of trucks along the Pan-American Corridor and major connections within Costa Rica.

4. Identify anticipated transportation developments in Costa Rica and surrounding regions and assess potential implications of these developments for truck transportation in the country and the Central American region.

The scope of this research is limited to civil engineering considerations that are affected by truck operations on the national highway system in Costa Rica with a particular emphasis on the Pan-American corridor and connecting links.

1.4 RESEARCH METHODOLOGY

The conduct of this research involved the following:

1. Characterization of Costa Rica's transportation system. This included the following:
    a) The region's road network: Information on road network operations and characteristics in Costa Rica were obtained from three sources: (1) the literature; (2) a survey of highway agency personnel; and (3) a synthesis of available field-based data sources.

b) Railway network: Details on the current status and future plans of the railway network in Costa Rica were obtained through government reports and discussion with local transportation officials.

c) Major border crossings: Using the literature, industry sources, government sources, and personal visits, the status, performance, and developmental plans about key border crossings was established.

d) Major ports: The port subject involved a similar approach to that used for border crossings.

e) Transportation system constraints: Information collected through the literature, interviews with local transportation officials, and site visits were used to identify constraints in the transportation system that limit the efficient movement of freight.

2. Description of the truck size, weight, and safety regulations in Costa Rica and the associated enforcement practices. This portion of the research identifies the purpose of TS&W regulations, safety regulations, and enforcement practices. A series of interviews were conducted in Costa Rica with those involved with the creation of regulations and those that enforce regulations relating to truck size, weight, and safety. Site visits to the weigh stations operating in the country were also used to better understand truck size and weight, and enforcement issues.

3. The trucking activity in Costa Rica was determined through data collection, data analysis, and a series of interviews. Several data sets were obtained over the course of the research, including vehicle characteristics and volume data, vehicle weight data, and road inventory data. Three data sources were utilized specifically for

understanding truck fleet characteristics in Costa Rica: (1) permanent weigh stations, (2) temporary automatic vehicle classifiers, and (3) manual counts.

The operating weights of trucks in the country were determined through an analysis of weight compliance data collected at four weigh stations operating throughout the country. Different vehicle classifications were analyzed with respect to axle loadings and gross vehicle weight (GVW). Cumulative distribution and frequency histograms were used to present the results of the analysis. This analysis was done to determine the level of compliance with national weight regulations and to increase understanding of truck operations in the country.

4. The details of major changes underway or anticipated in the transportation system can be used to determine how/to what extent these developments can be expected to significantly impact truck flows in the corridor. These developments are: (1) port developments; (2) road developments; and (3) Panama Canal developments. Information on these developments was collected through qualitative research that involved gathering information from interviews with local transportation officials and the literature.

1.5 THESIS ORGANIZATION

The thesis comprises five chapters. Chapter 2 characterizes the transportation system in Costa Rica as it relates to trucking. The transportation system is described in terms of: (1) road network; (2) international trade (3) railway network; (4) international border crossings; (5) major marine ports; and (6) transportation network constraints.

Chapter 3 addresses truck size, weight and safety regulations in Costa Rica. They are described in terms of: (1) a general overview of truck size, weight, and safety regulations; (2) enforcement need; (3) legislative authority and enforcement practices in Costa Rica; (4) truck size and weight regulations in Costa Rica; and (5) truck safety regulations in Costa Rica.

Chapter 4 describes the trucking activity and operating weights of trucks in Costa Rica. The chapter describes: (1) data sources used for the analysis; (2) Costa Rica’s truck fleet; (3) vehicle body type distribution; (4) operating weight of trucks in Costa Rica; and (5) a discussion about truck operating weights.

Chapter 5 identifies a number of planned developments in Costa Rica which can be expected to affect truck transportation and freight movement in the country. These fall under the following three categories: (1) port developments; (2) road developments; and (3) Panama Canal expansion.

Chapter 6 presents the conclusions and recommendations for future research.

2. TRANSPORTATION SYSTEM IN COSTA RICA

This chapter characterizes the transportation system in Costa Rica as it relates to trucking. The transportation system is described in terms of: (1) road network; (2) international trade; (3) railway network; (4) international border crossings; (5) major marine ports; and (6) transportation network constraints.

2.1 ROAD NETWORK

The transportation network in Costa Rica is primarily characterized by its national road network and the industries it serves. The national railroads currently have little involvement in terms of freight movement and the road network is central in serving the international ports and border crossings for facilitating international trade. Background information is provided on the current road network in Costa Rica and the road network is then described in terms of its extent, current condition, and general operations.

2.1.1 Background

The Ministerio de Obras Públicas y Transportes (MOPT) is responsible for the National Road Network (Red Vial Nacional) in Costa Rica. The MOPT's general purpose is to provide the country with the required infrastructure to ensure adequate operation of the transportation system.

A key consideration in road network operations with regards to the movement of freight is providing reliability and redundancy in the transportation system to ensure efficient and dependable freight service. Burks, et al. (2010) identify three key freight mobility constraints restricting the free flow of freight at both network and site specific levels:

1. Physical constraints: comprise geometric or infrastructure conditions preventing freight operators from operating at designed or safe speeds.

2. Operational constraints: comprise practices, events, or occurrences that constrain the throughput of a system and optimal and legal operating conditions.
3. Regulatory constraints: imposed by government regulatory requirements.

The breakdown and blockage of key routes is a common occurrence in the Central American region and the Pan-American Corridor, in part due to the geographic environment which in turn can have negative impacts on the economic activity in the region. The road network is the fundamental method of moving freight in Costa Rica and is of paramount importance to the economic activity of the country. A number of sources provide insight on these topics:

- López & Shankar (2011) identify the most serious deficiencies in the Central America transportation network as being the quality and connectivity of roads and ports, domestic and regional surface transportation mainly involving trucking, and security of surface freight. Additional issues involve border management and border-crossing facilities, the ability of carriers to manage their supply chains efficiently, and logistics operators and intermediaries.

- The Ministry of Public Works and Transportation (MOPT, 2010a) highlights the importance of the road network in the transportation system and recognizes a need to concentrate efforts on replacement and maintenance initiatives to ensure the connectivity of activity centers in the country. They describe quality infrastructure as a means to enhance conditions for development in order to foster the exchange of goods and services, and the movement of people.

- The Secretariat of Economic Integration of Central America (SIECA, 2007) discusses difficulties in regards to the current state of the transportation system in Central America. A significant issue identified are the challenges associated with sustaining road maintenance programs that ensure a functional condition of the roadway. This is further exacerbated as the region is prone to natural disasters such as hurricanes and seismic activity. The disasters absorb available resources that disrupt regular maintenance programs.

SIECA recognizes a key initiative is to improve internal and external connectivity of Central American economies. This can be done through improvement to road infrastructure corridors, and the harmonization of legislation and transport regulations. The specific initiative includes construction, rehabilitation, and improvement to the main Meso-American highways and key branch lines and connections within Central America. These routes are presented in Figure 1. The red line represents the primary Pan-American Corridor in Central America with alternative options outlined in blue and green.

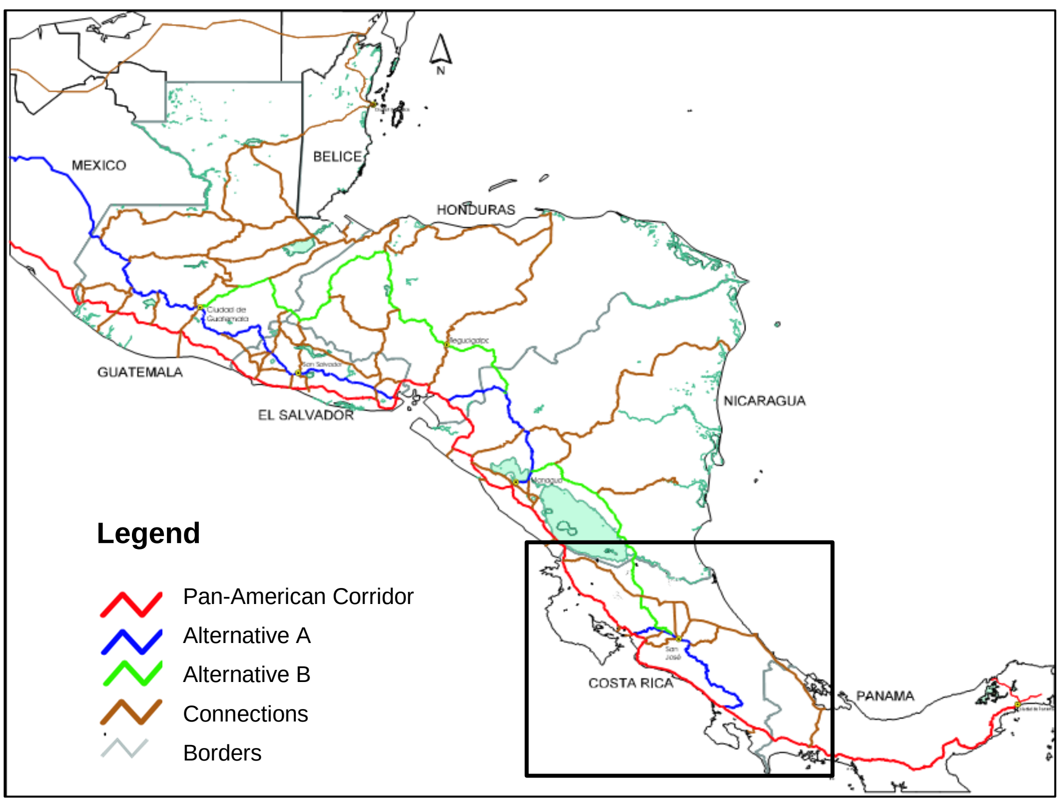


Figure 1: Meso-American Highways
Source: Adapted from SIECA (2001)

- Sanchez and Wilmsmeier (2005) identify issues in regards to the current transport infrastructure in Central America. Issues include limited capacity, poor condition and lack of maintenance of roads, railways, and ports. The authors suggest the following methods to improve road transportation and the road network: compliance of basic standards to ensure a smooth, safe, and effective regional system; improve quality and standards of pavement; improve bridge load capacity; improve geometric design; and increase self-funding maintenance programs.

2.1.2 Extent of Road Network and Current Condition

The National Road Network in Costa Rica is divided into three categories: (1) primary roads; (2) secondary roads; and (3) tertiary roads. Primary roads have higher traffic volumes and a high proportion of international travel or long distance trips. Secondary roads connect provincial capitals not served by primary roads and connect centers of population, tourism, and production. Tertiary roads are collector roads to primary or secondary roads; and are the primary roads within a small local region. The extent of Costa Rica's National Road Network is presented in Figure 2.

Costa Rica has seven provinces each having several cantons or municipalities that are responsible for the municipal roads in their respective regions. There are three levels of municipal roads: (1) regional public roads; (2) local streets; and (3) unclassified public roads. Oltremari and Fernando (2001) describe regional public roads as providing direct access to farms or other rural economic activities. These roads typically carry a high volume of short distance local trips. Unclassified roads serve only a few local users and the local users contribute to the costs of maintenance or improvement.

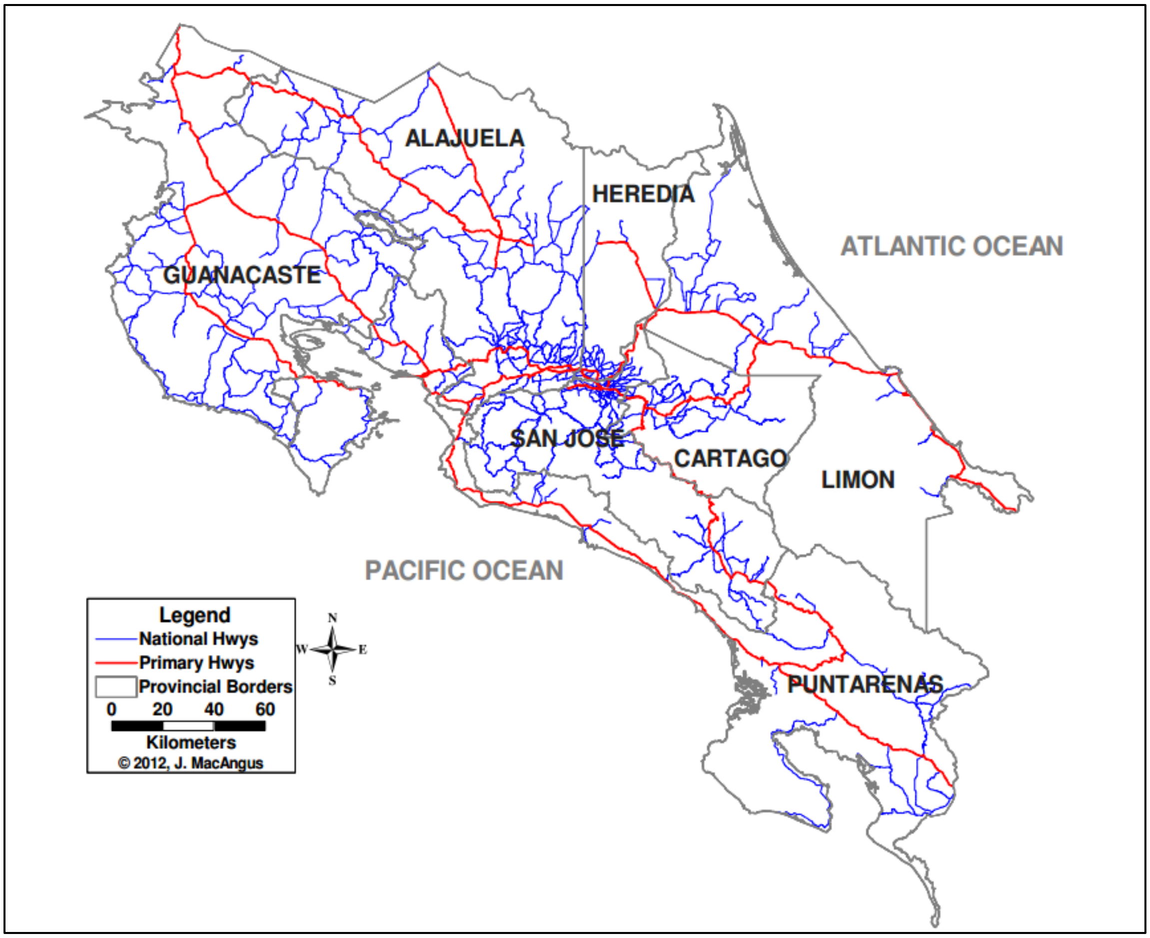


Figure 2: National Road Network in Costa Rica
Source: Developed by Jane MacAngus using data provided by MOPT

The National Institute of Statistics and Census (INEC) in Costa Rica provides an annual report on transportation related items including the length and condition of the road network with the most recent report published in 2010. INEC (2010) reported that there was a total of 39,043 kilometres of State road (National Road Network and municipal roads) in Costa Rica in 2009. The National Road Network has 65 percent of its roads paved and the municipal road network has 16 percent of its network paved. For reference, Canada has 1,042,200 kilometres of public roadways, 40 percent of which are paved with the remaining 60 percent unpaved (Transport Canada, 2005). Figure 3 outlines the road distribution in Costa Rica with respect to the type and pavement status of State roads.

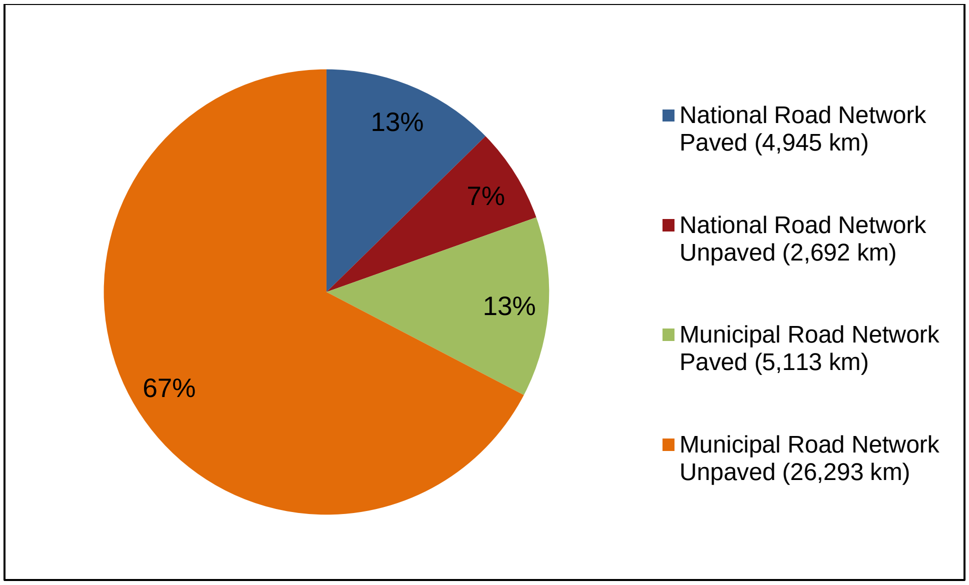


Figure 3: Road Network Distribution in Costa Rica in 2009
Source: Modified from INEC (2010)

State roads were rated based on their condition as good, fair or poor in 2007. Approximately 11 percent of roads were rated as good, 46 percent as fair, and 44 percent as poor when considering all types of State roads. In terms of paved roads, 27 percent were rated as good, 53 percent as fair, and 20 percent as poor. The ballast or gravel and earth roads (unpaved) had significantly poorer ratings with five percent of the network rated as good, 43 percent as fair, and 52 percent as poor (Gonzalez, et al., 2008).

2.1.3 Road Network and Truck Operations

The transportation system in regards to trucking is defined through site visits to primary highways, connecting links, and freight generators and attractors (ports and border crossings), in addition to obtaining information from multiple meetings with local officials involved in the transportation sector.

The key connecting links of importance to the truck transportation system in Costa Rica are National Highways 1, 2, 4, 10, 18, 21, 27, 32, 34, and 36 as illustrated in Figure 4.

These highways represent 10 of the 19 primary highways in Costa Rica and each highway was visited during the course of this research to observe infrastructure and traffic characteristics.

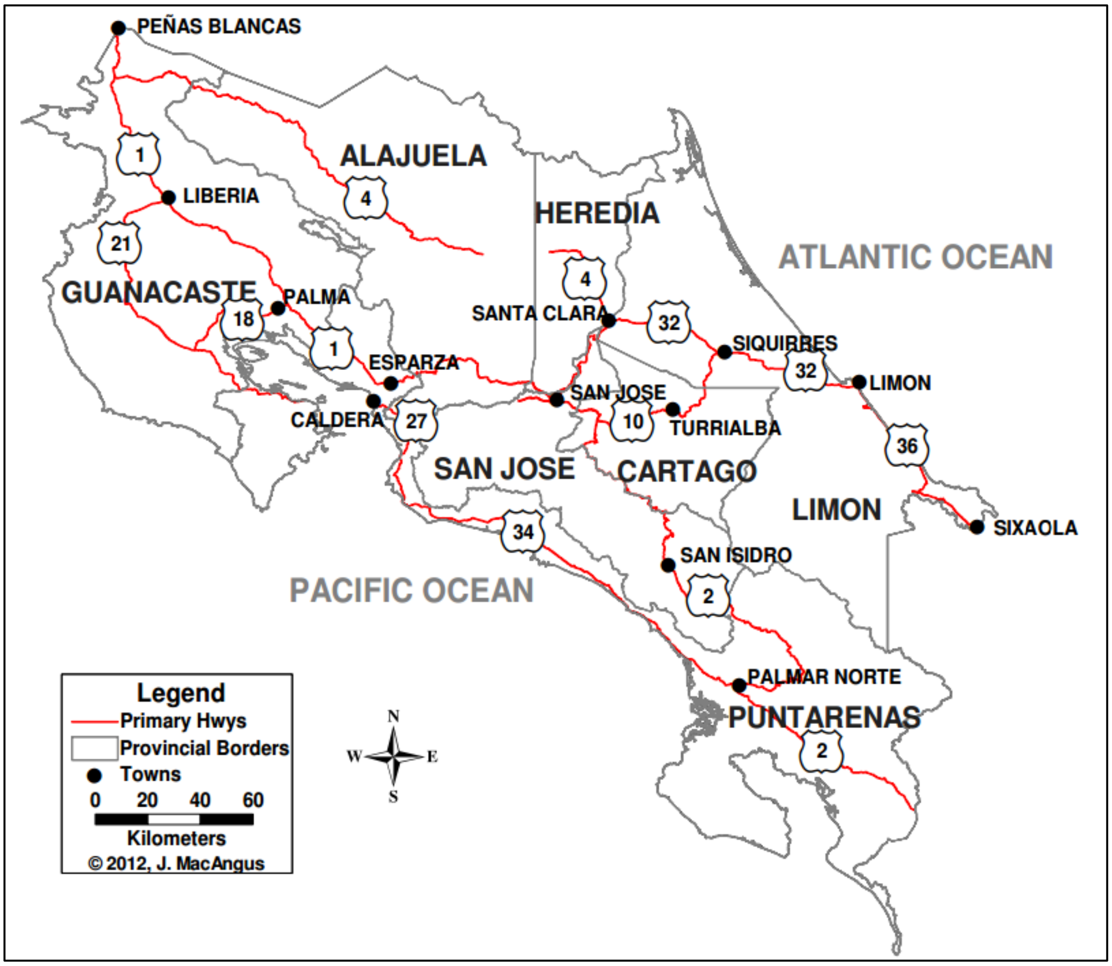


Figure 4: Primary Highways for Truck Operations in Costa Rica
Source: Developed by Jane MacAngus using data provided by MOPT

Representative locations depicting portions of these highways are shown in Table 1. The table comprises six different characteristics defining the highway segment: (1) location; (2) speed limit; (3) geometry; (4) access control; (5) design issues; and (6) percent heavy trucks. Field visits to each of the segments were conducted between February 15, 2011 and May 19, 2011.

Table 1: Primary Highway Network Properties

HWY	Significance to National Highway Network	Example	Segment Properties
1	Highway 1 is a portion of the Pan-American Highway and the primary connection between the Nicaragua border at Peñas Blancas and San José. This is also a primary link for those trucks traveling from Nicaragua to the Atlantic ports as they must pass through the San José region before reaching the ports. The highway is a two-lane undivided highway and the topography surrounding it is relatively flat near the Nicaragua border with increased vertical and horizontal geometry existing further south. Portions of the surrounding regions are densely populated with trees posing concerns for clear zone distances. Traffic characteristics on this highway change considerably when comparing the northern border region to the San José region. The traffic mix in the border region consists of over 20 percent heavy trucks (tractor semi-trailers with five or more axles) while nine percent of traffic is classified as heavy trucks in the southern portion of the highway. The movement of freight on this highway experiences serious congestion issues at the Nicaragua border crossing in terms of the processing and throughput of trucks. There is insufficient truck parking facilities at the border location resulting in trucks parking directly on the Pan-American Highway. Trucks parked on the highway pose a safety risk to other road users. Other areas of concern with respect to deficiencies in the movement of freight exist on the southern portion of the Pan-American Highway due to increased challenges with road geometry making the passing of slower moving vehicles difficult. General congestion issues also exist near the urban centre of San José.	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** February 16, 2011 Between Peñas Blancas and Liberia **Speed Limit:** 70-75 km/hr **Geometry:** Two lane highway with narrow shoulders. Topography relatively flat and straight allowing vehicles to pass with relative ease. **Access Control:** Limited **Design Issues:** No passing lanes or truck rest areas. **Percent Heavy Trucks*:** 20%
		 Photo by J. MacAngus, (2011)	**Time/Location of Photo:** February 15, 2011 Between Palma and Esparza **Speed Limit:** 70 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. Terrain featuring frequent hills and curves. **Access Control:** Semi-limited **Design Issues:** No passing or turning lanes provided. Issues with passing in hilly areas, particularly with trucks on grades. Clear zone widths are often small. **Percent Heavy Trucks*:** 9%

Note: * Heavy trucks consist of vehicles in classes 9-13 in the FHWA Scheme F classification system (Appendix B)

HWY	Significance to National Highway Network	Examples	Segment Properties
2	Highway 2 begins South of San José connecting to the main border crossing with Panama at Paso Canoas. Highway 2 was once a portion of the Pan-American Highway, however, the completion of an alternative route has caused a recent shift in traffic to Highway 34 for those vehicles traveling south-east to Paso Canoas. Highway 2 is a two-lane undivided highway with a speed limit ranging from 50 to 80 kilometres per hour. Highway 2 is primarily located in a mountainous region with challenging geometry such as steep grades and tight horizontal curvature. The southern portion of Highway 2 is located in a region producing palm oil, and rice which is either transported throughout the country or exported through the Pacific ports. In terms of the traffic mix on this highway, heavy trucks make up between 2 and 6 percent of all vehicles. This is likely due to the challenging mountainous terrain and the alternative route from San José to Paso Canoas. Additionally, Costa Rica's exports and imports with the Panama border comprise a small percentage of freight in terms of weight by road through international borders (between 15 and 20 percent) (Gonzalez, et al. 2008). The MOPT operates a weigh station near the Panama border crossing that processes approximately 160 trucks per day. Another weigh station, Ochomogo, is located on Highway 2 near San José that processes 2,870 trucks per day. The truck traffic at this location is characterized by a high percentage of small trucks (two-axle single unit trucks), due to its more urban setting. This is also not a primary thoroughfare for heavy trucks traveling to or from the country's international ports.	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 19, 2011 Between San José and San Isidro **Speed Limit:** 80 km/hr **Geometry:** Two-lane highway with narrow shoulders at some locations. Mountainous terrain with frequent steep grades and tight horizontal curvature. **Access Control:** Semi-limited **Design Issues:** No passing or turning lanes. Lack of passing lanes an issue as drivers take risks when passing slower moving heavy vehicles. Limited clear zone widths. **Percent Heavy Trucks*:** 6%
		 Photo by J. MacAngus, (2011)	**Time/Location of Photo:** May 19, 2011 between San Isidro and Palmar Norte **Speed Limit:** 50-80 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. **Access Control:** Semi-limited **Design Issues:** No passing or turning lanes. Limited truck activity along this segment. Multiple locations with infrastructure failures in need of maintenance and repair. **Percent Heavy Trucks*:** 2%

Note: * Heavy trucks consist of vehicles in classes 9-13 in the FHWA Scheme F classification system (Appendix B)

HWY	Significance to National Highway Network	Examples	Segment Properties
10	Highway 10 is an alternative route to Highway 32 connecting San José to the Atalantic coast ports of Limón and Moín. When a closure occurs on Highway 32 vehicles proceed on Highway 10. Highway 10 is typically restricted for heavy trucks due to its challenging geometry and is only used for heavy trucks in the event of closures on Highway 32. This highway is a two lane undivided highway in mountainous terrain with challenging geometry particularly for heavy trucks. The speed limit ranges from 40 to 60 kilometres per hour with the presence of school zones and pedestrian traffic along the roadside.	 Photo by J. Montufar, (2011)	**Location:** May 7, 2011 between Siquirres and Turrialba **Speed Limit:** 40-60 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. Mountainous terrain with frequent steep grades and tight horizontal curvature. **Access Control:** Semi-limited **Design Issue**s: No passing or turning lanes. Lack of passing lanes an issue as drivers take risks when overtaking slower moving heavy vehicles. Presence of school zones and pedestrians along roadside without designated space. **Percent Heavy Trucks*:** Unavailable
27	Highway 27 is a toll road connecting San José to the Pacific coast port of Caldera and is operated under a concession. It is an alternative and faster option to Highway 1. Highway 27 is a two-lane undivided highway at some locations while in others it is an undivided highway; shoulders are present at most locations in addition to passing and turning lanes. The speed limit is 80 kilometres per hour. Although this is a newly constructed highway it has experienced issues with slope stability during wet periods resulting in operational concerns. The severe wet weather system that hit Costa Rica in July and August 2010 resulted in bridge collapses and serious problems with slope stability.	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 17, 2011 Between Caldera and San José **Speed Limit:** 80 km/hr **Geometry:** Two-lane highway with presence of shoulders at most locations. Frequent passing and turning lanes provided. **Access Control:** Limited **Design Issues:** Newly constructed highway with issues in regards to slope stability during wet periods. **Percent Heavy Trucks*:** Unavailable

Note: * Heavy trucks consist of vehicles in classes 9-13 in the FHWA Scheme F classification system (Appendix B)

HWY	Significance to National Highway Network	Examples	Segment Properties
32	Highway 32 is crucial to the freight movement in Costa Rica due to its connection with the Atlantic coast ports in Moín and Limón. Highway 32 is the key route from San José to these ports; however, it experiences heavy rainfall resulting in frequent closures. Highway 32 has two distinct portions, the first is through mountainous terrain with limited access and the second through flatter terrain with frequent access points to towns and freight storage centers. This highway has speed limits ranging from 55 to 80 kilometres per hour with the presence of school zones and pedestrians on the roadside. Eleven percent of the traffic on this highway consists of heavy vehicles. The MOPT operates a weigh station directly on Highway 32 that weighs trucks in both directions of travel. The weigh station processes around 2,270 trucks per day (total for both directions). Trucks are typically traveling from the Nicaragua border, San José, or nearby farmland rich in fruit production, particularly bananas for export. There is an issue with traffic congestion within 20 kilometres of the city of Limón; this is discussed further in section 2.5.2.	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 6, 2011 Between San José and Santa Clara **Speed Limit:** 60-80 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. Occasional passing lanes. Mountainous terrain with frequent steep grades and tight horizontal curvature. **Access Control:** Limited **Design Issues:** Lack of passing lanes an issue as drivers take risks when overtaking slower moving heavy vehicles. The highway is susceptible to frequent closures due to side slope stability issues during wet periods. **Percent Heavy Trucks*:** 12%
		 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 6, 2011 between Santa Clara and Limón **Speed Limit:** 55-80 km/hr **Geometry:** Two lane highway with narrow shoulders. Relatively flat and straight terrain. **Access Control:** Semi-limited **Design Issues:** High frequency of pedestrians and cyclists traveling on roadside without designated space. Multiple school zones located along segment. **Percent Heavy Trucks*:** 11%

Note: * Heavy trucks consist of vehicles in classes 9-13 in the FHWA Scheme F classification system (Appendix B)

HWY	Significance to National Highway Network	Examples	Segment Properties
34	Highway 34 runs along the Pacific coast of Costa Rica connecting San José to Pacific coast ports and areas of agricultural production. Highway 34 has recently undergone construction completing the route from San José to the Panama border as an alternative route to Highway 2. Highway 34 allows vehicles to avoid traveling through the mountainous terrain experienced on Highway 2. Highway 34 is a two lane undivided highway with narrow shoulders. The speed limit ranges from 30 to 80 kilometres per hour. Heavy vehicles comprise around five percent of the traffic on this highway.	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 19, 2011 Between Palmar Norte and Caldera **Speed Limit:** 30-80 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. **Access Control:** Semi-limited **Design Issues:** No passing or turning lanes. **Percent Heavy Trucks*:** 5%
36	Highway 36 connects the ports of Limón and Moín to the Panama border crossing at Sixaola. The area surrounding Highway 36 is rich in banana produce destined for the ports of Limón and Moín. Highway 36 is a two lane undivided highway with speed limits ranging from 40 to 70 kilometres per hour. There is a high presence of pedestrians and cyclists traveling on the roadside in this area with multiple school zones. A small number of trucks traveling on Highway 36 cross at the Sixaola border crossing (approximately 50 trucks per day total).	 Photo by J. Montufar, (2011)	**Time/Location of Photo:** May 7, 2011 Between Limón and Sixaola **Speed Limit:** 40-70 km/hr **Geometry:** Two lane highway with narrow shoulders at some locations. Relatively straight and flat terrain. **Access Control:** Semi-limited **Design Issues:** High frequency of pedestrians and cyclists traveling on road side without designated space. Multiple school zones located along segment. Failing infrastructure observed at some locations in terms of pavement condition. No passing or turning lanes. **Percent Heavy Trucks*:** Unavailable

Note: * Heavy trucks consist of vehicles in classes 9-13 in the FHWA Scheme F classification system (Appendix B)

2.2 INTERNATIONAL TRADE

With respect to international trade patterns, goods are predominantly exported through the Atlantic coast in Costa Rica. Both the Atlantic and Pacific coasts handle imports. Details of the freight moved in and out of Costa Rica in 2008 are presented in Figure 5.

In terms of international freight movement in and out of Costa Rica by road, the majority of freight is transported through the Northern border to Nicaragua. The Panama border crossings handle very little international freight at this time as shown in Figure 5. The following sections provide details on international freight specific to the ports and border crossings.

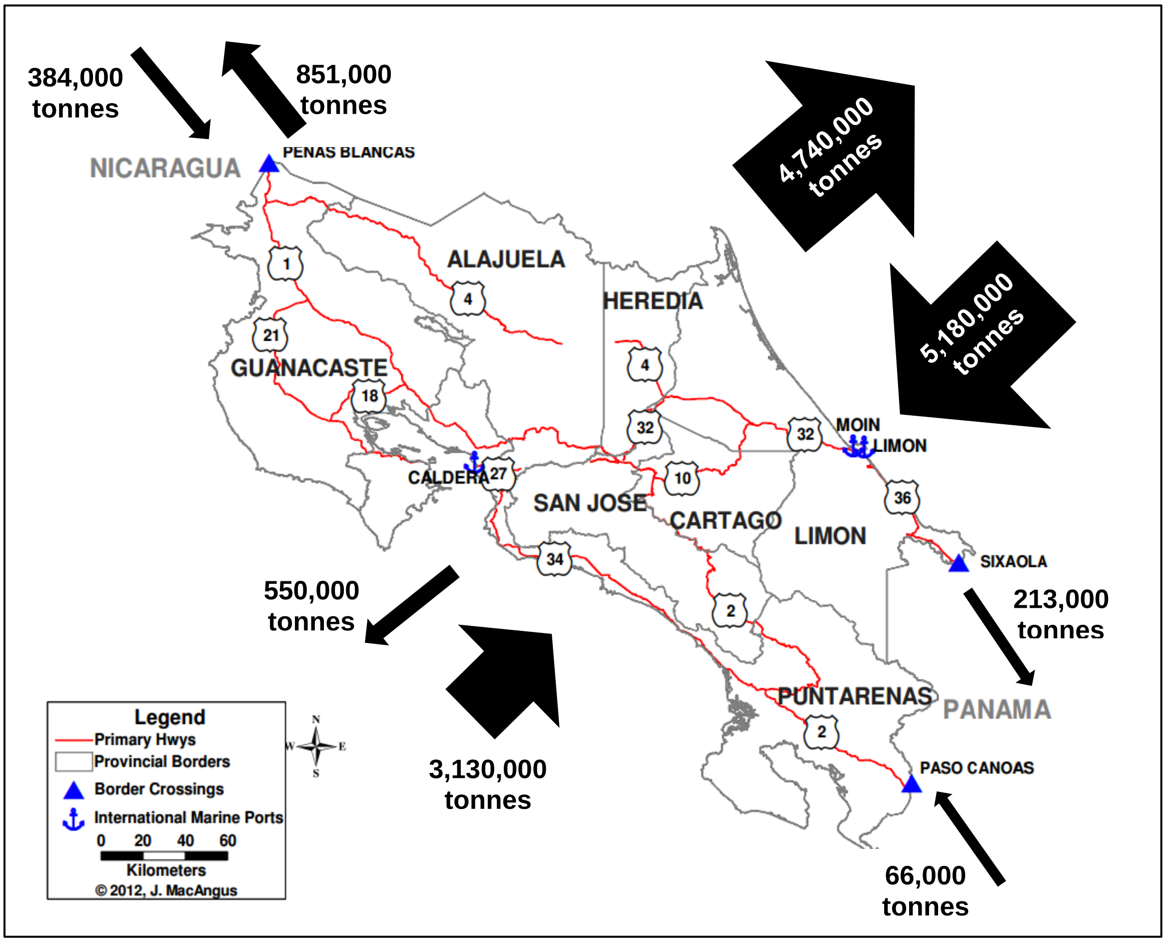


Figure 5: Freight Moved In and Out of Costa Rica in 2008
Source: Developed by Jane MacAngus using data provided by MOPT

2.3 RAILWAY NETWORK

Costa Rica has two national freight railways: (1) Atlantic Railroad, and (2) Pacific Railroad. These are shown in Figure 6.

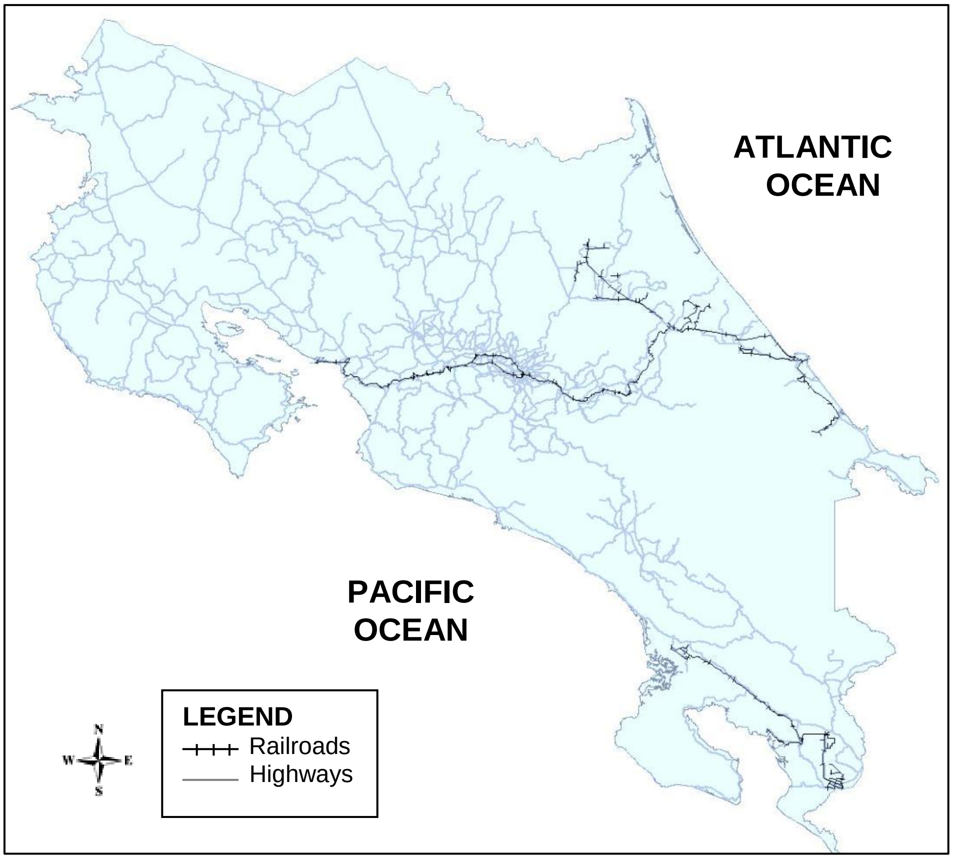


Figure 6: Railroads in Costa Rica
Source: Modified from LANAMME

While the railroad network is extensive, only a small fraction is in use (MOPT, 2010b). Table 2 shows the commodities moved by the two railroads between 2005 and 2009. In 2009 the railroads moved approximately 231,254 tonnes of freight; this is equivalent to approximately two percent of the freight moved annually by Costa Rica's international ports. This further emphasizes the dependence on trucks for freight transportation by land within the country and to surrounding regions. The majority of freight handled by the Atlantic railroad consists of bananas and iron. The Pacific railroad carried a total of

12,384 tonnes of iron ore and grains in 2006, and has since been out of service for freight transportation (MOPT, 2010b).

Table 2: Commodities Moved by Costa Rica Railroads (tonnes)

Year	Product	Pacific Railroad	Atlantic Railroad	Total
2005	Bananas	0	73,697	73,697
	Iron	2,861	45,288	48,149
	Grain	9,229	0	9,229
2006	Bananas	0	173,034	173,034
	Iron	2,593	61,585	64,178
	Grain	9,791	0	9,791
2007	Bananas	0	105,082	105,082
	Iron	0	126,172	126,172
	Grain	0	0	0
2008	Bananas	0	105,082	105,082
	Iron	0	126,172	126,172
	Grain	0	0	0
2009	Bananas	0	105,082	105,082
	Iron	0	126,172	126,172
	Grain	0	0	0

Source: Modified from MOPT and Instituto Costarricense de Ferrocarriles (INCOFER) (2010)

2.4 INTERNATIONAL BORDER CROSSINGS

There are three border crossings between Costa Rica and its surrounding countries, Nicaragua and Panama. The border crossing between Costa Rica and Nicaragua is located to the north at Peñas Blancas and the border crossings with Panama are located in the south at Paso Canoas and Sixaola. Figure 7 presents the locations of the border crossings.

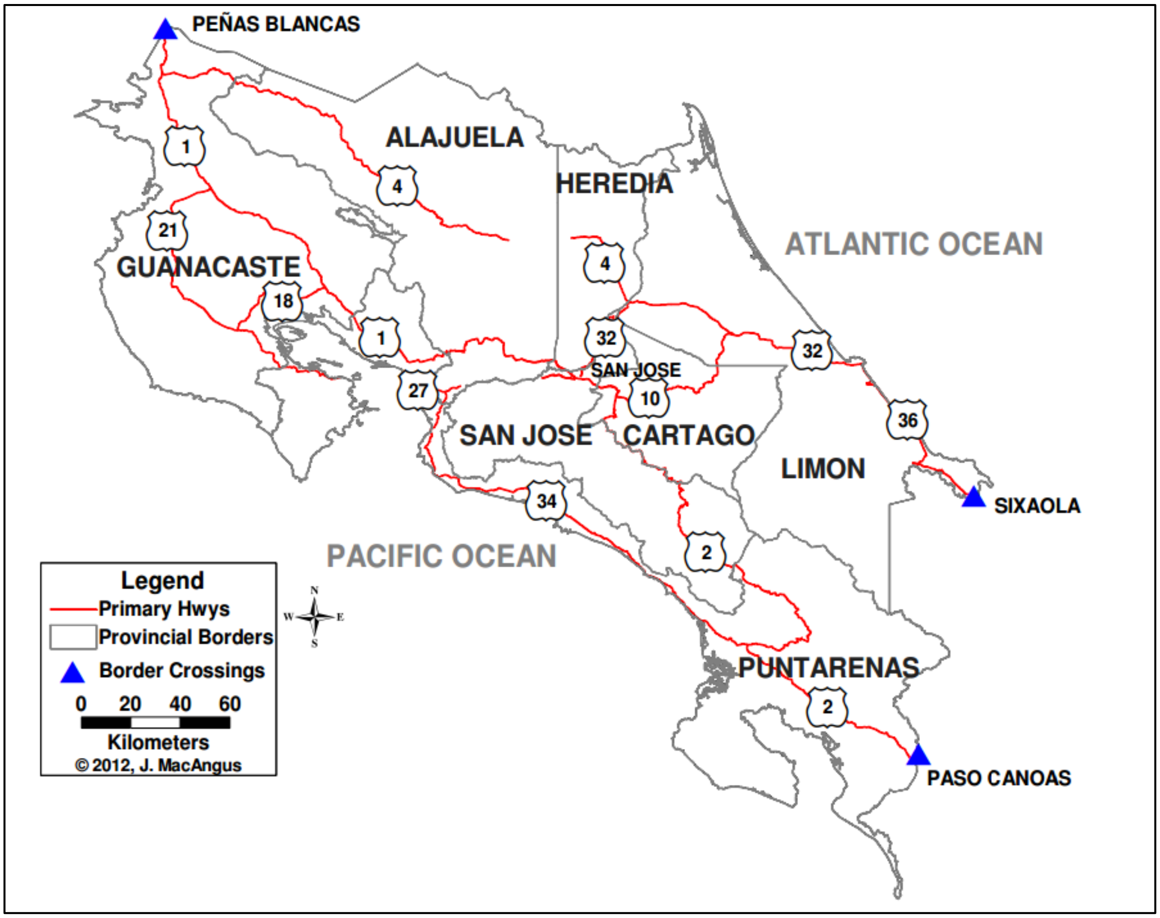


Figure 7: International Border Crossings in Costa Rica
Source: Developed by Jane MacAngus using data provided by MOPT

Each of the three border crossings is unique in terms of operations, vehicle volumes, and infrastructure. Table 3 presents an overview of each of the three border crossings resulting from field visits to each of the crossings and personal interviews with officials operating at each of the locations.

Table 3: Description of Costa Rica's National Borders

PEÑAS BLANCAS

Border Crossing: Costa Rica and Nicaragua
Processing Time for Trucks: Up to 3 days
Issues: The Nicaragua border crossing experiences issues with the processing and throughput of trucks. Trucks queue prior to crossing the border with waiting periods of up to three days. There is insufficient truck parking facilities at the border location resulting in trucks parking directly on the Pan-American Highway. Trucks parked on the highway pose a safety risk to other road users.

PASO CANOAS

Border Crossing: Costa Rica and Panama
Processing Time for Trucks: Several hours
Issues: The crossing has recently undergone geometric upgrades to better accommodate trucks.

SIXAOLA

Border Crossing: Costa Rica and Panama
Processing Time for Trucks: Several hours
Issues: The Panama border crossing at Sixaola has experienced serious infrastructure deterioration. The current bridge was constructed in 1908 and was utilized for rail operations. There are plans to construct a temporary bridge 50 metres away from the current site with a permanent structure being constructed 500 metres from the site at a later time (MOPT, 2011). Planning for these projects has been ongoing for 10 years. Trucks, passenger vehicles, bicycles, and pedestrians all utilize the current bridge although the future plans incorporate cyclist and pedestrian accommodation.

Photos by J. MacAngus, (2011)

In terms of international freight movement in and out of Costa Rica by road, the majority of freight is transported through the Northern border to Nicaragua. The Northern border accounts for 80 percent of exports and 85 percent of imports in terms of weight, by road. Table 4 gives details of freight transportation by road in Costa Rica to its surrounding countries, Nicaragua and Panama.

Table 4: International Freight Transport by Road in Costa Rica in 2007

	Exports		**Imports**	
	Tonnes	**%**	**Tonnes**	**%**
Nicaragua	851,486	80	383,585	85
Panama	213,025	20	66,540	15
Total	1,064,511	100	450,125	100

Source: Modified from Gonzalez, et al. (2008)

2.5 MAJOR MARINE PORTS

Costa Rica has a total of seven international marine ports, five located on the Pacific coast and two on the Atlantic coast (MOPT, 2010b). Three of the seven ports are responsible for moving the majority of international freight by sea. Moín is the largest port in Costa Rica in terms of tonnage followed by the Caldera Port and the Limón Port. Moín is located on the Atlantic coast 150 kilometres from San José, and six kilometres from the Limón Port. The Caldera Port is located on the Atlantic coast approximately 80 kilometres from San José.

The four additional international ports in Costa Rica are: Puntarenas, Quepos, Golfito, and Punta Morales. Puntarenas typically serves cruise ships and handles little freight. Quepos accommodates small boats often used for tourism and fishing. Golfito mainly exports palm oil and agricultural products in addition to accommodating fishing, tourism, and commercial activity. Punta Morales is used almost exclusively for the export of sugar (MOPT, 2010b). The locations of the seven ports are shown in Figure 8.

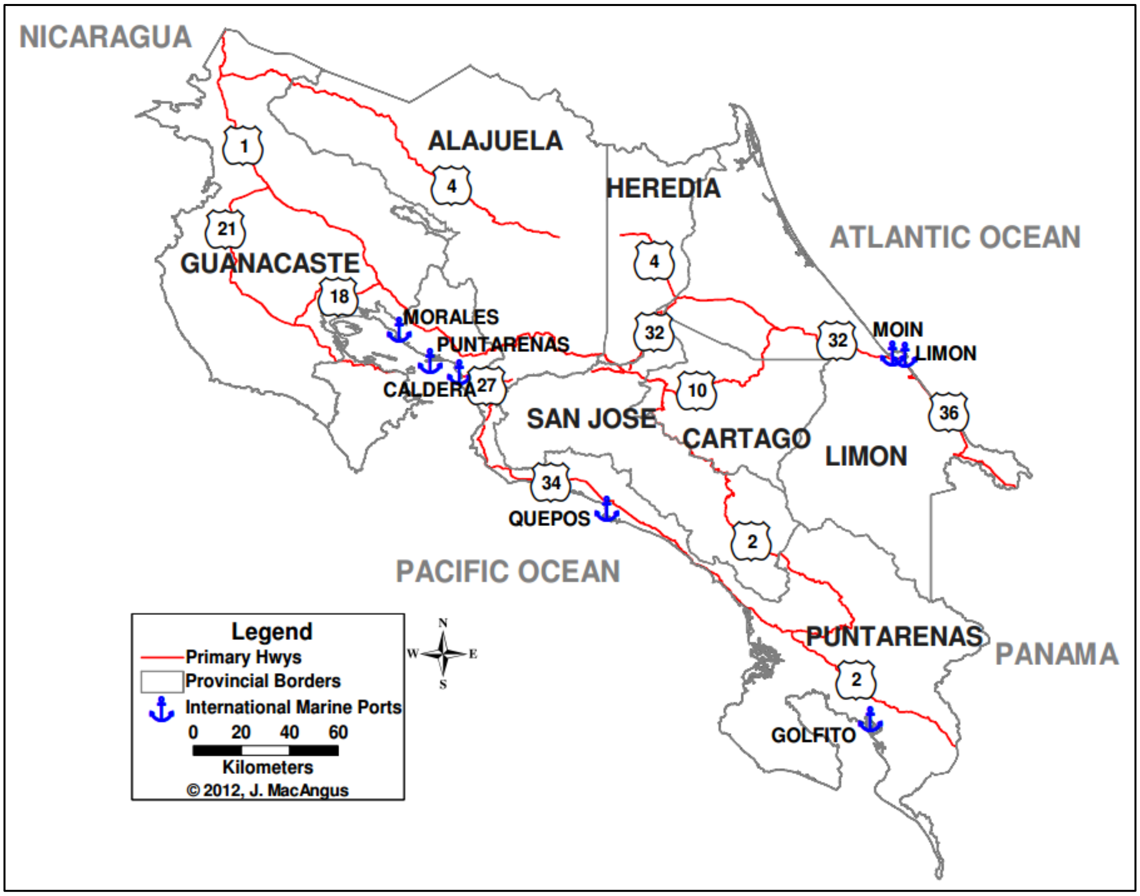


Figure 8: International Marine Ports in Costa Rica
Source: Developed by Jane MacAngus using data provided by MOPT

2.5.1 Overall Port Activity

The MOPT provides an annual report of incoming and outgoing cargo by sea in Costa Rica (Gonzalez, et al. 2008). A full list of cargo moved by five of the international ports in Costa Rica is shown in Table 5.

Table 5: Cargo Moved by Costa Rica Ports in 2007

Movement Type	Total (tonnes)	Port (tonnes)				
		Limón	**Moín**	**Caldera**	**Puntarenas**	**Punta Morales**
Total	13,601,333	2,866,697	7,053 920	3,324 002	1,384	355,330
Shipping	5,291,027	1,369,709	3,370,363	367,752	648	182,555
Landing	8,310,306	1,496,988	3,683,557	2,956,250	736	172,775

Source: Modified from Gonzalez, et al. (2008)

Costa Rican ports move approximately 13,600,000 tonnes of freight annually. This translates to approximately 37,000 tonnes per day that in turn translates to approximately 1,500 25-tonne trucks operating daily in the vicinity of Costa Rica's ports.

There were 2,999 ships entering and leaving the ports of Costa Rica in 2009. Nearly half of these ships were container ships (1,200) followed by refrigerated (802) and passenger vessels (251). Limón and Moín handled 2,326 (78 percent) of these ships (INEC, 2010).

The largest commodity moved (total inbound and outbound) in 2007 by Costa Rica's ports in terms of weight was bananas in containers (2,289,431 tonnes) followed by petroleum and derivatives (2,238,342 tonnes), and fruit containers (1,521,468 tonnes).

2.5.2 Limón and Moín Ports

Truck access to Limón and Moín via Highway 32 is identified as a concern associated with the ports due to congestion (MOPT, 2010b). There is a particular issue with traffic within 20 kilometres of Limón due to increased population density and the confluence of several routes serving the Limón and Moín ports. The situation is further aggravated by the presence of sixteen container storage terminals within 10 kilometres of Limón and Moín. These facilities help to alleviate the lack of current space on the docks; however, they contribute largely to the traffic congestion experienced on Highway 32 near the ports. The lack of space on the docks and the need for terminals is also dysfunctional in terms of the logistical flow of goods and additional costs incurred for the required multi-modal procedures. The Moín and Limón ports are shown in Figure 9.

Moín **Limón**

Figure 9: Moín and Limón Ports
Source: Google Maps (2012)
Notes: Not to scale.

The Limón and Moín ports are currently accessed by land in three ways. The key method is trucking which creates issues in the town of Limón as it contributes to congestion, noise, and pollution. Moín is connected to a minor operational railway serving nearby banana production and industrial centers. Additionally, there is a pipeline at the Moín port for transporting petroleum and derivatives to nearby refineries and storage centers.

The ports of Limón and Moín are located within proximity of one another although the two sites serve different purposes. Royal Haskoning (2008) reports that the port of Limón primarily handles containers while the Moín port is a banana pier with an oil terminal. The port of Moín experienced physical alterations in 1991 due to an earthquake which caused the sea floor to lift 1.5 metres, adversely affecting the capacity of the vessels on the permitted draught. Dredging has been done to mitigate this problem; however, the original condition has not been restored. Royal Haskoning (2008) states that the port is currently faced with congestion issues resulting in time delays for ships. Future developments for the Moín port are discussed in Section 5.1.

2.5.3 Caldera Port

Imported goods account for 89 percent of the freight in terms of weight that is moved at the Port of Caldera (Gonzalez, et al. 2008). The Caldera port was recently concessioned and since then container movement has nearly doubled (López and Shankar, 2011). The port has approximately 500 metres of berths, and storage yards covering more than 70,000 square metres (World Port Source, 2012). Figure 10 shows an aerial veiw of the Caldera port.

Figure 10: Caldera Port
Source: Google Maps (2012)
Notes: Not to scale.

2.6 TRANSPORTATION SYSTEM CONSTRAINTS

The research identifies two types of constraints related to the freight transportation system in Costa Rica: (1) operational constraints; and (2) engineering infrastructure constraints.

2.6.1 Operational Constraints

Traffic operations impact truck efficiency and productivity through traffic congestion that in turn, increases costs to shippers, consumers, and the environment. Freight transportation capacity is often constrained by geography, population density, and urban land use patterns resulting in increased congestion, travel delays, emissions, and commercial operational cost (NCFRP, 2010). Similarly, increased congestion and delay make the transportation system less reliable, making businesses less competitive and resulting in increases to the cost of goods and services for consumers on the whole (NCFRP, 2009). The following observations relate to this issue:

- Traffic congestion was observed to be a barrier to freight movement in several instances. Particularly near the urban centre of San José and the ports of Moín and Limón. Both of these locations experience some of the highest truck volumes in the country (between 2,200 and 2,900 trucks per day) and are primary freight activity centers of great importance to the economic development of the region. Highways leading to these areas also experience congestion. Figures 11a and 11b provide examples of delays due to traffic congestion near the Limón and Moín ports.

(a) **(b)**

Figure 11: Traffic Congestion near the Limón and Moín Ports
Photos by J. Montufar, (2011)

- The closures of highways due to unexpected events such as collisions or planned events such as highway maintenance were identified as a serious source of delays. In the event of a collision or highway closure there are few alternative network options for not only trucks but passenger vehicles. In most cases vehicles must wait until the problem is handled. Figures 12a and 12b present two examples of highway closures causing delays. Figure 12a illustrates a collision that occurred on the Pan-

American Highway that closed the highway for three hours. This resulted in delays of up to five hours for traffic movement. Figure 12b shows traffic congestion near Limón due to port capacity constraints.

(a)

(b)

Figure 12: Highway Closure Examples
Photos by J. Montufar, (2011)

- Border crossing delays were observed to be an issue at the Nicaragua border crossing that handles the majority of freight by land to surrounding countries. The delays at this border crossing have impacts on the efficiency of the freight transportation system and also contribute to safety issues due to trucks parking directly on the Pan-American Highway. Figures 13a and 13b demonstrate the queues that form at this location, resulting in up to three days for processing of trucks into Nicaragua. In both instances, the Figures show trucks parked along the highway, resulting in safety issues for other road users.

(a)

(b)

Figure 13: Border Delays at Peñas Blancas
Photos by J. MacAngus, (2011)

2.6.2 Engineering Infrastructure Constraints

According to NCFRP (2010) physical freight mobility constraints are: long, steep grades lacking passing lanes, inadequate radii of loop ramps at intersections or driveways into freight generators, obsolete freeway ramps built during a time of shorter trucks/trailer combinations, inadequate vertical or horizontal clearances, lack of adequate ingress/egress gates at ports and intermodal terminals, lack of sufficient rest areas and secure parking space for trucks, and lack of alternative routes for trucks. The following observations relate to this issue:

- Deterioration of roads due to adverse weather conditions mainly associated with heavy rains was a common occurrence on primary highways in the country. Bridge failures and side slope failures were all identified as being associated with these types of weather events. The deterioration or failures result in delays for both trucks and passenger vehicles and contribute to negative road safety impacts. Figure 14a shows a temporary bridge on the Pan-American Highway that reduced the capacity of the road to one lane. Figure 14b shows a river bank failure on Highway 2 that also reduced the capacity of the highway to one lane.

(a) **(b)**

Figure 14: Engineering Infrastructure Failures due to Heavy Rains
Photos by J. MacAngus, (2011)

- Many of the bridges currently used for freight movement in Costa Rica were constructed in the early 1950's and some much earlier (for example the Panama border crossing at Sixaola was constructed in 1908). The traffic characteristics operating on these bridges have changed significantly over time with heavier trucks being introduced to the country. The maintenance of bridge infrastructure and operations are key for the movement of freight in and around Costa Rica. Figure 15a shows an example of a bridge that was constructed in 1952 and Figure 15b shows a bridge that was constructed in 1908.

(a) (b)

Figure 15: Bridge Infrastructure in Costa Rica
Photos by J. MacAngus, (2011)

- The provision of truck specific infrastructure such as climbing lanes, passing lanes, and, truck run-offs were present at some locations but not many. This type of infrastructure promotes safety for all road users and helps to alleviate traffic congestion due to slower moving heavy vehicles. It allows faster vehicles to pass slower moving vehicles in a safe manner so drivers avoid engaging in risk taking behaviour in order to make these manoeuvres. Figure 16 presents examples where additional infrastructure considerations for trucks, such as passing lanes would be useful.

(a) (b)

Figure 16: Examples Where Truck Specific Infrastructure would be Helpful
Photos by J. Montufar, (2011)

2.7 SUMMARY

- Costa Rica has over 7,600 kilometres of National Highway with 64 percent of the network paved and the remaining 36 percent unpaved. The key connecting links of importance to the truck transportation system in Costa Rica consist of the National Highways 1, 2, 4, 10, 27, 32, 34, and 36. The highway network primarily consists of two-lane undivided highways with narrow shoulders and few passing lanes. The network characteristics vary throughout the different topographical regions in the country.

- Costa Rica has a railroad network on each coast, however, only a small fraction is in use for the movement of freight. The Pacific railroad ceased operations in 2007 while the Atlantic railroad continues to move a small amount of freight.

- Most international freight movement by road is moved through the Nicaragua border crossing (between 80 and 85 percent of all tonnage moved internationally by land). Issues associated with the border crossings comprise congestion and lack of truck parking areas at the Nicaragua border crossing, and deteriorating infrastructure at Sixaloa. Past studies demonstrate that the design and operating practices of border crossings in a corridor can significantly influence trucking productivity and efficiency.

- There are three primary ports in Costa Rica, serving the Atlantic and Pacific coasts. The ports are critical in moving freight in and out of the country and account for approximately 90 percent of all freight by weight leaving or entering the country. Current issues include congestion and lack of dock space at the Atlantic ports.

- Several transportation system constraints were identified as being barriers to the safe and efficient movement of freight within Costa Rica and to/from surrounding regions. These comprise operational constraints such as traffic congestion and highway closures due to collisions or road maintenance, and border crossing delays. Engineering infrastructure constraints primarily comprise deterioration or failure of infrastructure due to adverse weather conditions, ageing bridge infrastructure, and lack of truck specific infrastructure.

- Reliability of the transportation network is key to ensure freight is moved in an efficient and effective manner. Providing alternative options in the network for redundancy helps to ensure that freight arrives at its intended destinations in a timely manner. Access to marine transportation is critical to economic development because it is the primary means of importing and exporting goods in Costa Rica. Freight must be able to reach and leave these areas in a safe and reliable way.

3. TRUCK SIZE, WEIGHT, AND SAFETY REGULATIONS

This chapter addresses truck size, weight and safety regulations in Costa Rica. The chapter describes: (1) a general overview of truck size, weight, and safety regulations; (2) enforcement need; (3) legislative authority and enforcement practices in Costa Rica; (4) truck size and weight regulations in Costa Rica; and (5) truck safety regulations in Costa Rica.

3.1 TRUCK SIZE, WEIGHT, AND SAFETY REGULATIONS OVERVIEW

Truck size and weight (TS&W) regulations are of great importance to any country. They define the types of vehicles that may operate on roadways, protect infrastructure investment, ensure safety, and increase productivity of goods movement, among others.

The purpose of TS&W regulations is to control public costs associated with large trucks. The Transportation Research Board (TRB) suggests seeking the optimal balance between the public costs and the shipper and carrier costs to ultimately give the public the most effective transportation system (TRB, 2002). One of the primary purposes of TS&W regulations is to ensure compatibility of vehicles with roadway design and operations (Luskin & Walton, 2001). This is important to ensure that the types of trucks operating on a roadway can do so in a safe and efficient manner.

Truck size and weight regulations not only directly impact the transportation system but also contribute to societal issues such as economies of freight transport, condition of roadway infrastructure, traffic congestion, road safety, and the environment (Cambridge Systematics, 2009)

Truck safety regulations address driver-related issues, and the mechanical fitness of the vehicle, including the safe transport of the goods that they haul. Driver-related regulations comprise driver training, physical qualifications, hours of service, and log requirements (Knipling, 2009).

The Federal Motor Carrier Safety Regulations (FMCSA) in the United States discusses the following driver qualifications: physical qualifications, hours of service, and drug and alcohol testing. A truck driver's focus on the roadway and driving task is a principal safety factor. Driving ability can be impaired by fatigue, inattention or drug or alcohol use. In terms of fatigue issues, the provision of hours of service regulations help ensure that drivers only operate vehicles when they are alert and capable of handling the driving task. Also, truck drivers require appropriate parking facilities so they may rest and recover in order to prevent fatigue related collisions (Burks, et al. 2010).

The Commercial Vehicle Safety Alliance (CVSA) is an organization of local, state, provincial, territorial, and federal motor carrier officials in the U.S., Canada, and Mexico that are dedicated to achieving uniformity, compatibility, and reciprocity of commercial vehicle inspections, and enforcement. The North American Standard Inspection Program is one of CVSA's programs resulting in nearly four-million commercial motor vehicle inspections annually throughout North America to ensure that trucks driving on highways are operating safely.

There are seven different levels of inspection. In terms of the mechanical fitness of a vehicle, a Level 1 standard inspection would include: (1) brake systems; (2) coupling devices; (3) exhaust systems; (4) frames; (5) fuel systems; (6) lighting devices (headlamps, tail lamps, stop lamps, turn signals, and lamps/flags on projecting loads); (7) securement of cargo; (8) steering mechanisms; (9) suspensions; (10) tires; (11) van and open-top trailer bodies; (12) wheels; (13) rims and hubs; and (14) windshield wipers (CVSA, 2012).

3.2 ENFORCEMENT NEED

Enforcement is one the most important government activities in easing truck traffic costs (TRB, 2002). Enforcement with respect to the trucking industry consists of truck size and weight specifications, vehicle standards related to safety and environmental concerns, carrier qualifications, and driver qualifications (TRB, 2002).

The protection of highway infrastructure is a principal driving force for truck size and weight regulations. Their purpose is to mitigate the impacts of large vehicles on pavement and bridge infrastructure (US DOT, 2000). Overweight travel has been the topic of much research because of the relative importance of the economic consequences of overweight travel in the form of pavement and bridge damage (US DOT, 1995)

The degree of compliance depends greatly on resources and legislation and is further hampered by the difficulty in obtaining non-compliance rates of overweight vehicles (US DOT, 2000).

Principal elements for truck weight laws and regulation requirements are relatively simple to understand, enforce and are reasonable to the trucking industry and police standpoints. Effective enforcement is needed in order to deter those who disregard laws and regulations. Behaviour will only be changed if they face a high probability of being apprehended and receive costly fines and sanctions. Considerations in TS&W regulations should promote uniformity, simplicity and reasonableness for both industry and enforcement communities (US DOT, 1995).

3.3 LEGISLATIVE AUTHORITY AND ENFORCEMENT PRACTICES

The Ministry of Public Works and Transportation (MOPT) is responsible for the control and regulation of truck size and weight on public roads in Costa Rica. This further extends to the materials and goods they haul. Additionally, the regulations state that the government is responsible for the construction and operation of weigh stations on domestic routes for the purposes of regulation enforcement.

Four major weigh stations are administered by the MOPT on three primary highways in Costa Rica. These stations are located at Cañas, Búfalo, Ochomogo, and Villa Briceño. The locations of the weigh stations are presented in Figure 17. Descriptions of the operations of each station are shown in Table 6.

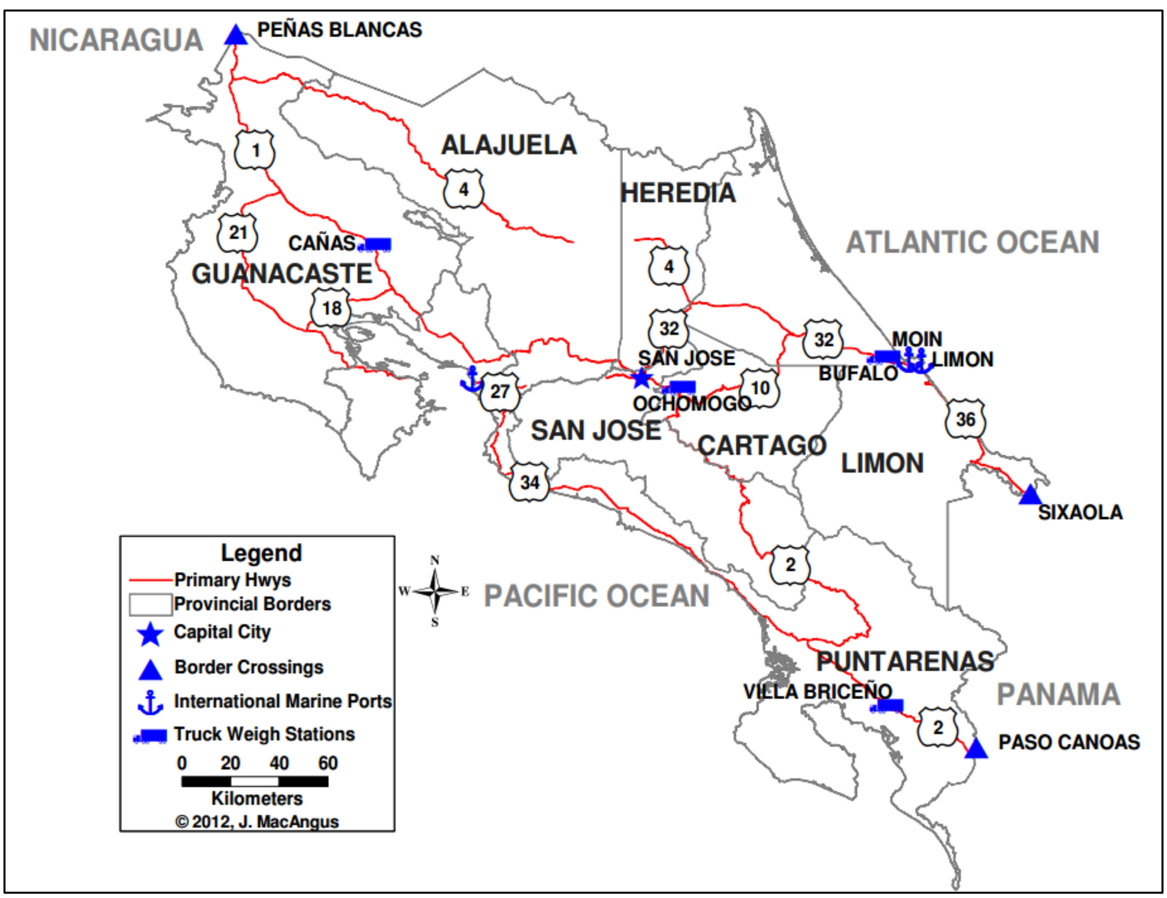


Figure 17: Primary Highways and Weigh Station Locations
Source: Developed by Jane MacAngus using data provided by MOPT

Table 6: Description of Weigh Stations Operating in Costa Rica

CAÑAS

Location: Pan-American Highway between Liberia and Palma
Hours of Operation: 24 hours per day, 365 days a year
Truck Direction of Travel: Southbound only
Volume of Trucks per Day: 320

BÚFALO


Location: Highway 32 between Siquirres and Limon
Hours of Operation: 24 hours a day, 365 days a year
Truck Direction of Travel: Eastbound and Westbound
Volume of Trucks per Day: 2,270 for two directions combined

OCHOMOGO

Location: Highway 2 near San José
Hours of Operation: 24 hours a day, 365 days a year
Truck Direction of Travel: Northbound and Southbound
Volume of Trucks per Day: 2,870 for two directions combined

VILLA BRICEÑO


Location: Highway 2 between Palmar Norte and Paso Canoas
Hours of Operation: 24 hours a day, 365 days per year
Truck Direction of Travel: Northbound only
Volume of Trucks per Day: 160

Photos by J. MacAngus, (2011)

While the MOPT is responsible for the control and regulation of truck size and weight on public roads they do not have the authority to enforce these regulations. The enforcement of regulations is the responsibility of the National Transit Police. Officials operating the weigh stations are only allowed to weigh the trucks but have no authority of issuing citations to vehicles that violate the law. If a violation occurs, the enforcement officials must contact the National Transit Police with a description of the vehicle for follow up. The vehicle may then be pulled over at a different location along the highway and the Transit Police can take appropriate action.

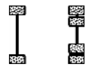
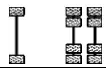
The officials operating the scales are also not authorized to address truck safety issues that they may encounter. For example, defective equipment is not addressed by the law and no-one has real jurisdiction over it.

It was observed during the course of the research and by the weigh scale operators that the vast majority of trucks enter weigh stations to be weighed despite the lack of physical enforcement presence at the stations. A small number of trucks bypass the weigh scales.

3.4 TRUCK SIZE AND WEIGHT REGULATIONS IN COSTA RICA

Costa Rica's truck size and weight regulations encompass 30 different truck classes. Four truck classes account for over 95 percent of the fleet: (1) two-axle single unit trucks (C2); (2) three-axle single unit trucks (C3); (3) five-axle tractor-semitrailers (T3-S2); and (4) six-axle tractor-semitrailers (T3-S3). Table 7 outlines the truck size and weight regulations for the four most common truck classes.

Table 7: Truck Size and Weight Regulations for Selected Truck Classes

Class	Axle Configuration	Maximum Allowable Weight (tonnes)*				Maximum Length (m)	Maximum Height (m)
		Axle Group			GVW		
		1st	2nd	3rd			
C2		6	10	-	16	12	4.15
C3		6	15	-	21	12	4.15
T3-S2		6	16.5	16.5	39	21	4.15
T3-S3		6	16.5	23	45.5	21	4.15

* Vehicles having up to four axles have a maximum tolerance of 0.5 tonnes on axle loads and vehicles with five or more axles have a maximum tolerance of 1.0 tonne per axle so long as the maximum allowable gross vehicle weight is not exceeded. The tolerance is not cumulative.
Source: MOPT

The four primary truck classifications in Costa Rica exhibit similarities to trucks operating in the U.S. and Canada because many trucks are imported from these countries as used vehicles, particularly large trucks (tractor-semitrailers with five or more axles). With similar vehicle types, Costa Rica has similar truck size and weight regulations for the four primary vehicle types.

Notable differences in truck size and weight regulations for North America and Costa Rica are identified below:

- Costa Rica's regulations limit maximum vehicle length of T3-S2s and T3-S3s to 21 metres while Canadian regulations allow up to 23 metres for these vehicle combinations. Imported vehicles in Costa Rica exceeding the allowable 21 metres exist due to vehicles exceeding this length in Canada. For example, this could include vehicles with 53-foot trailers combined with tractors with sleeper cabs. Although imported vehicles are inspected upon their arrival in the country, the owner or operator can choose to use a shorter trailer to meet the length restrictions at the time of the inspection for vehicle registration.

- The weight regulations for GVW and axle group weights are similar, particularly after applying the allowable one tonne tolerance for large trucks in Costa Rica.
- Due to the vast number of imported trucks operating in Costa Rica, the national truck size and weight regulations comprise 30 different vehicle classes. These classes emulate characteristics from different jurisdictions across the U.S. and Canada, and from different time periods. This results in imported vehicles operating on Costa Rica's highways that include trucks governed by outdated regulations or trucks that may not be suitable for the unique highway environment in Costa Rica.
- A very common vehicle type in Costa Rica includes lift axles. While these types of axles are not allowed in some North American jurisdictions, and are currently being discontinued in others, they are common in Costa Rica as a result of this equipment being acquired by Costa Rican trucking companies. The impact that lift axles have on the pavement is unknown but anecdotal evidence shows that these axles are not used in Costa Rica the way in which they are intended in the U.S. and Canada. In this context, lift axles are one of three axles (tridem axle group) on the rear of a trailer that can be lowered or lifted. This is shown in Figure 18.

Figure 18: Examples of Lift Axles in Costa Rica
Photos by J. MacAngus, (2011)

Tridem axle groups on the rear of a trailer allow for higher weights but may be lifted if a truck is empty or lightly loaded. There are advantages to operating lift axles as tire wear and fuel use reduces when an axle can be lifted when it is not needed (US DOT, 2000). The appropriate use of lift axles can be difficult to enforce because truck drivers can lower lift axles just prior to being weighed. Drivers could later lift the axle while still maintaining the weight that would be regulated for a tridem axle group rather than a tandem. This results in the trucks weight being dispersed over fewer axles then regulations require.

- The T3-S2 and T3-S3 vehicles are typically the largest trucks observed operating on Costa Rica's highways, although some 7-axle B-trains are also in operation.

3.5 TRUCK SAFETY REGULATIONS IN COSTA RICA

Costa Rica has no laws or regulations with regards to truck driver hours of service, roadside inspections or truck safety enforcement programs. The country does, however, have a nationally implemented program requiring the inspection of all vehicles. The government requires all vehicles (passenger and commercial) to undergo mandatory periodic mechanical inspections. These are done at fixed, state-of-the-art centers located around the country. All vehicles must pass inspections to receive a decal for operation.

3.5.1 National Vehicle Inspection Program

RITEVE is the national organization that conducts vehicle inspections. They verify that vehicles meet minimum safety standards, based on design criteria and manufacturing specifications. This is done under contract for the Costa Rican government. The vehicle inspection program has several objectives (RITEVE, 2010):

- Contribute to the reduction of collisions;

- Contribute to environmental conservation through effective control of emissions;
- Contribute to the optimization of energy consumption by improving the state of the vehicle fleet; and
- Cooperate with authorities in the protection of vehicle ownership.

The inspection process is completed in limited time without removing or handling any part of the vehicle. Vehicle owners in Costa Rica are required to book an appointment with RITEVE for their inspection. The time of year of the inspection is based on the last digit of the vehicle's license plate. The frequency of the required inspections is dependent on the age and type of vehicle as shown in Table 8.

Table 8: Frequency of Vehicle Inspections

Vehicle Age	Frequency
Newer than 5 years	Every 2 years
Older than 5 years	Every year
Public transport vehicle	Every 6 months

Source: Modified from RITEVE (2010)

RITEVE provides a checklist for operators so they may be more prepared for inspections and subsequently more likely to pass. The checklist for trucks consists of the condition of seat belts, speedometer, windshield, reflectivity of the vehicle, pollutants, and lighting among others.

After the inspection, vehicles are assigned one of four outcomes:

- Approved: vehicles with no issues.
- Approved with minor defect: vehicle owners not required to report back to the inspection facility but are urged to make the repairs on their own.
- Not approved with a serious defect: 30 days to address the issue and return to the inspection facility.

- Dangerous defects: no longer permitted to circulate until repaired and often removed from the inspection station with a tow-truck.

Table 9 presents inspection results for 2009. Commercial vehicles have some of the highest failing rates on initial inspection. Trucks with GVW under 3,500 kilograms had 62 percent of vehicles fail with serious defects while three percent failed due to dangerous defects; single unit trucks with GVW above 3,500 kilograms had 68 percent of vehicles fail with serious defects while six percent failed due to dangerous defects; and tractor-semitrailer combinations had 65 percent of vehicles fail with serious defects while three percent failed due to dangerous defects (RITEVE, 2009).

Table 9: RITEVE Vehicle Inspection Summary in 2009

Vehicle Type	Approved	Approved with Minor Defect	Not Approved with Serious Defect	Not Approved Dangerous Defect
Motorcycles	52.7	27.7	19.6	0.0
Passenger Vehicles	5.8	41.8	51.4	1.1
Taxis	3.6	29.8	65.2	1.5
Trucks <3,500 kg	2.7	33.1	61.6	2.6
Trucks >3,500 kg	1.1	24.7	68.4	5.8
Public Transportation	2.0	52.6	43.2	2.3
Special Transportation	3.3	42.7	51.8	2.3
Tractor– Semitrailers	4.5	27.7	64.6	3.3
Dangerous Goods	2.2	24.0	70.6	3.3
Other	1.8	39.8	56.6	1.7

Note: Totals may not sum to 100 due to rounding.
Source: Modified from RITEVE (2009)

Table 10 provides a summary for the types of defects found in commercial vehicles. Trucks greater than 3,500 kilograms are most likely to have an issue due to brake issues (42 percent), axle and suspension issues (27 percent), and signage issues (27 percent). Tractor-semitrailers have similar defects with 38 percent, 36 percent, and 20 percent, respectively. With slightly higher rejection percentages in these same categories, dangerous goods have defects of 40 percent, 34 percent, and 28 percent, respectively.

Table 10: Vehicle Type and Percentage of Vehicles not Approved in 2009

Vehicle Type	Exterior Condition	Body Work	Interior Condition	Signage	Lights	Brakes	Steering	Axles & Suspension	Engine	Other
Trucks <3,500 kg	13.2	5.1	2.2	10.8	6.3	29.8	16.0	17.8	25.6	0.6
Trucks >3,500 kg	14.8	10.3	3.9	27.1	13.0	42.1	15.8	27.2	16.2	1.6
Tractor – Semitrailers	11.4	5.9	1.2	21.0	8.1	38.2	0.1	36.4	0.9	0.0
Dangerous Goods	8.5	10.5	8.5	28.0	9.65	40.6	5.3	34.4	8.8	0.8

Note: Since vehicles may be rejected for failure in multiple categories percentages do not sum to 100.
Source: Modified from RITEVE (2009)

Table 11 outlines the basic thresholds for rejection for different types of defects for heavy trucks. From Table 10, heavy trucks have the greatest issues with brakes, axles and suspension, and signage in terms of rejection during inspection. The threshold for rejection based on brake condition is when brake adjustment imbalances exceed 35 percent for wheels on the same axle. Retro-reflectivity falls under a signage defect and heavy trucks typically fail during inspection in this category if the retro-reflectivity signage is either missing or inadequate.

Table 11: Heavy Truck Inspection Items and Rejection Thresholds

Inspection Item	Threshold for Rejection
Service Brakes	-Brake adjustment imbalance for wheels on the same axle >35 percent
Retroreflectivity	-Inadequate -Missing where required
Bumper	-Front bumper is missing or rear bumper allows vehicles to be embedded under trucks during a rear end collision
Wheels (dimensions and surface condition)	-Indentations <2mm wide on tire tracks
Joints and articulation	-Excessive movement
Light on rear licence plate	-Missing, not working or not attached properly
Emissions	-Don’t meet requirements to take emissions test -Don’t meet emission test requirements

Source: Modified from RITEVE (2009)

3.5.2 Issues with Current Inspection Program

Although the national vehicle inspections provide a certain level of coverage in terms of evaluating compliance with basic vehicle safety standards, the program does have limitations, particularly for large trucks. Two principal issues emerge from the research:

- Tractor-semitrailer combinations consist of two or more components. Typically, trailers in the best physical condition are chosen by the truck owners or operators for the inspection process, although a tractor hauls numerous trailers throughout the year. This results in trailers being excluded from the inspections and likely those in the poorest condition.
- Predictability of the inspection periods. With a scheduled inspection time an owner or operator can ensure that a vehicle passes at the time of inspection but the general day to day operating conditions of the vehicle could be quite different. Trucks are typically empty during the inspection procedure; however, issues could arise from the types of loads a vehicle is carrying and the securement of the load.

3.6 SUMMARY

- Truck size and weight regulations are intended to control the public infrastructure costs associated with large trucks. These regulations also ensure compatibility of vehicles with roadway design and operations.

- Safety regulations are important to ensure that truck drivers are well trained individuals with the appropriate physical qualifications to operate a vehicle in the safest possible manner. The provision of hours of service regulations also help to ensure that drivers only operate vehicles when they are alert and capable of handling the driving task. Additionally the mechanical working condition of a vehicle plays a principal role in safe trucking operations.

- The MOPT is responsible for the control and regulation of TS&W in Costa Rica; however, they do not have the authority to enforce regulations. The enforcement of regulations is the responsibility of the National Transit Police.

- Costa Rica's truck size and weight regulations encompass thirty different truck classifications. The four primary truck classifications in Costa Rica exhibit similarities to trucks operating in the U.S. and Canada as many trucks are imported from these countries as used vehicles. With similar vehicle types, Costa Rica has similar truck size and weight regulations for the four primary vehicle types.

- Imported vehicles emulate characteristics from different jurisdictions across the U.S. and Canada, and from different time periods. This results in imported vehicles operating on Costa Rica's highways that include trucks governed by outdated regulations or trucks that are not be suitable for the unique highway environment in Costa Rica.

- Costa Rica has no laws or regulations with regards to truck driver hours of service, roadside safety inspection or enforcement programs. Costa Rica does have a nationally implemented program requiring the mechanical inspection of all vehicles. The government requires all vehicles (passenger and commercial) to undergo mandatory periodic mechanical inspections.

- Commercial vehicles have some of the highest failing rates on initial mechanical fitness inspection. Failures are most common for brake issues, axle and suspension issues, and signage issues. However, only a small percentage of vehicles are cited for dangerous defects, and banned from continued operation. Between 62 and 71 percent of trucks failed the inspection due to serious defects while two to six percent failed due to dangerous defects.

4. TRUCKING ACTIVITY AND OPERATING WEIGHTS

This chapter describes the trucking activity and operating weights of trucks in Costa Rica. The chapter describes: (1) data sources used for the analysis, (2) Costa Rica's truck fleet, (3) vehicle body type distribution, (4) operating weights of trucks in Costa Rica, and (5) a discussion about truck operating weights.

4.1 DATA SOURCES

Three data sources were utilized in understanding different aspects of the truck fleet in Costa Rica: (1) permanent weigh stations, (2) temporary automatic vehicle classifiers, and (3) manual counts. The permanent weigh stations provide the most robust data set because they count year round, 24 hours a day. Over two million records are available for the 2010 year. Data from the temporary vehicle counters consist of 10 48-hour counts on primary highways. Manual counts were recorded from February 2011 through to May 2011 for the purpose of collecting vehicle body types. The weigh stations and temporary automatic vehicle classifiers do not collect this information. These data sets are described in the following sections.

4.1.1 Permanent Weigh Stations

The four weigh stations operating in the country collect data on every truck 24 hours through the year. Data from 2010 are used in this research and consist of 2,050,186 truck records. The stations collect the following information for every truck weighed: date, time, speed while crossing scale, vehicle classification, and the weight of each axle. The vehicle classification is assigned manually by a technician. Weigh station locations and descriptions are presented in Section 3.3.

4.1.2 Temporary Automatic Vehicle Classifier Counts

As part of this research, LANAMME assisted in implementing automatic vehicle classifiers at 10 locations on primary highways in Costa Rica. Counts were conducted between June 21, 2011 and July 26, 2011. All counts were a minimum of 48 hours in length beginning on a Tuesday and ending on a Thursday.

MetroCount classifying equipment was used to collect the data. Directional travel was of interest to this research and counts were collected in this manner. To achieve this, two counters were used at each site as this is the most accurate way for this type of counter to obtain directional counts. The count data presents traffic characteristics in terms of vehicles by classification, and hour of day.

The FHWA classification Scheme F was selected as the classification scheme for the counters; details of the classification scheme can be seen in Appendix B. Scheme F was selected due to its similarities with the observed Costa Rican truck fleet. Many vehicles are imported from the U.S. and Canada to Costa Rica making the classification Scheme F well suited for this application. Some issues arose in regards to the classification of small trucks that are further described in Section 4.2.

Sites were selected based on their relevance to the freight transportation system in Costa Rica. Locations near weigh stations were avoided as data are already available at these sites. Counters were dispersed across the country to provide a comprehensive understanding of the traffic characteristics on Costa Rica’s primary highways. The counter locations are shown in Figure 19.

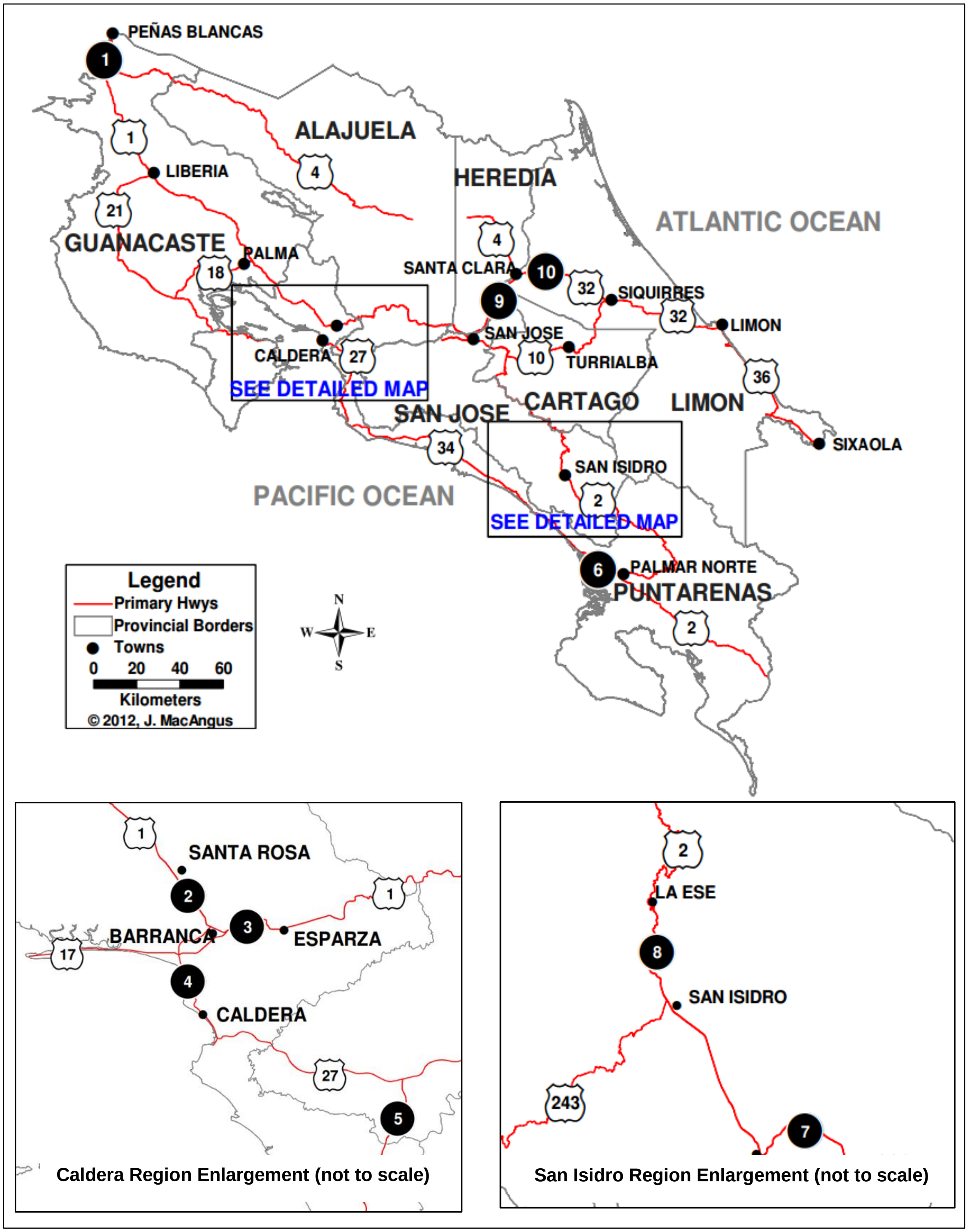


Figure 19: Location of Automatic Vehicle Classifiers
Source: Developed by Jane MacAngus using data provided by MOPT

4.1.3 Manually Collected Counts

Manual counts and classification data were recorded by the author while driving Costa Rica's primary highways. Counts took place on National Highways 1, 2, 10, 14, 18, 27, 32, 34, and 36 between February 2011 and May 2011. Counts were recorded during daylight hours between 7:00 am and 7:00 pm. The counts were taken at various hours throughout the day and included counts on both weekdays and weekends. These counts provide an overview of the truck fleet operating on Costa Rica's primary highways in terms of vehicle classification and body type.

4.2 COSTA RICA TRUCK FLEET

The truck fleet in Costa Rica primarily consists of vehicles in the C2, C3, T3-S2, and T3-S3 classes as indicated earlier. These four classes account for 95 percent of the truck fleet. In terms of understanding the truck classifications in the North American context:

- Costa Rica's C3 classification is similar to the FHWA Scheme F Class 6 vehicle (3-axle, single unit).
- The T3-S2 vehicle classification is comparable to the FHWA Scheme F Class 9 vehicle (5-axle, tractor-semitrailer).
- The T3-S3 vehicle classification is comparable to the FHWA Scheme F Class 10 vehicle (6 or more axle, tractor-semitrailer).
- The C2 vehicle classification posed an issue in terms of comparison to the North American situation. There was great variability in terms of the size of two axle single unit vehicles in Costa Rica. These vehicles comprise nearly 40 percent of the truck fleet as observed from the weigh station and manually collected data. This is not reflected in the automatic vehicle classifiers as some of these vehicles would be classified under FHWA Scheme F Class 3 (2-axle, 4-tire single unit) or Class 5 (2-

axle, 6-tire single unit) vehicles. Figure 20 shows the variety of observed C2 vehicles operating on primary highways in Costa Rica.

Figure 20: Examples of C2 Vehicles Operating in Costa Rica
Photos by J. MacAngus, (2011)

The following sections present findings regarding vehicle classification based on the three available data sources.

4.2.1 Weigh Station Vehicle Classification Results

The distribution of vehicle types was determined across the four weigh stations individually. The results were then combined to better understand the truck fleet in Costa Rica as a whole. Figure 21 depicts the distribution of vehicles for each weigh station and the distribution across the four stations combined.

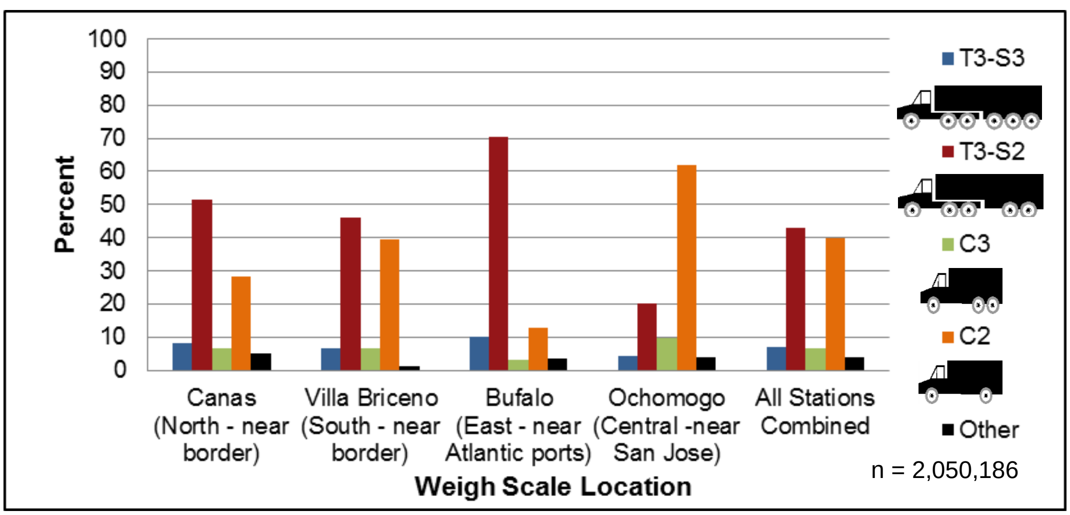


Figure 21: Vehicle Classification at Weigh Stations
Source: Created from analysis using data provided by MOPT.

The results of the analysis are summarized as follows:

- Four vehicle classes (C2, C3, T3-S2, and T3-S3) account for 95 percent of the truck fleet operating in Costa Rica (40 percent C2s, 7 percent C3s, 43 percent T3-S2s, and 7 percent T3-S3s). The remaining 26 vehicle classes account for 5 percent of the fleet.
- At the Cañas weigh station (located near the Nicaragua border), about half of the fleet is made up of T3-S2 trucks, followed by C2s, which account for nearly 30 percent. Other truck types account for the remaining 20 percent.
- Similarly, the Villa Briceño weigh station (located near the Panama border) has 46 percent T3-S2 vehicles, and 40 percent C2 vehicles.
- At the Búfalo station (located near the Atlantic ports of Limón and Moín), 70 percent of the fleet comprises T3-S2s. Other vehicle types account for the remaining 30 percent, with T3-S3s and C2s accounting for about 10 percent each. This reflects the haulage of containers to the and from the ports.
- At the Ochomogo weight station (located near San José), 62 percent of the fleet is comprised of C2 vehicles, followed by 20 percent T3-S2 vehicles. This disproportionate number of smaller trucks represents the distribution activities among the principal cities that are located in and around the San Jose Valley.

4.2.2 Automatic Vehicle Classifier Results

The weigh stations collect vehicle classification data by manually assigning vehicle classes to each passing vehicle. This could not be determined to the same degree using automatic vehicle classifiers due to issues with defining and identifying C2 vehicles automatically. Because of this, vehicles were divided into four categories in the automatic vehicle classifier data:

- C3 (FHWA Class 6)
- T3-S2 (FHWA Class 9)
- T3-S3 (FHWA Class 10)
- all other trucks (FHWA Classes 5, 7, 8, 11, 12, and 13)

Figure 22 presents the percentage of trucks by type and counter location.

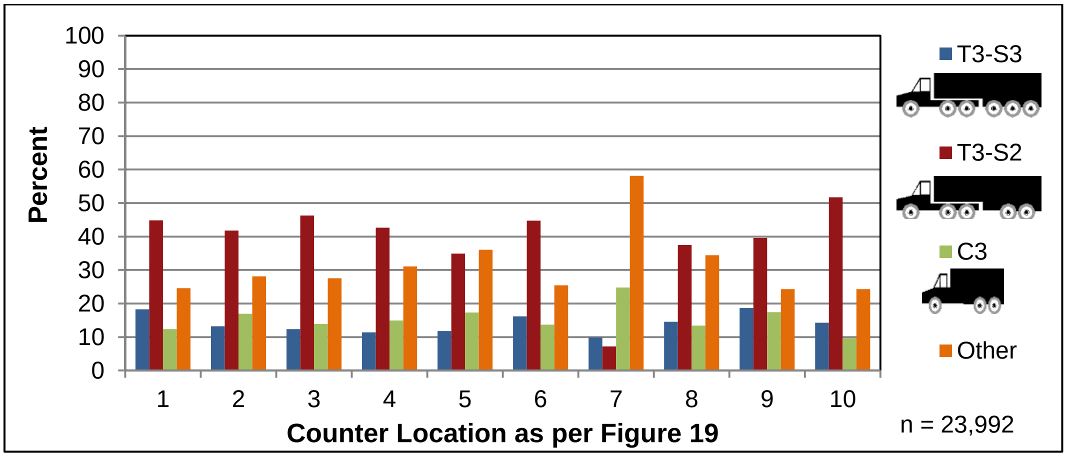


Figure 22: Percentage of Trucks by Type and Counter Location
Note: Reference Figure 19 for counter locations.
Source: Created from analysis using data provided by LANAMME.

The results of the analysis are summarized below:

- In terms of the truck fleet mix at different locations throughout Costa Rica, the majority of stations saw a higher percentage of T3-S2 vehicles than any other configuration accounting for between 35 and 52 percent.
- Counter location seven, located near San Isidro was the only exception to this. Counter seven is located on Highway 2 near San Isidro that is characterized by mountainous terrain. This station has a high percentage of C2 vehicles (58 percent).
- The highest percentage of T3-S2 vehicles (52 percent) is at counter location 10 located on Highway 32 between Siquirres and Santa Clara. This highway serves a primary freight activity center at the ports of Moín and Limón.

4.2.3 Comparison of Data Sources for Fleet Mix Composition

The results of the analyses of the three data sources are compared to understand trends in vehicle characteristics throughout the country. Results are presented in Table 12.

Table 12: Comparison of Percentage by Class from Weigh Station Data, Manual Counts, and AVCs

Vehicle Class	Weigh Station Data (Percent)	Manual Counts (Percent)	Automatic Vehicle Classifiers (Percent)
Total Records	2,050,186	2,047	23,992
C2	40	37	N/A
C3	7	9	15
T3-S2	43	40	42
T3-S3	7	12	14
Other	3	2	29
Total	100	100	100

N/A – Not applicable

The table shows the following:

- The weigh station classification counts consist of 2,050,186 records, manual counts consist of 2,047 records, and the automatic vehicle classifiers comprise 23,992 records.
- The percentage of C2 vehicles is consistent between the weigh station counts and manual counts (40 and 37 percent, respectively). As indicated earlier, it was not possible to classify C2 vehicles using the automatic classifiers.
- The T3-S2 class is consistent between the three data sources comprising 40 to 43 percent of the truck fleet.
- The T3-S3 distribution varies across data sources ranging from 7 to 14 percent of the fleet.
- The C3 distribution also varies across data sources ranging from 7 to 15 percent of the fleet.
- The "other" category is significantly larger in the automatic vehicle classifier data due to many C2 vehicles being classified under this category.

4.3 VEHICLE BODY TYPE

The manual counts were used primarily for collecting body type and classification data that could not be obtained from the other two data sources. Examples of common body types together with their relative proportion within the truck fleet are shown in Table 13.

Table 13: Common Truck Body Types in Costa Rica

Configuration	Example	Percent of Fleet (n=2,047)
Van (with and without reefer units)		39
Container (20’ and 40’)		20
Box		13
Flat Deck		11
Dump		9
Tanker		5

Source: Percentages based on data collected by the author between February and May 2011. A range of other truck body styles account for the remaining three percent.
Photos by J. MacAngus, (2011)

The body types varied across the four primary vehicle classifications as shown in Figure 23. The results of the analysis are as follows:

- C2 vehicles are mainly composed of van body types (61 percent) followed by box body types (30 percent).
- C3 vehicles are typically dump vehicles (51 percent) followed by van body types (19 percent), and some flat decks and boxes (11 percent each).
- T3-S2 vehicles are typically container-carrying trucks (42 percent) or van style body types (30 percent). Containers are all international with 20 or 40 feet in length.
- T3-S3 vehicles consist largely of flat deck body types (33 percent), containers (21 percent), and vans (17 percent).

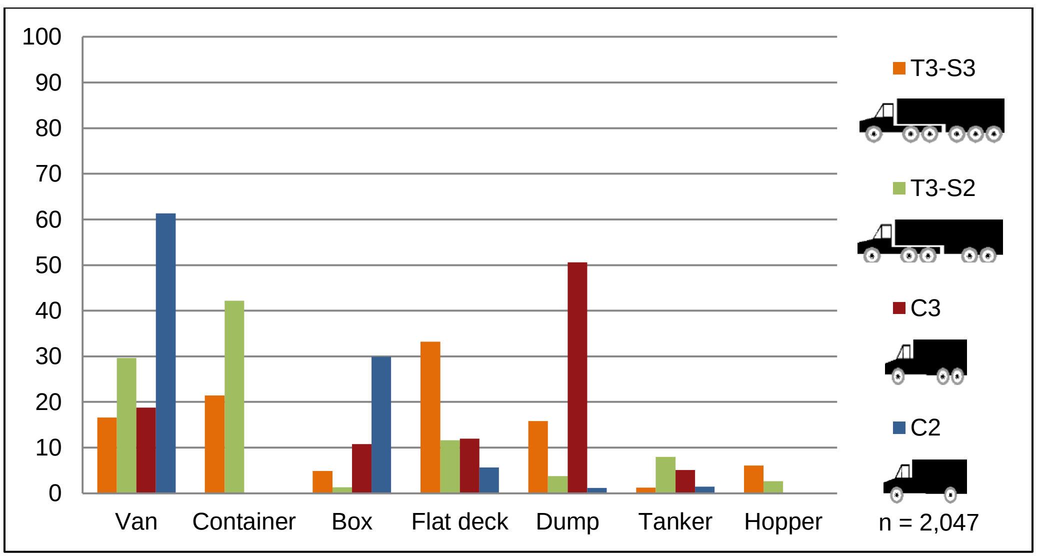


Figure 23: Percentage of Trucks by Body Type and Classification
Source: Manually collected between February and May 2011.

4.4 OPERATING WEIGHTS OF TRUCKS IN COSTA RICA

Data from the four weigh stations operating in Costa Rica were analyzed to obtain a better understanding of truck weight issues throughout the country.

4.4.1 Analysis Methodology

The weight data analysis consisted of combining the provided monthly weight data for each of the individual weigh stations. Analyses were then conducted for the four vehicle classes. The weight data were analyzed with respect to axle groups and gross vehicle weight (GVW). For example, the T3-S2 configuration was analyzed in terms of: (1) steering axle, (2) drive tandem, (3) rear tandem, and (4) GVW. Cumulative distribution graphs and frequency histograms were prepared for each of the axle groups and the GVW for each weigh station.

The C2 vehicle classification accounts for a wide variety of vehicles in terms of size within its respective class and for this reason the results of the C2 analysis were not the focus of this part of the research.

Appendix C provides frequency histograms and cumulative distribution graphs for all stations and each of the four vehicle types.

4.4.2 Weight Distribution of C3 Trucks

The four weigh stations recorded a total of 136,883 C3 vehicles in 2010. Details on percentages of overweight C3 vehicles by station are shown in Table 14.

Table 14: Non-Compliance of C3 Trucks with Weight Regulations

Station	N	Percent Overweight on GVW	Percent Overweight on Steering Axle Only	Percent Overweight on Drive Tandem Only
Búfalo (East-near Atlantic ports)	25,248	0.9	4.6	1.6
Cañas (West-near border)	7,895	2.8	10.3	3.8
Villa Briceño (East-near border)	3,705	1.7	5.1	2.5
Ochomogo (Central-near San José)	100,035	1.1	4.9	2.3
Total	136,883	1.2	5.2	2.2

Figures 24 and 25 show cumulative weight distribution graphs for steering axle groups and gross vehicle weights of C3 vehicles.

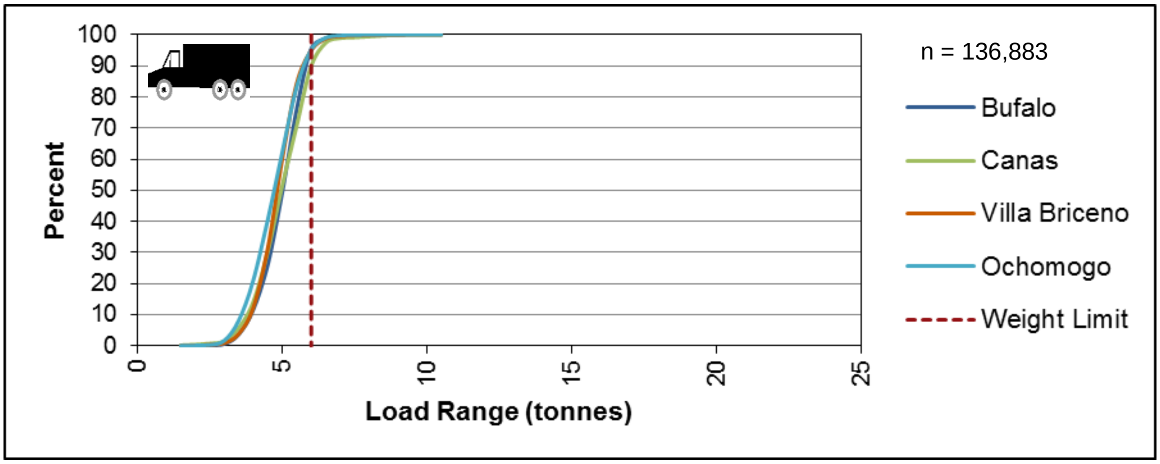


Figure 24: Cumulative Weight Distribution for the Steering Axle Group on C3s

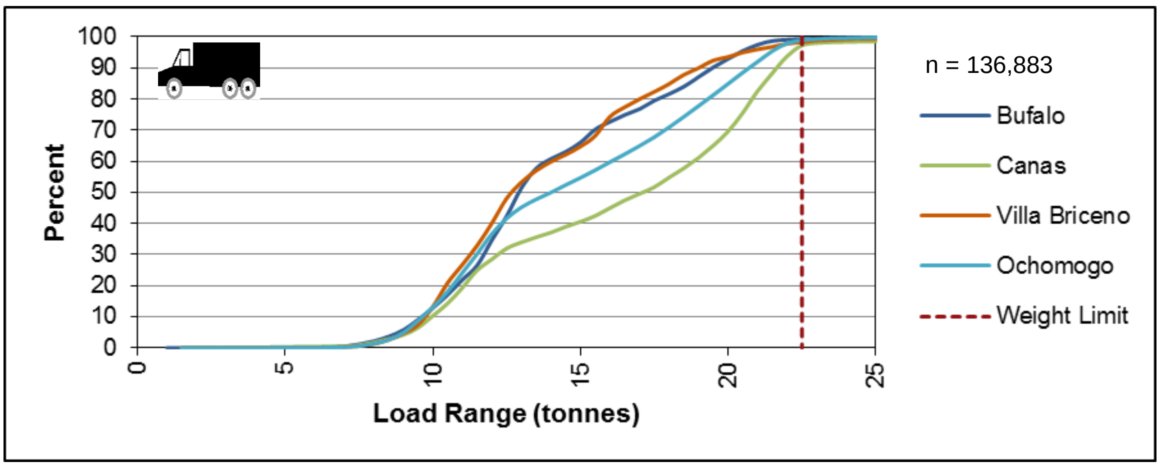


Figure 25: Cumulative Weight Distribution for GVW on C3s

Principal observations from these figures are:

- Of these vehicles, 98.8 percent (134,282 of 136,883) were found to be in compliance with the allowable GVW weight.
- The C3 vehicles are consistent across stations/regions with respect to overweight axles and GVW, with the exception of the Cañas weigh station. The Cañas station showed higher percentages of overweight axles and GVW when compared to other stations.

- The steering axle was found to have the greatest issue with exceeding allowable weights. The allowable steering axle weight in Costa Rica is six tonnes while Canadian regulations allow up to 7.3 tonnes for this type of vehicle. The higher percentage of overweight steering axles observed at these sites (between 5 and 10 percent) could be due to the weight of the vehicle itself rather than the weight of the load.
- In terms of GVW, Cañas had the lowest percentage of unloaded vehicles.

The two weigh stations that distinctly record two-directional truck travel (Búfalo near the Atlantic ports and Ochomogo near San José) can be examined in terms of the loaded and empty status of vehicles by direction. Figure 26 shows the cumulative weight distribution for GVW for the two directions at the Búfalo and Ochomogo weigh stations.

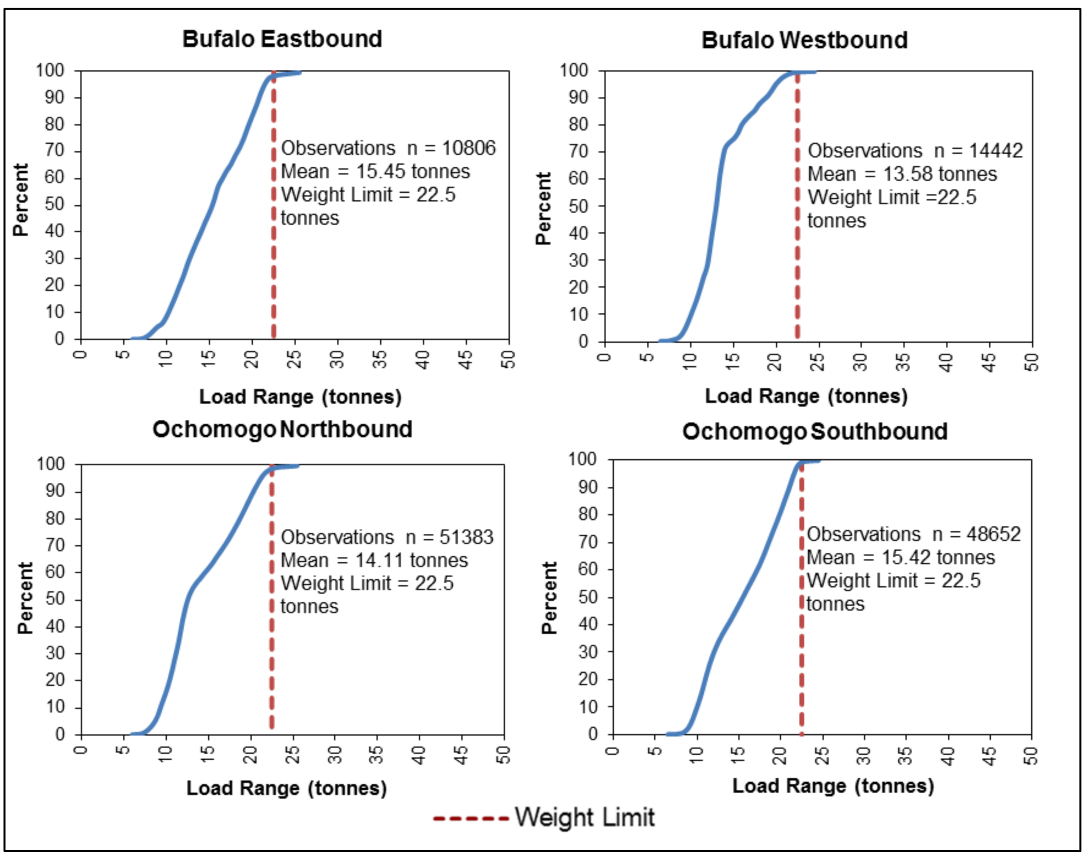


Figure 26: Cumulative GVW Distribution for C3s by Direction at Búfalo and Ochomogo

Principal observations from this figure are:

- The mean GVW of C3 vehicles traveling eastbound or westbound at the Búfalo weigh station are similar (15.5 tonnes eastbound and 13.6 tonnes westbound). This station is located near the ports of Limón and Moín and the results show that the direction of travel for this type of vehicle has little impact on GVW.
- Similarly, the mean GVW of C3 vehicles traveling northbound or southbound at the Ochomogo weigh station are similar (14.1 tonnes northbound and 15.4 tonnes southbound). These is little difference in outbound and inbound travel for C3 trucks in the San José region.

4.4.3 Weight Distribution of T3-S2 Trucks

The four weigh stations recorded a total of 881,076 T3-S2s in 2010. Table 15 outlines the level of non-compliance for T3-S2 vehicles at each of the four weigh stations.

Table 15: Non-Compliance of T3-S2 Trucks with Weight Regulations

Station	N	Percent Overweight			
		GVW	Steering Axle Only	Drive Tandem Only	Rear Tandem Only
Búfalo (East-near Atlantic ports)	584,337	0.1	0.1	3.3 (0.4*)	1.5
Cañas (West-near border)	61,013	0.8	0.02	13.4 (2.8*)	5.7
Villa Briceño (East-near border)	26,313	0.6	0.1	3.3 (0.6*)	3.7
Ochomogo (Central-near San José)	209,413	0.1	0.1	5.6 (0.7*)	3.3
Total	881,076	0.2	0.1	4.5 (0.6*)	2.3

* Percentage of overweight drive tandem axle groups after applying one tonne tolerance as per the truck size and weight regulations.

Figures 27 and 28 show cumulative weight distributions for the drive tandem axle group and gross vehicle weight of T3-S2 vehicles.

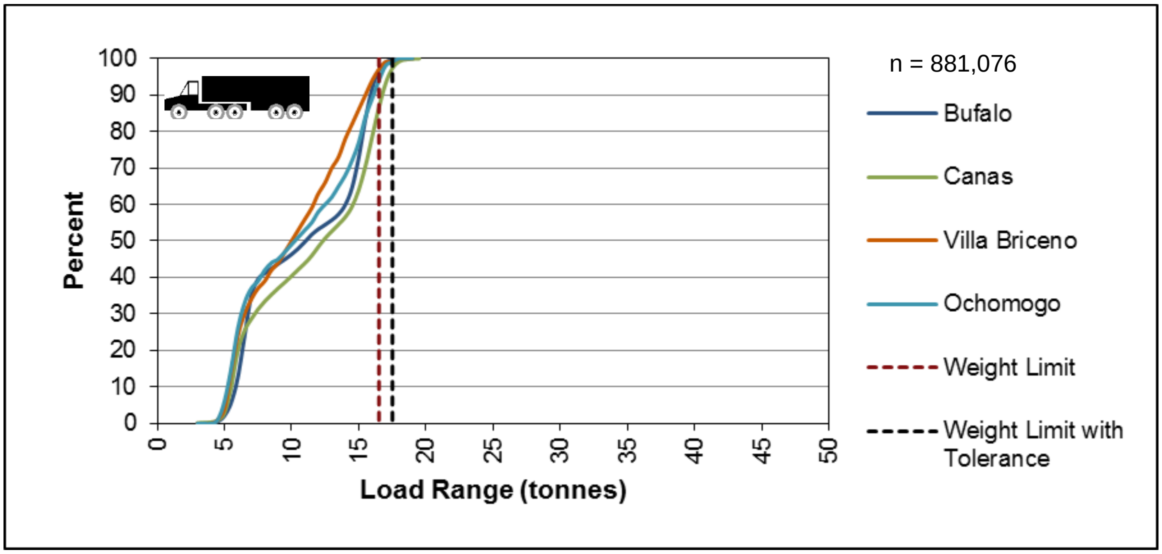


Figure 27: Cumulative Weight Distribution for Drive Tandem Axle Group on T3-S2s

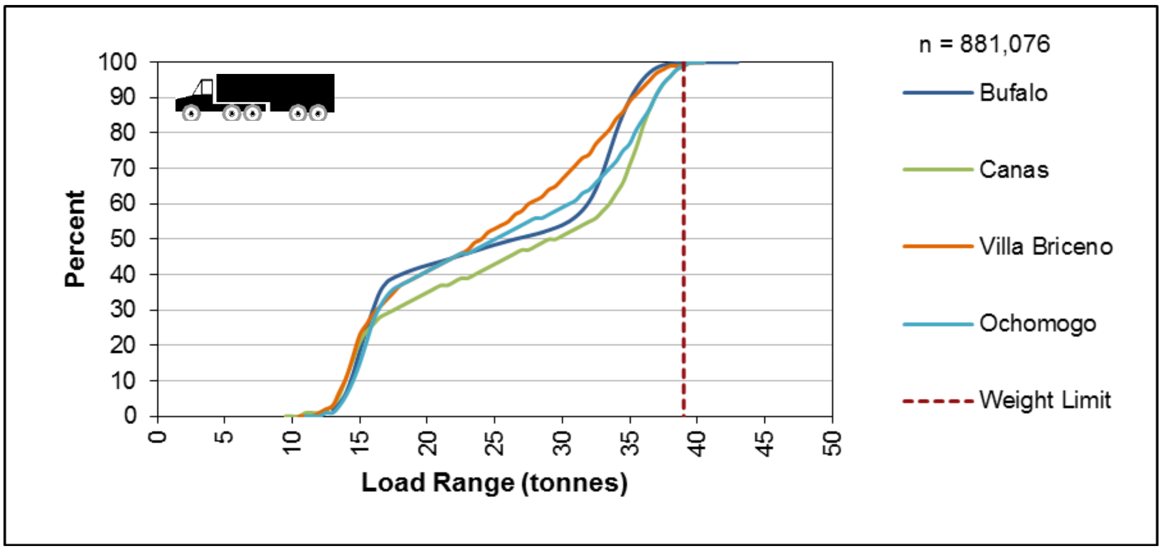


Figure 28: Cumulative Weight Distribution for GVW on T3-S2s

Principal observations from these figures are:

- Of these vehicles, 99.8 percent (879,445 of 881,076) were in compliance with the allowable GVW weight.
- The most significant overweight axle group was the drive tandem with 4.5 percent (39,925 of 881,076) of vehicles exceeding the allowable weight.
- Since the drive tandem had the most significant issue with exceeding the allowable axle weight, the tolerance of one tonne was applied to it for the analysis (given that

the tolerance is written into national law, therefore, for all intents and purposes, the axle weight could include that allowable tolerance). The tolerance may only be applied to one axle group as per the truck size and weight regulations. This allows an increase of weight from 16.5 tonnes to 17.5 tonnes on the drive tandem (or the rear tandem, but not both). After including this tolerance, the percentage of overweight drive tandems decreased from 4.5 percent to 0.6 percent. This demonstrates that by including an additional one tonne to incorporate the tolerance there are few overweight drive tandems, indicating that the drive tandems that are overweight are only overweight by a small amount (within the tolerance).

- With respect to GVW, approximately 50 percent of vehicles are fully loaded, 35 percent empty, and the remaining partially loaded.
- In terms of individual station analyses, the percentage of T3-S2 vehicles exceeding the GVW and individual axle weights remained consistent across stations/regions. The Cañas weigh station was an exception to this, having a significantly higher percentage of overweight drive tandems (13 percent) and rear tandems (6 percent) when compared to other stations.

Figure 29 shows the cumulative weight distribution for GVW for the two directions of travel at the Búfalo and Ochomogo weigh stations to highlight the operations of the trucking sector.

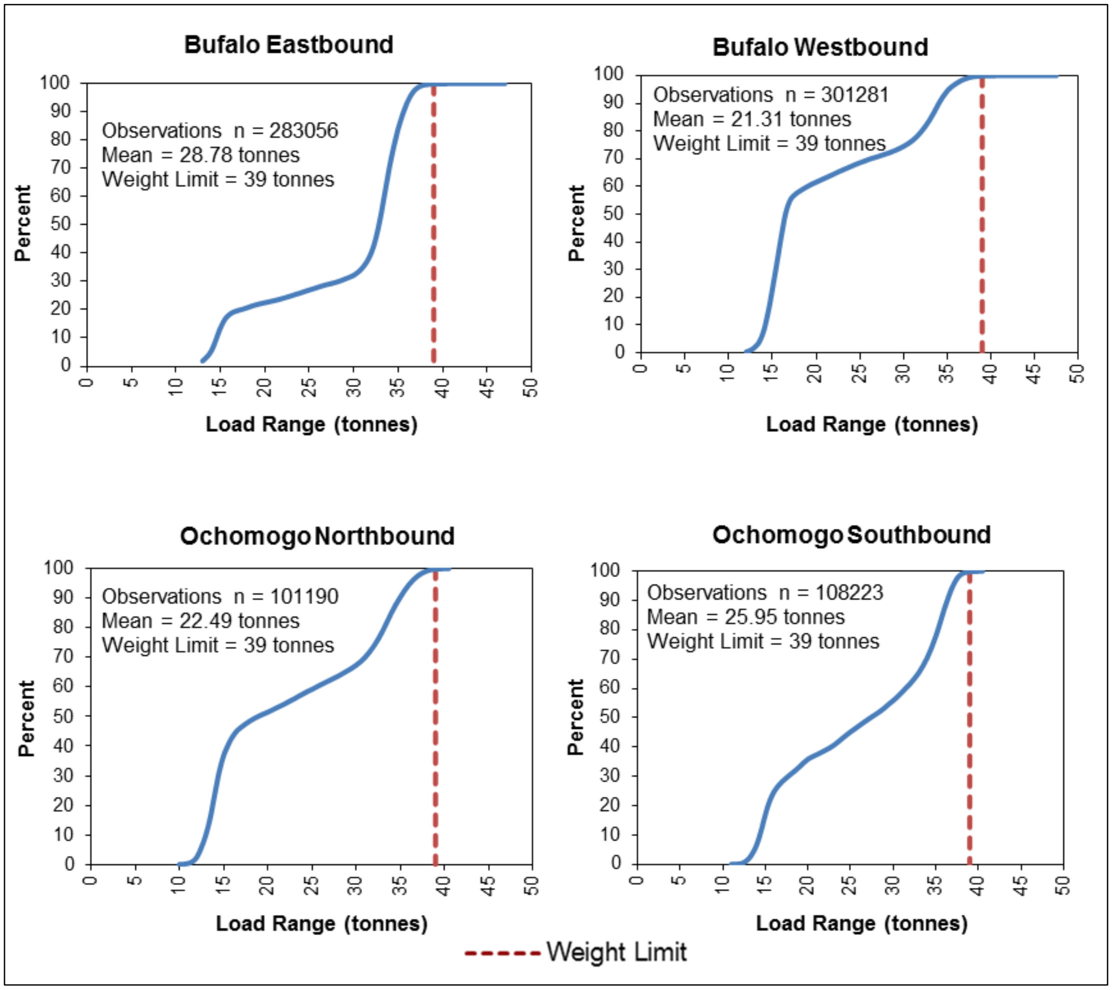


Figure 29: Cumulative GVW Distribution for T3-S2s by Direction at Búfalo and Ochomogo

Principal observations from this figure are:

- There is a distinct directional pattern for GVW at the Búfalo weigh station for T3-S2 trucks. Those trucks traveling eastbound are approximately 20 percent empty, 15 percent partially loaded, and 65 percent fully loaded. The westbound direction, however, is comprised of a higher percentage of unloaded trucks (approximately 55 percent). This shows that there are more loaded trucks headed in the direction of the Limón and Moín ports than those returning from the ports. The mean GVW of trucks traveling eastbound is 28.8 tonnes and those traveling westbound have a mean GVW of 21.3 tonnes. Trucks traveling to the ports haul bananas and other fruit in containers for exportation.

- The Ochomogo station did not present as distinct of a pattern as that of the Búfalo weigh station. The northbound direction experienced a higher percentage of empty trucks with approximately 45 percent of trucks traveling empty. Approximately 30 percent of trucks traveling southbound were empty. The mean GVW of northbound trucks was 22.5 tonnes and the mean GVW of southbound trucks was 26 tonnes.

4.4.4 Weight Distribution of T3-S3 Trucks

The four weigh stations recorded 141,349 T3-S3s in 2010. Table 16 outlines the level of non-compliance for T3-S2 vehicles at each of the four weigh stations.

Table 16: Non-Compliance of T3-S3 Trucks with Weight Regulations

Station	N	Percent Overweight			
		GVW	Steering Axle Only	Drive Tandem Only	Rear Tandem Only
Búfalo (East-near Atlantic ports)	82,623	0.2	0.1	14.6 (3.3*)	0
Cañas (West-near border)	9,786	1.2	0.1	34.0 (11.2*)	0
Villa Briceño (East-near border)	3,719	1.7	0.2	10.9 (3.5*)	0
Ochomogo (Central-near San José)	45,221	0.8	0.2	15.9 (3.5*)	0.2
Total	141,349	0.5	0.2	16.3 (3.9*)	0.1

* Percentage of overweight drive tandem axle groups after applying one tonne tolerance as per the truck size and weight regulations.

Figures 30 and 31 show cumulative weight distributions for drive tandem axle groups and gross vehicle weights of T3-S2 vehicles.

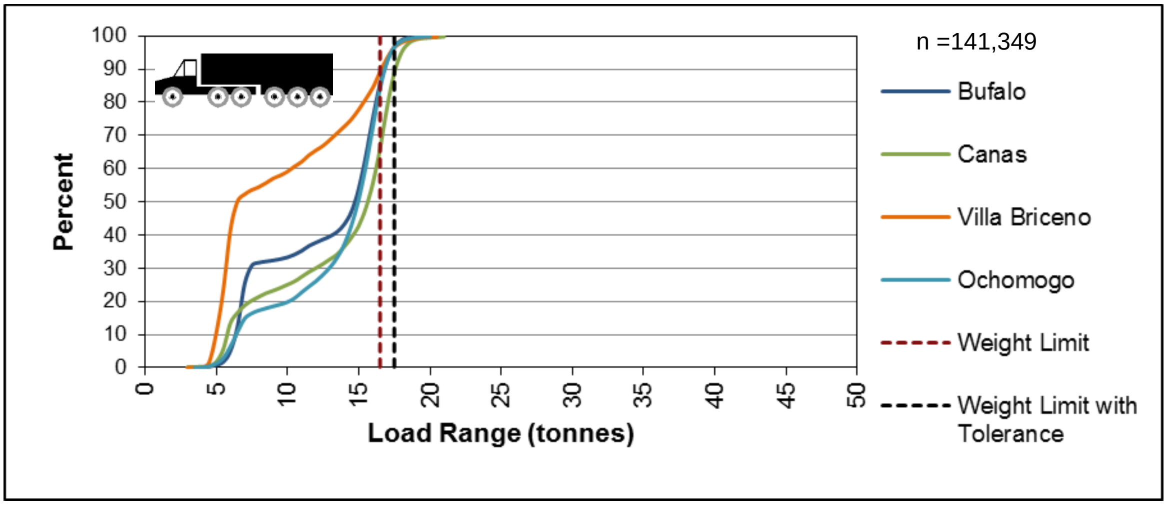


Figure 30: Cumulative Weight Distribution for Drive Tandem Axle Group on T3-S3s

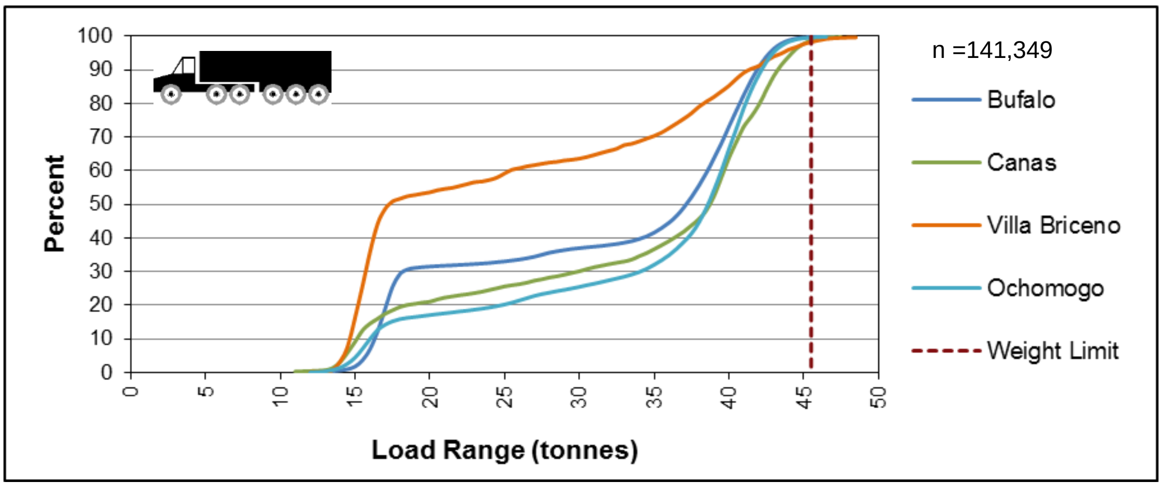


Figure 31: Cumulative Weight Distribution for GVW on T3-S3s

Principal observations from these figures are:

- Of these vehicles, 99.6 percent (140,842 of 141,349) complied with the allowable GVW.
- The drive tandems, similarly to the T3-S2 vehicles, have the most significant overweight issue with 16.3 percent (22,963 of 141,349) of trucks exceeding the weight limit.
- After applying the one tonne tolerance to the drive tandem axle group, the percentage of drive tandems exceeding the allowable weight decreased from 16

percent to 4 percent. This indicates that many of the vehicles exceeding the drive tandem weight are overweight by only a small amount (within the tolerance).

- The analysis of the T3-S3 vehicles revealed similar results to the T3-S2 analysis in terms of consistency. The Cañas weigh station was highlighted as having a higher percentage of overweight drive tandems (11 percent after applying tolerance).
- In terms of all stations, few vehicles exceed the allowable tridem axle group weight (8 of 141,349). This indicates an issue with load distribution within the vehicle as some vehicles exceed the drive tandem while almost none exceed the tridem axle weight limit.
- The T3-S3 configuration demonstrates a more pronounced trend with respect to fully loaded and empty vehicles when compared to the T3-S2 configuration. The weigh station at Villa Briceño (east near border with Panama) is represented by a different curve shape than those formed from the other weigh stations. Around 50 percent of vehicles are empty at the location of this weigh station. The other stations, however, show higher percentages of fully loaded vehicles and fewer empty vehicles when compared to the T3-S2 distribution.
- From the cumulative distribution graphs it can be seen that many vehicles take advantage of the increased weight benefits associated with operating a tridem axle group rather than a tandem axle group. These vehicles are likely specifically chosen for these benefits and for the specific commodities they haul. This vehicle configuration was commonly observed operating with a flat deck body style (82 of 247) or carrying 40-foot containers near the international ports (53 of 247).

Figure 32 shows the cumulative weight distribution for GVW for the two directions of travel at the Búfalo and Ochomogo weigh stations to highlight the operations of the trucking sector.

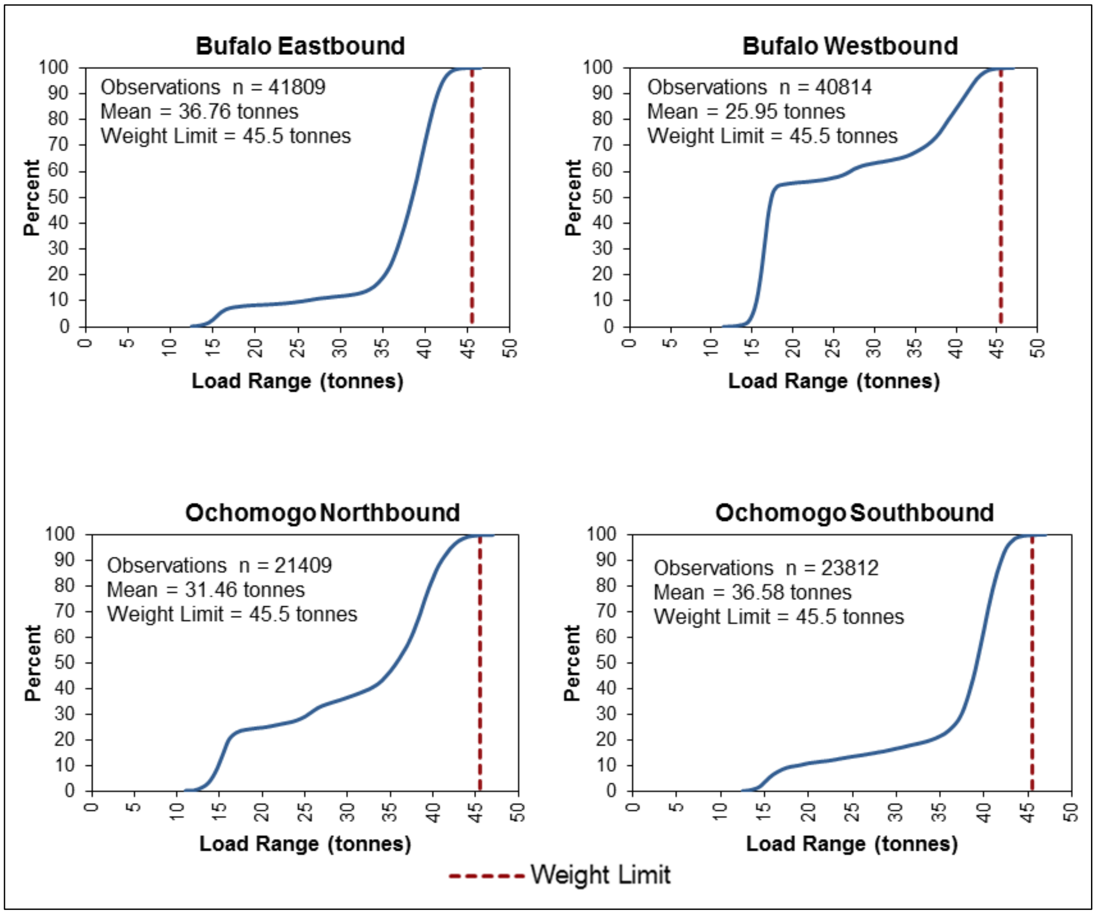


Figure 32: Cumulative GVW Distribution for T3-S3s by Direction at Búfalo and Ochomogo

Principal observations from this figure are:

- The Búfalo weigh station exhibits a distinct pattern by directional travel in terms of loaded and empty trucks. Figure 30 shows that there are more T3-S3 trucks traveling loaded eastbound towards the ports of Limón and Moín than upon return from the ports. The mean GVW for T3-S3s traveling eastbound to the ports is nearly 37 tonnes while the returning trucks traveling westbound have a mean GVW of 26 tonnes. Many T3-S3s travel to the ports fully loaded (approximately 85 percent and return empty (approximately 55 percent).
- The GVW of T3-S3 trucks was observed to be more consistent when comparing the northbound and southbound directions at Ochomogo, with the proportions of loaded and empty vehicles remaining similar for both directions.

4.5 DISCUSSION ABOUT OPERATING WEIGHTS

Two primary items are discussed with respect to the truck weight data analysis: (1) the magnitude and significance of the current compliance with weight regulations in the country, and (2) the utilization and operation trends of trucks based on the weigh station data results.

4.5.1 Compliance Issues

After incorporating the allowable tolerances written into Costa Rican law on the most problematic axle groups in each configuration, overall, the percent of overweight on axle groups reduces significantly. There are very few large trucks operating above allowable GVW limits on Costa Rica's highways at the locations of the weigh stations. Furthermore, the vehicles that do exceed allowable weights on any given axle group do so by a small margin or within the allowable tolerance provided in the truck weight regulations.

4.5.2 Truck Operations

Truck operations in Costa Rica were determined through examining the status of empty and loaded vehicles at the four weigh stations. The two weigh stations that provided directional travel (Búfalo and Ochomogo) were particularly helpful in this area.

The Búfalo weigh station was highlighted as having an imbalance in empty and loaded vehicles traveling to and from the ports of Limón and Moín. Trucks predominantly travel loaded to the port destinations and return empty. This could be driven by market demand in Costa Rica or there could be opportunities to increase truck efficiency with respect to logistics within the trucking industry to reduce the frequency of unload trucks.

The Ochomogo weigh station experienced a far less pronounced trend in terms of empty and loaded T3-S2 vehicles where in many cases vehicles are partially loaded. The T3-

S3 vehicles, however, demonstrated a trend suggesting trucks are either empty or loaded (10 to 25 percent empty, and 75 to 90 percent loaded). The percentage of empty vehicles is lower than that experienced at the Búfalo weigh station showing that the truck operations in the San Jose Valley have different characteristics than near the port locations with the freight demand being more balanced.

4.6 SUMMARY

- The truck fleet in Costa Rica primarily consists of 2-axle single unit trucks (C2), 3-axle single unit trucks (C3), 5-axle tractor-semitrailers (T3-S2), and 6-axle tractor semitrailers (T3-S3). Although these four classes account for 95 percent of the truck fleet, there are 30 different truck classifications operating on Costa Rica's roads.

- Near the ports of Limón and Moín the majority of truck traffic comprises T3-S2 vehicles (71 percent) with a limited number of C2 vehicles (13 percent). This location has a higher percentage of long haul, heavy truck trips carrying goods to and from the ports of Moín and Limón. The Ochomogo station located near San José has a higher percentage of C2 vehicles (62 percent), likely carrying smaller loads over smaller distances due to its urban location.

- The analysis of vehicle body types revealed that nearly 40 percent of vehicles had a van body type followed by 20 percent having a container body type. Box and flat deck types were also common.

- From the analysis of weight data it was found that few large trucks are operating above allowable GVW limits on Costa Rica's highways at the locations of the weigh stations. Furthermore, the vehicles that do exceed allowable weights on any given axle group do so by a small margin or within the allowable tolerance provided in the truck weight regulations.

- In terms of operations, the weight data analysis revealed that many trucks were found to be operating empty in at least one direction at the weigh station locations with two-directional data. This could be driven by market demand in Costa Rica or there could be opportunities to increase truck efficiency with respect to logistics within the trucking industry to reduce the frequency of unload trucks.

5. FUTURE TRANSPORTATION ENGINEERING DEVELOPMENTS

Three types of planned developments can be expected to affect truck transportation and freight movement in the country: (1) port developments; (2) road developments; and (3) Panama Canal expansion. These system changes are investigated through meetings with officials involved in current operations and future planning of transportation initiatives in the region. This includes officials at the major international ports and border crossings in Costa Rica in addition to officials involved with the expansion of the Panama Canal.

5.1 PORT DEVELOPMENTS

There are plans for expansion at the Limón and Moín ports due to congestion issues caused by lack of sufficient number of berths, and yard storage for container handling and equipment. A long term strategy is being developed as a part of a Master Plan for the ports of Limón and Moín. This includes gradually transforming the Limón port into a facility that primarily handles cruise ships and no longer general or container cargo (Royal Haskoning, 2008).

The proposed project consists of three phases. The first is to increase the existing capacity of the infrastructure and tender the concession and construction of a new port located to the west of the existing Moín port. Phase 2 consists of transferring cargo currently handled by the Limón port to the Moín port and increasing the container handling quay by 900 metres. The final phase consists of extending the container handling quay by 600 metres (Royal Haskoning, 2008). At the same time, the port of Moín is intended to become the main location for handling freight for the Atlantic coast.

The proposed expansion project will alleviate some of the congestion experienced in the city of Limón as truck traffic can be routed directly to the Moín port. With the increased size of the Moín port, the 16 nearby facilities currently used to handle excess cargo from the ports would be less essential and in turn reduce the number of truck trips in the area around the port site.

5.2 ROAD DEVELOPMENTS

Meetings with individuals at the MOPT indicated some future road construction plans that may impact the movement of freight in the country. The first is the completion of Highway 4 that would provide direct access for heavy vehicles between the Nicaragua border and the Atlantic coast ports along the northern part of the country. This route could also be used to access San José from the Atlantic coast in the event of closures on Highway 32 providing redundancy within the system for this crucial link.

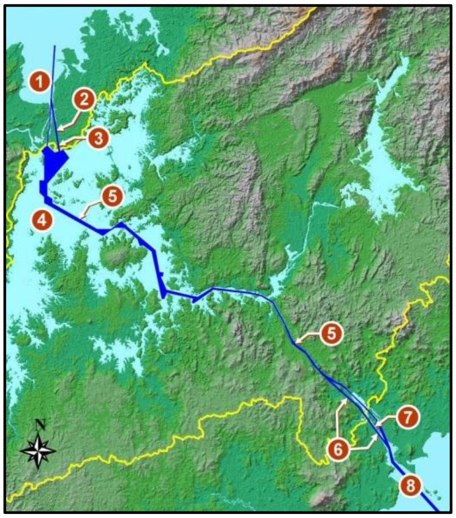
Additionally, there are plans for the construction of a new bridge at the Sixaola border crossing with Panama. The existing structure was built in 1908 and has experienced serious infrastructure deterioration. There are plans to construct a temporary bridge 50 metres from the current site with a permanent structure to be constructed 500 metres from the site at a later time (MOPT, 2011). Planning for these projects has been ongoing for 10 years. Trucks, passenger vehicles, cyclists, and pedestrians all utilize the current bridge although the future plans incorporate cyclist and pedestrian accommodation. With the completion of this new bridge there are opportunities to increase freight transportation in this region.

5.3 PANAMA CANAL EXPANSION

After nearly a century in operation the current infrastructure of the Panama Canal is being expanded to increase capacity and accommodate vessels of greater size. The current maximum size vessel capable of navigating the Canal is the Panamax, having a capacity of approximately 4,500 TEUs. Upon completion of the Canal expansion project the Canal will be able to accommodate Post-Panamax vessels carrying 12,000 TEUs and representing 27 percent of the world's containerized maritime shipping. By accommodating the Post-Panamax vessels, the Panama Canal can maintain its present competitiveness with the Northeast Asia to U.S. East Coast route through the Suez Canal (Panama Canal Authority, 2006).

The expansion project includes the construction of two new locks, one on the Atlantic side and one on the Pacific side. Access channels to accompany the new locks are being excavated and the current channels widened and deepened to accommodate the larger vessels. Combined with the expansion of the current channels the elevation of Gatun Lake will be raised to a level that increases usable water reserve capacity (Harrison, et al. 2010). These are shown in Figure 33.

The Panama Canal Authority expects the expansion project to take between seven and eight years, with completion between 2014 and 2015 (Panama Canal Authority 2006). The project is underway and shipping related organizations worldwide are preparing for the changes the expansion will bring to the shipping industry.



1. Deepening and widening of the Atlantic entrance channel
2. New approach channel for the Atlantic Post-Panamax locks
3. Atlantic Post-Panamax lock with 3 water saving basins per lock chamber
4. Raise the maximum Gatun lake operating water level
5. Widening and deepening of the navigational channel of the Gatun lake and the Culebra Cut
6. New approach channel for the Pacific Post-Panamax locks
7. Pacific Post Panamax locks with 3 water saving basins per lock chamber
8. Deepening and widening of the Pacific entrance channel

Figure 33: Panama Canal Development
Source: (Panama Canal Authority, 2006)

Costa Rica's principal trading partners at the Limón and Moín ports in 2010 consisted of the United States (40 percent of all cargo), Colombia (10 percent of all cargo), and the Netherlands (3 percent) (JAPDEVA, 2011). Of the remaining cargo, 24 percent is traded within Central America. This suggests that a portion of the freight typically seen at the Moín and Limón ports originates or is destined for the Panama region. With the expansion of the canal there are opportunities to increase cargo at the Moín and Limón ports due to the expected increases in cargo in the Central American region from the Panama Canal expansion. Figure 34 shows the construction progress of the Panama Canal Expansion.

Figure 34: Panama Canal Expansion Progress
Photo by Jane MacAngus, (2011)

5.4 SUMMARY

Truck transportation is critical to economic development in Costa Rica, with 95 percent of freight movement traveling by road to surrounding regions and ports. Three principal planned developments are expected to affect freight movement in the country:

- Expansion of the Limón and Moín would increase the capacity of the ports and alleviate some of the congestion experienced in the city of Limón. With this expansion, truck traffic would be routed directly to Moín that would handle the majority of cargo upon completion of this project. The resulting benefits would present themselves in the form of: (1) increased safety due to lower traffic exposure on the two-lane highway leading to the port; (2) reduced emissions due to reduced truck kilometres of travel to and from the 16 container storage facilities located along the highway; (3) reduced congestion, which is also associated with greenhouse emissions; and (4) increased transport productivity due to a reduced need for drayage to and from the storage terminals.

- Future road construction plans could impact the movement of freight in the country. These include infrastructure upgrades at one of the Panama border crossings and the completion of a highway that would provide redundancy in the freight transportation network serving the ports of Limón and Moín. The resulting benefits would present themselves in the form of: (1) increased trade with Panama; (2) the provision of a reliable link to the Atlantic coast ports which could potentially increase international trade; (3) lower costs and associated risks for trucking as delays due to closures could be avoided; and (4) avoidance of congested areas that in turn increases truck efficiency and decreases associated environmental impacts.

- The Panama Canal is being expanded to increase capacity and accommodate vessels of a greater size. The project is expected to be completed in 2014 and shipping related organizations worldwide are preparing for the changes the expansion will bring to the shipping industry. With the expansion of the canal there are opportunities to increase cargo at the Moín and Limón ports due to the expected increases in cargo in the Central American region from the Panama Canal expansion. Other countries in the Caribbean are preparing for likely transhipment opportunities that will arise from larger ships traveling through the canal. Costa Rica is a prime location to benefit from these opportunities if the required infrastructure is made available. This infrastructure would involve the ports and their capacity to handle more freight in addition to improved logistics centers.

6. CONCLUSIONS

This research is intended to increase transportation engineering knowledge about trucking operations and truck size and weight regulations in Costa Rica. The research: (1) characterizes the transportation system and operations in the region as they relate to trucks; (2) describes the truck size, weight, and safety regulations in Costa Rica and the associated enforcement practices; (3) determines truck activity and analyzes the operating weights of trucks in the country; and (4) identifies activity system developments to determine their likely impact on truck flows and characteristics in the region.

6.1 TRANSPORTATION SYSTEM IN COSTA RICA

- Costa Rica has over 7,600 kilometres of National Highway with 64 percent of the network paved and the remaining 36 percent unpaved. The key connecting links of importance to the truck transportation system in Costa Rica consist of the National Highways 1, 2, 4, 10, 27, 32, 34, and 36. The highway network primarily consists of two-lane undivided highways with narrow shoulders and few passing lanes. The network characteristics vary throughout the different topographical regions in the country.

- Most international freight movement by road is moved through the Nicaragua border crossing (between 80 and 85 percent of all tonnage moved internationally by land). Issues associated with the border crossings comprise congestion and lack of truck parking areas at the Nicaragua border crossing, and deteriorating infrastructure at Sixaloa. Past studies demonstrate that the design and operating practices of border crossings in a corridor can significantly influence trucking productivity and efficiency.

- There are three primary ports in Costa Rica, serving the Atlantic and Pacific coasts. The ports are critical in moving freight in and out of the country and account for approximately 90 percent of all freight by weight leaving or entering the country. Current issues include congestion and lack of dock space at the Atlantic ports.

- Several transportation system constraints are identified as barriers to the safe and efficient movement of freight within Costa Rica and to surrounding regions. These comprise operational constraints such as traffic congestion and highway closures due to collisions or road maintenance, and border crossing delays. Engineering infrastructure constraints primarily comprise deterioration or failure of infrastructure due to adverse weather conditions, ageing bridge infrastructure, and lack of truck specific infrastructure such as climbing lanes, truck parking facilities, and truck escape ramps.

- Reliability of the transportation network is key in ensuring freight is moved in an efficient and effective manner. Providing alternative options in the network for redundancy is important to ensure freight arrives at intended destinations in a timely manner. Access to marine transportation is critical to economic development because it is the primary means of importing and exporting goods in Costa Rica. Freight must be able to reach and leave these areas in a safe and reliable way.

6.2 TRUCK SIZE, WEIGHT, AND SAFETY REGULATIONS

- The MOPT is responsible for the control and regulation of TS&W in Costa Rica; however, they do not have the authority to enforce regulations. The enforcement of regulations is the responsibility of the National Transit Police.

- Costa Rica's truck size and weight regulations encompass 30 different truck classifications. The four primary truck classifications in Costa Rica exhibit similarities to trucks operating in the U.S. and Canada because many trucks are imported from these countries as used vehicles. With similar vehicle types, Costa Rica has similar truck size and weight regulations for the four primary vehicle types.

- Imported vehicles emulate characteristics from different jurisdictions across the U.S. and Canada, and from different time periods. This results in imported vehicles operating on Costa Rica's highways that include trucks governed by outdated regulations or trucks that may not be suitable for the unique highway environment in Costa Rica. This has civil engineering implications for the accommodation of these trucks in the transportation system with respect to geometric design, traffic operations, road safety, and pavements and bridges.

- There are currently no laws or regulations with regards to truck driver hours of service, roadside safety inspections or enforcement programs for trucks with respect to safety regulations in Costa Rica. Costa Rica does, however, have a nationally implemented program requiring the periodic mechanical inspection of all vehicles.

6.3 TRUCKING ACTIVITY AND OPERATING WEIGHTS

- The truck fleet in Costa Rica primarily consists of 2-axle single unit trucks (C2), 3-axle single unit trucks (C3), 5-axle tractor-semitrailers (T3-S2), and 6-axle tractor semitrailers (T3-S3). Although these four classes account for 95 percent of the truck fleet there are 30 different truck classifications operating on Costa Rica's roads.

- Near the ports of Limón and Moín the majority of truck traffic comprises T3-S2 vehicles (71 percent) with a limited number of C2 vehicles (13 percent). This location has a higher percentage of long haul, heavy truck trips carrying goods to and from the ports of Moín and Limón. The Ochomogo station located near San José has a higher percentage of C2 vehicles (62 percent), carrying smaller loads over smaller distances due to its urban location.

- From the analysis of weight data it was found that few large trucks are operating above allowable GVW limits on Costa Rica's highways at the locations of the weigh stations. Furthermore, the vehicles that do exceed allowable weights on any given axle group do so by a small margin or within the allowable tolerance provided in the truck weight regulations.

- In terms of operations, the weight data analysis revealed that many trucks were found to be operating empty in at least one direction at the weigh station locations with two-directional data. This could be driven by market demand in Costa Rica or there could be opportunities to increase truck efficiency with respect to logistics within the trucking industry to reduce the frequency of unload trucks.

6.4 FUTURE TRANSPORTATION ENGINEERING DEVELOPMENTS

- Expansion of the ports of Limón and Moín will increase the capacity of the ports and alleviate some of the congestion experienced in the city of Limón.

- Future road construction plans are expected to impact the movement of freight in the country. These include infrastructure upgrades at one of the Panama border crossings and the completion of a highway that will provide redundancy in the freight transportation network serving the ports of Limón and Moín.

- The Panama Canal is being expanded to increase capacity and accommodate vessels of a greater size. With this expansion of the canal there are opportunities to increase cargo activity at ports in the Caribbean region due to the expected increases in cargo in the Central American region from the Panama Canal expansion. Moin and Limon are situated in a location that would benefit from this expansion if the appropriate infrastructure and logistics are provided.

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

This research identifies the need for future work to:

- Investigate the feasibility and effectiveness of introducing roadside truck inspections to ensure the mechanical fitness and load securement of trucks operating in the country.
- Collect and analyze truck collision data to quantify the truck safety problem in Costa Rica and determine collision causation in order to make more informed decisions with respect to truck safety in the country.
- Determine locations where truck specific infrastructure such as truck parking facilities, climbing lanes, and passing lanes may be most effective in improving truck safety.
- Analyze the impact of the existing truck fleet on the bridge infrastructure in the country.
- Characterize the commodity flows in the country to better accommodate the movement of freight.
- Determine the impact that the Panama Canal expansion will have on freight operations in Costa Rica and how this will affect road and port infrastructure and operations.

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APPENDIX A

LIST OF MEETINGS AND CONTACTS

Table 17: List of Meetings and Contacts

Date	Organization
Feb. 16, 2011	Esparza Weigh Scale
Feb. 17, 2011	Cañas Weigh Scale
Feb. 21, 2011	Panama Canal Expansion Site
Mar. 31, 2011	MOPT - Size and Weight Department
Apr. 5, 2011	MOPT - Planning Department
Apr. 6, 2011	Transit Police
Apr. 7, 2011	JAPDEVA, Limón
Apr. 7, 2011	JAPDEVA, Moín
May 11, 2011	MOPT - Ports Department
May 12, 2011	Transit Police
May 13, 2011	MOPT - Bridge Department
May 14, 2011	Sercansa
May 18, 2011	Paso Canoas Border Crossing
May 18, 2011	Villa Briceño Weigh Scale
May 20, 2011	RITEVE
May 24, 2011	Ochomogo Weigh Scale
May 26, 2011	Caldera Port

APPENDIX B

FHWA VEHICLE CLASSIFICATION SCHEME F

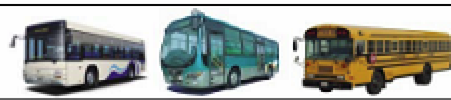
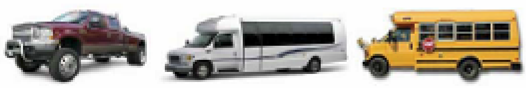
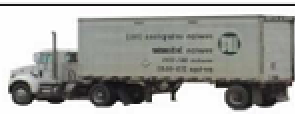
	FHWA Class 1 - Motorcycles
	FHWA Class 2 - Passenger Vehicles (With 1- or 2-Axle Trailers)
	FHWA Class 3 - 2-Axles, 4-Tire Single Units, Pickup or Van (With 1- or 2-Axle Trailers)
	FHWA Class 4 - Buses
	FHWA Class 5 - 2D - 2 Axles, 6-Tire Single Units (Includes Handicapped-Equipped Bus and Mini School Bus)
	FHWA Class 6 - 3 Axles, Single Unit
	FHWA Class 7 - 4 or More Axles, Single Unit
	FHWA Class 8 - 3 to 4 Axles, Single Trailer
	FHWA Class 9 - 5 Axles, Single Trailer
	FHWA Class 10 - 6 or More Axles, Single Trailer
	FHWA Class 11 - 5 or Less Axles, Multi-Trailers
	FHWA Class 12 - 6 Axles, Multi-Trailers
	FHWA Class 13 - 7 or More Axles, Multi-Trailers

Figure 35: FHWA Classification Scheme F
Note: Not to scale
Source: Manitoba Highway Traffic Information System (2010)

APPENDIX C

WEIGH SCALE DATA ANALYSIS

Appendix Description:

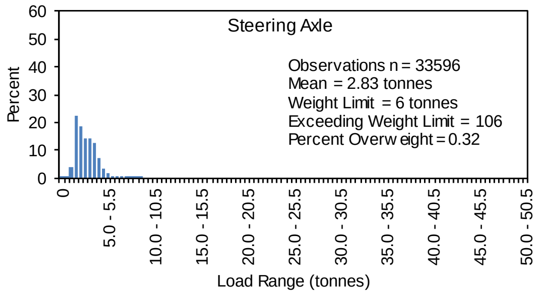
This appendix shows details about the weight data analysis conducted using truck data from four permanent weigh stations operating in Costa Rica. The analysis is presented by weigh station location: Cañas, Búfalo, Ochomogo, and Villa Briceño. For each station, the analysis flows from smallest to largest truck type (C2, C3, T3-S2, and T3-S3). In most cases, the graphs on the left of the template show the frequency histogram and those on the right show the cumulative distribution.

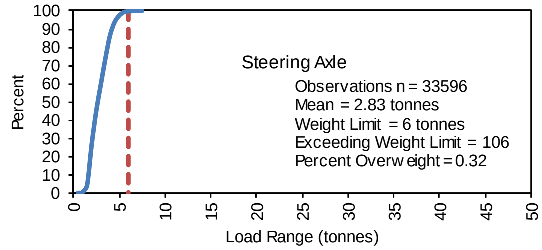
Station Location: **Cañas, Costa Rica**

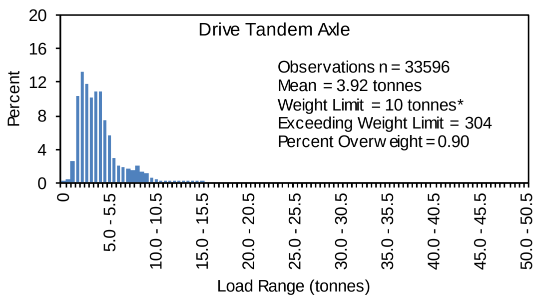
Vehicle Type: **C2**

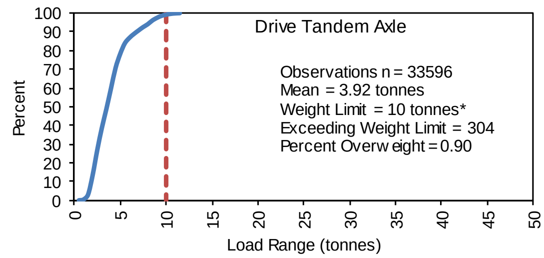
Data from 19/01/2010 to 30/11/2010

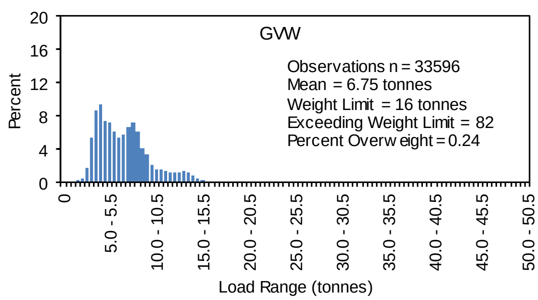
Location: Pan-American Highway - Southbound

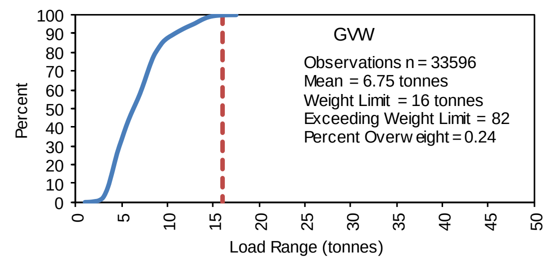












* subject to Tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT

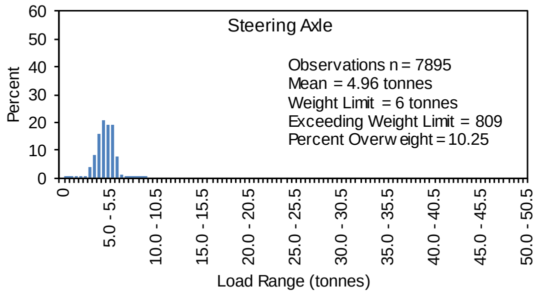
Source: MOPT

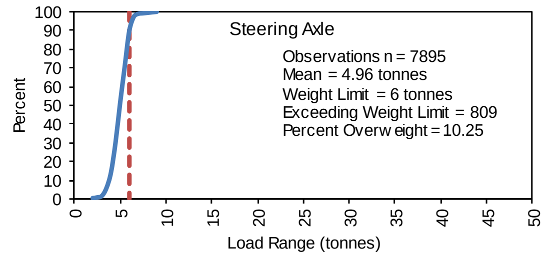
Station Location: **Cañas, Costa Rica**

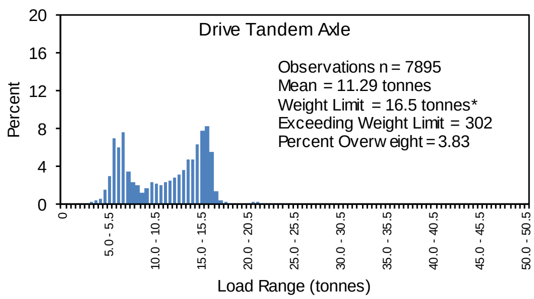
Vehicle Type: **C3**

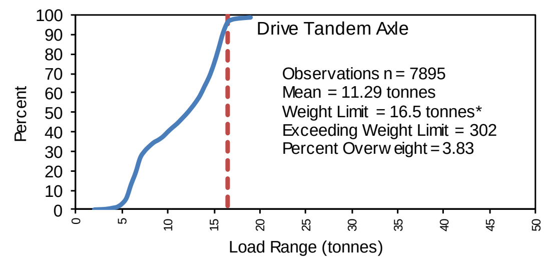
Data from 19/01/2010 to 30/11/2010

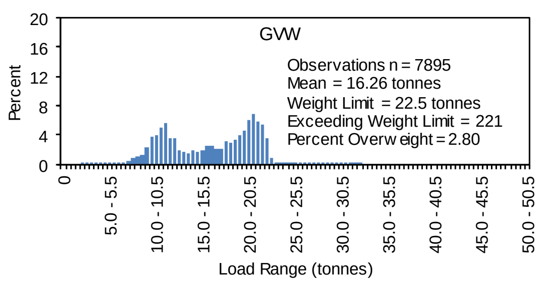
Location: Pan-American Highway - Southbound

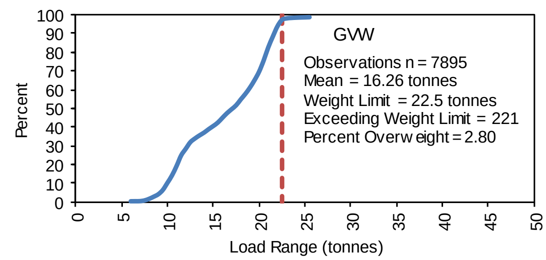












* Subject to tolerance policy/practice

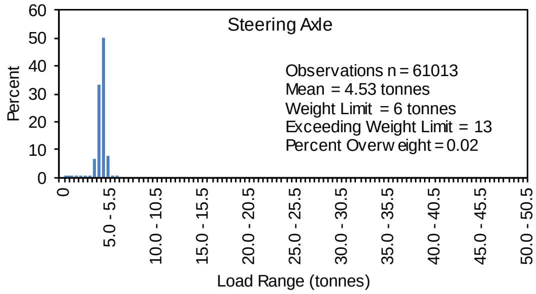
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

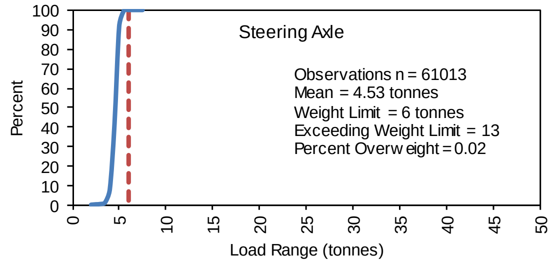
Station Location: **Cañas, Costa Rica**

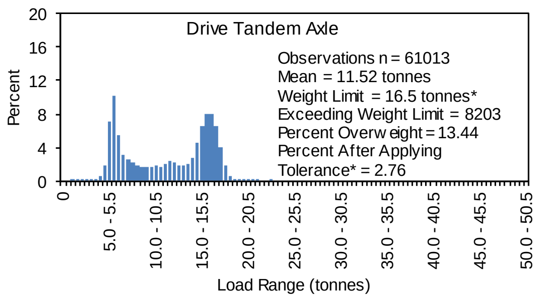
Vehicle Type: **T3-S2**

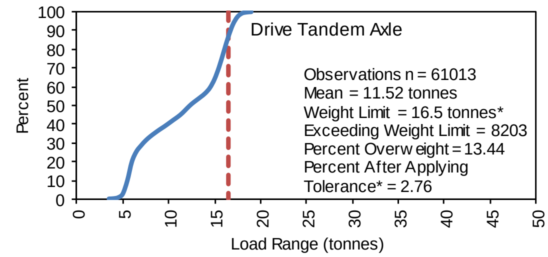
Data from 19/01/2010 to 30/11/2010

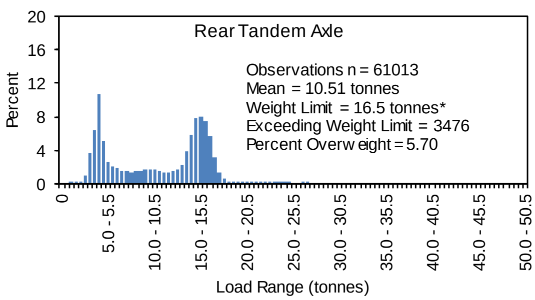
Location: Pan-American Highway Southbound

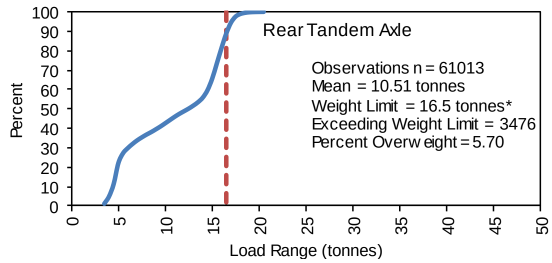


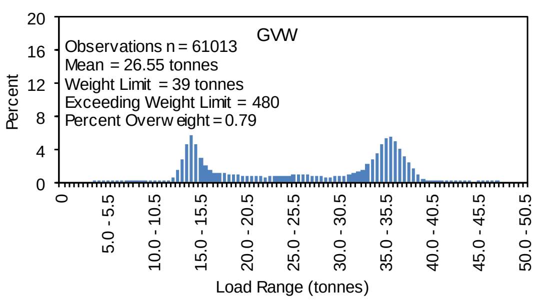


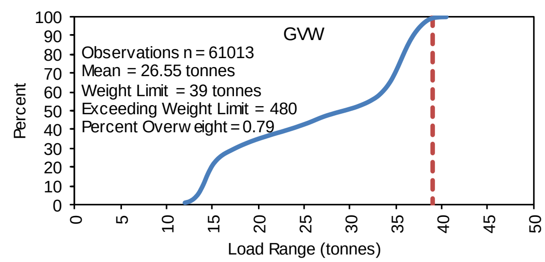












* Subject to tolerance policy/practice

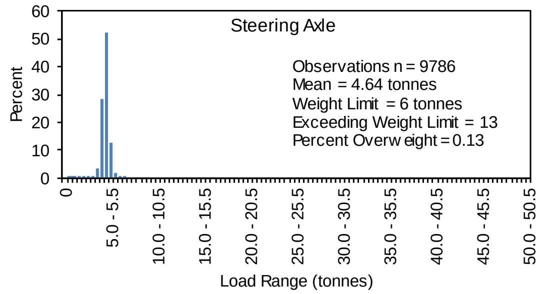
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

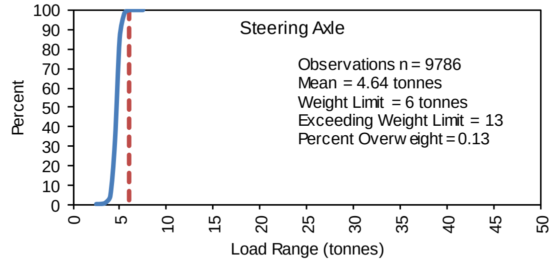
Station Location: **Cañas, Costa Rica**

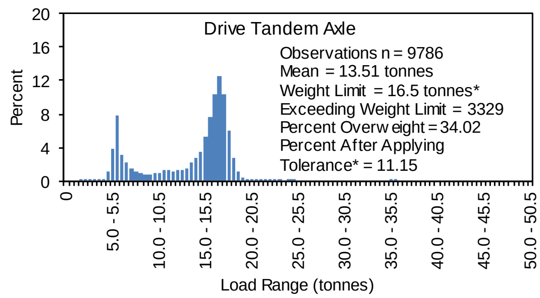
Vehicle Type: **T3-S3**

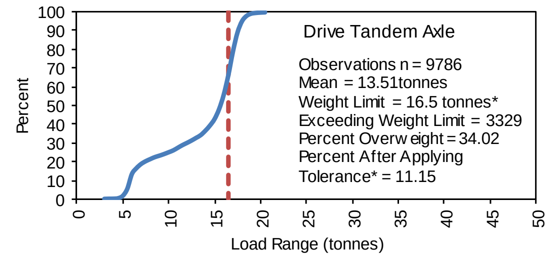
Data from 19/01/2010 to 30/11/2010

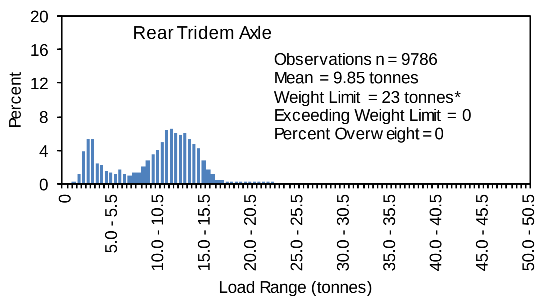
Location: Pan-American Highway Southbound

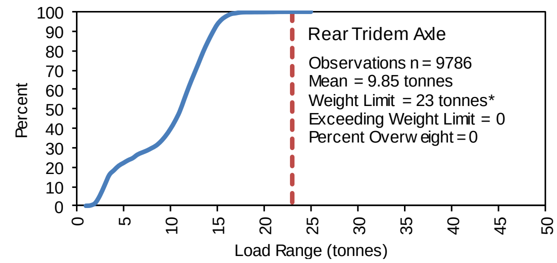


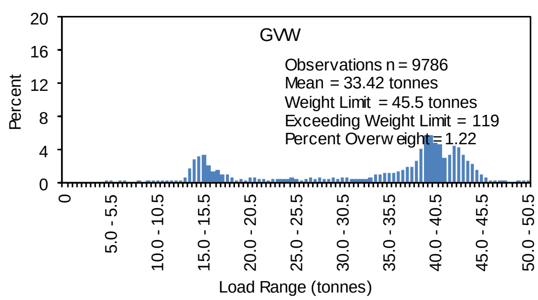


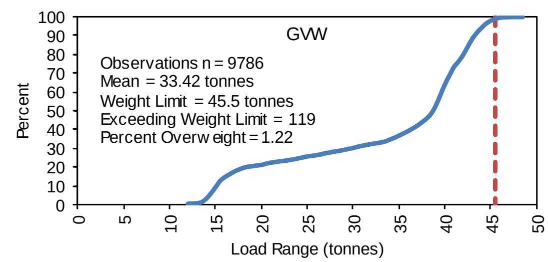












* Subject to tolerance policy/practice

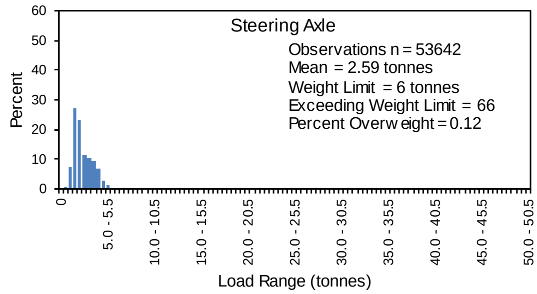
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

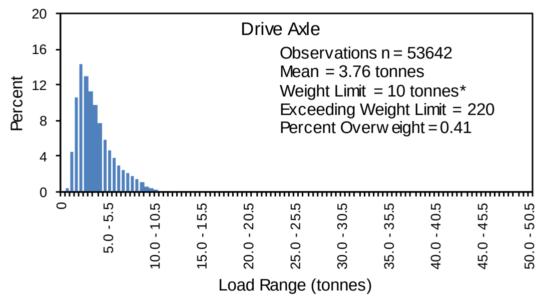
Station Location: **Búfalo, Costa Rica**

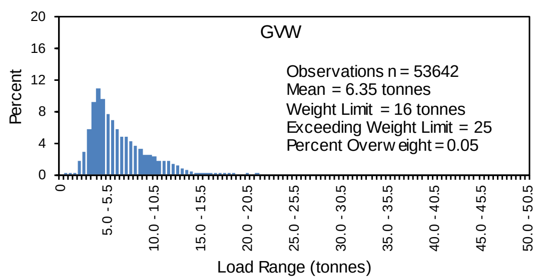
Vehicle Type: **C2**

Data from 01/01/2010 to 31/12/2010

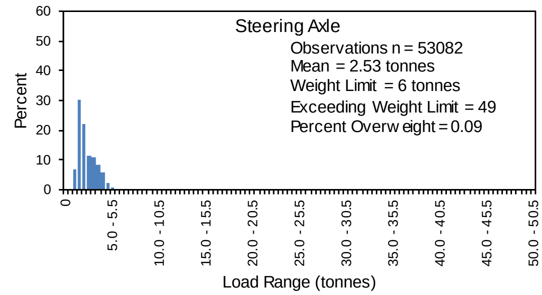
Highway 32 Eastbound (San José-Limón)

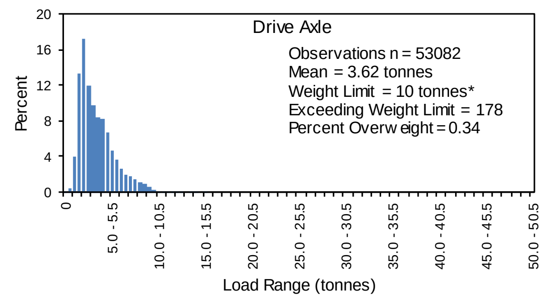


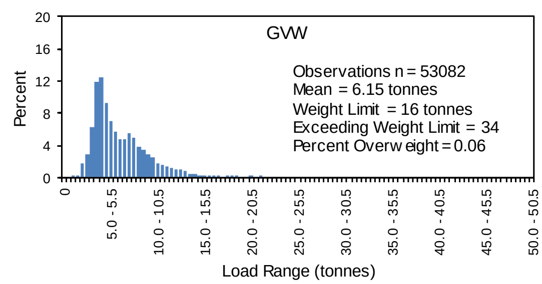




Highway 32 Westbound (Limón - San José)







* Subject to tolerance policy/practice

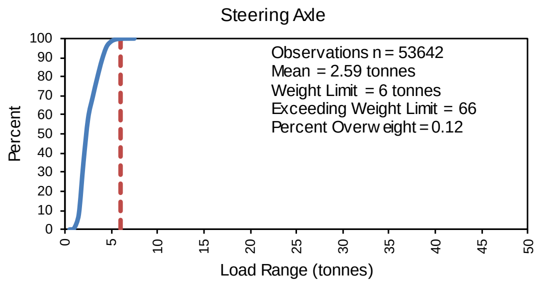
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

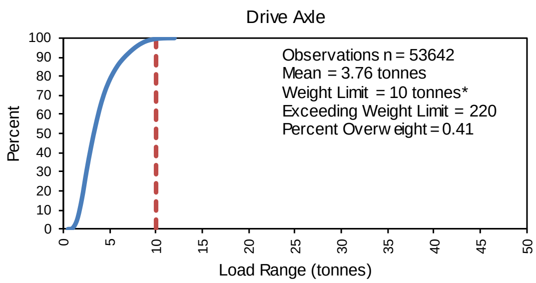
Station Location: **Búfalo, Costa Rica**

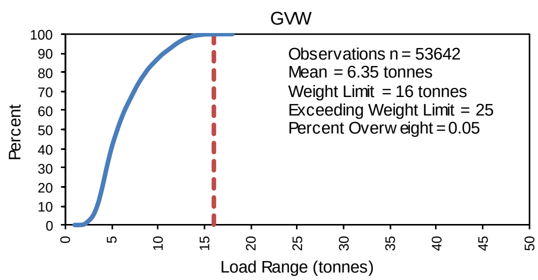
Vehicle Type: **C2**

Data from 01/01/2010 to 31/12/2010

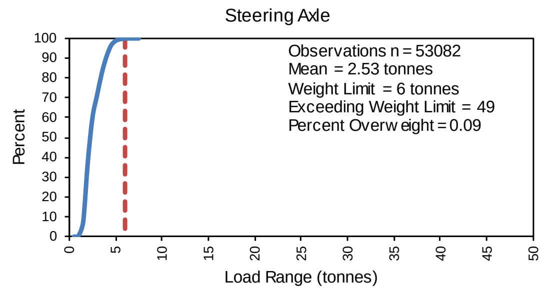
Highway 32 Eastbound (San José-Limón)

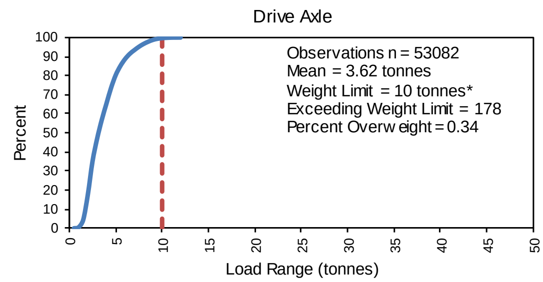


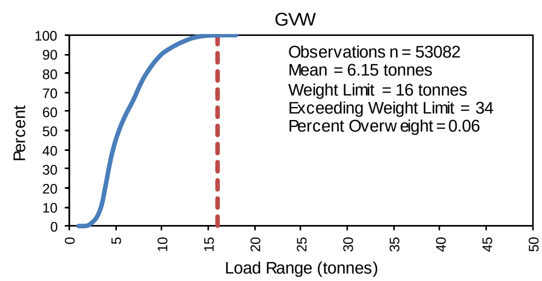




Highway 32 Westbound (Limón - San José)







* Subject to tolerance policy/practice

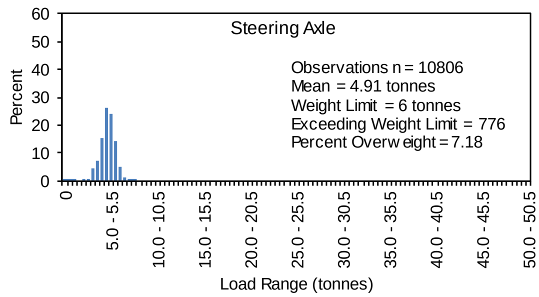
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

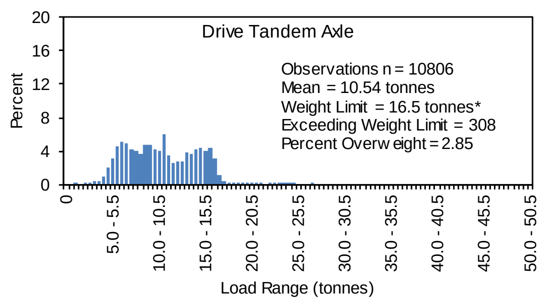
Station Location: **Búfalo, Costa Rica**

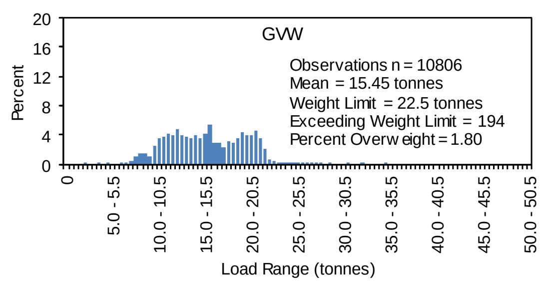
Vehicle Type: **C3**

Data from 01/01/2010 to 31/12/2010

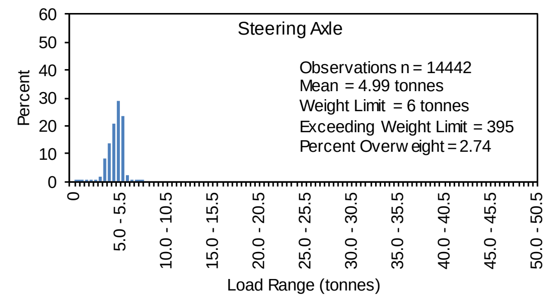
Highway 32 Eastbound (San José-Limón)

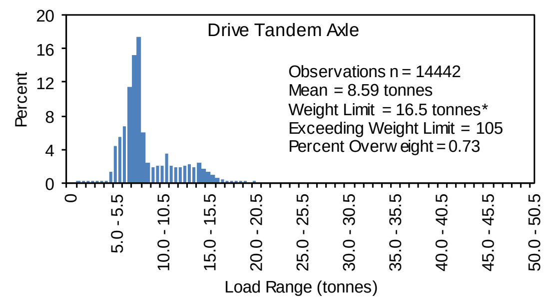


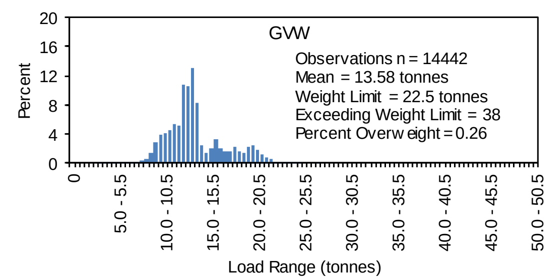




Highway 32 Westbound (Limón - San José)







* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

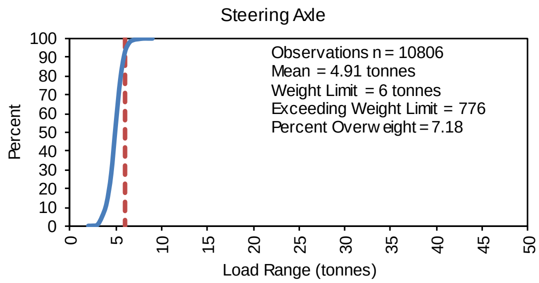
Station Location: **Búfalo, Costa Rica**

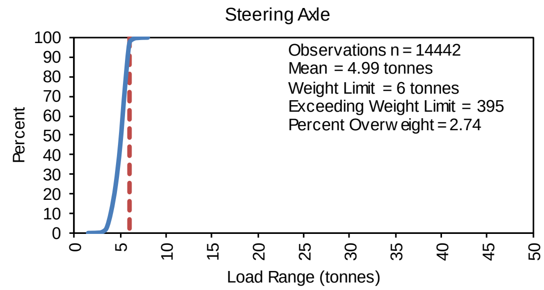
Vehicle Type: **C3**

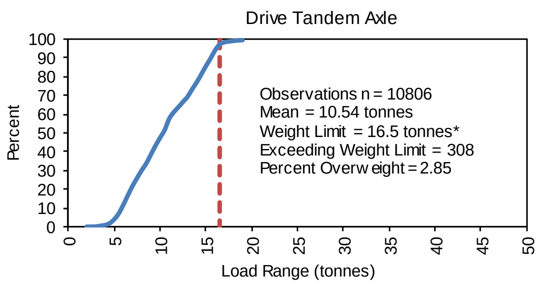
Data from 01/01/2010 to 31/12/2010

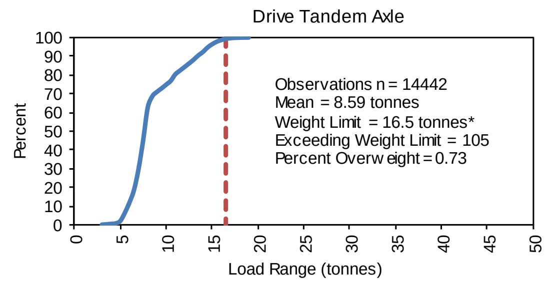
Highway 32 Eastbound (San José-Limón)

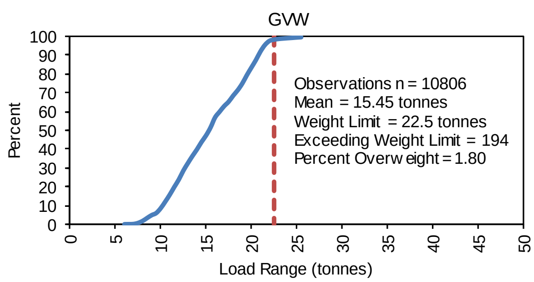
Highway 32 Westbound (Limón - San José)

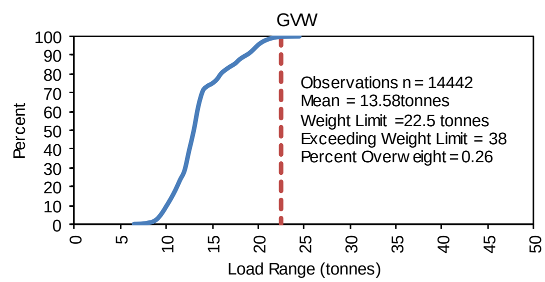












* Subject to tolerance policy/practice

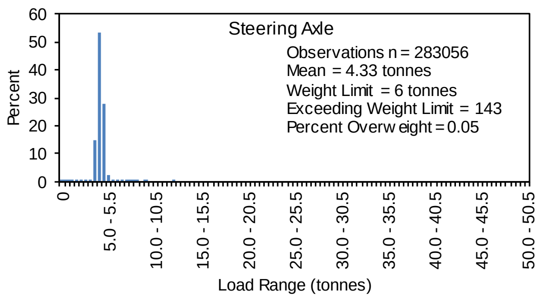
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

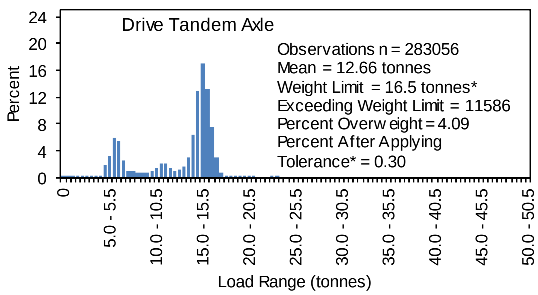
Station Location: **Búfalo, Costa Rica**

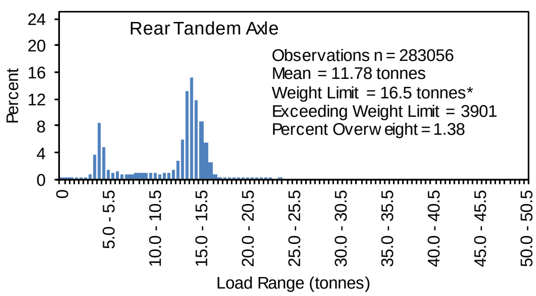
Vehicle Type: **T3-S2**

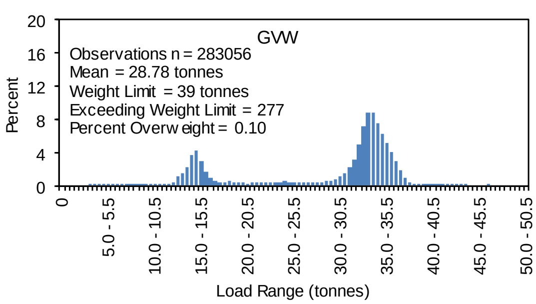
Data from 01/01/2010 to 31/12/2010

Highway 32 Eastbound (San José-Limón)

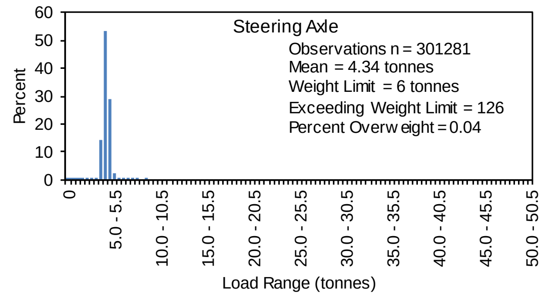


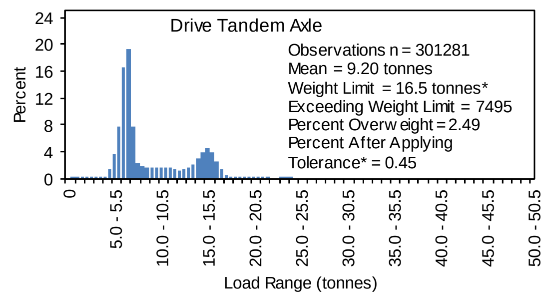


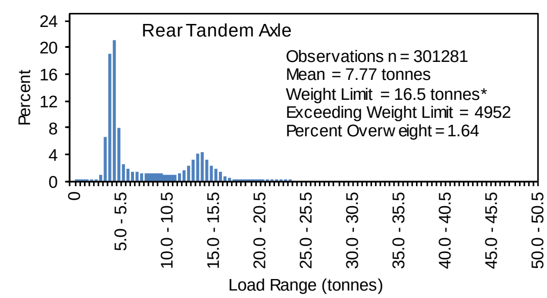


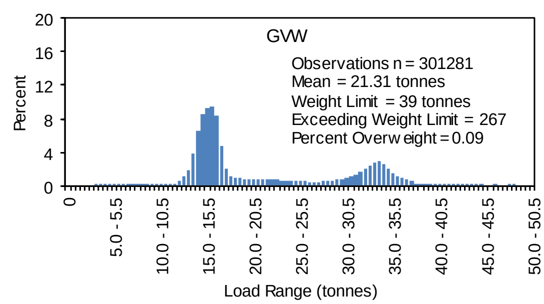


Highway 32 Westbound (Limón - San José)









* Subject to tolerance policy/practice

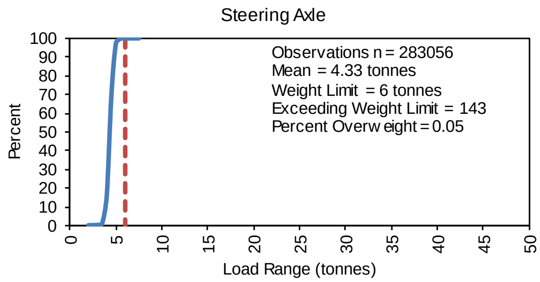
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

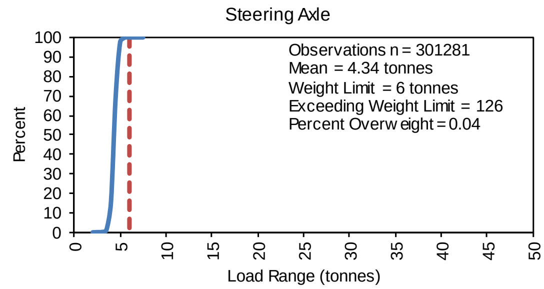
Station Location: **Búfalo, Costa Rica**

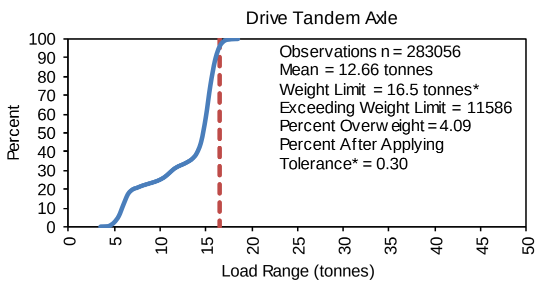
Vehicle Type: **T3-S2**

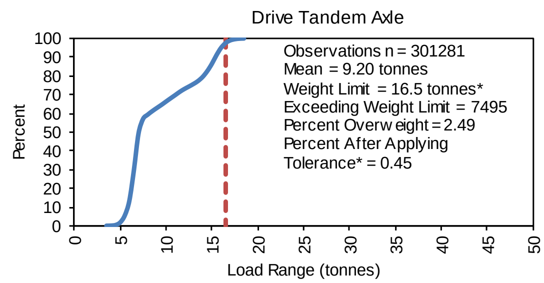
Data from 01/01/2010to 31/12/2010

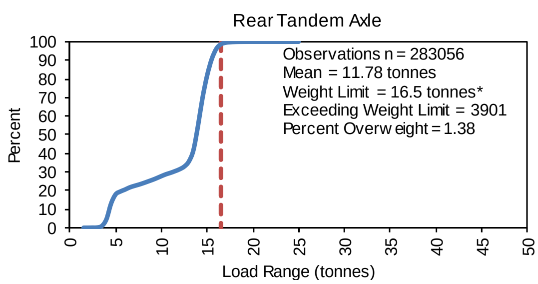
Highway 32 Eastbound (San José-Limón) | **Highway 32 Westbound (Limón - San José)**

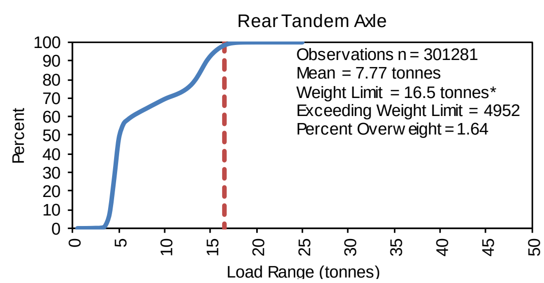


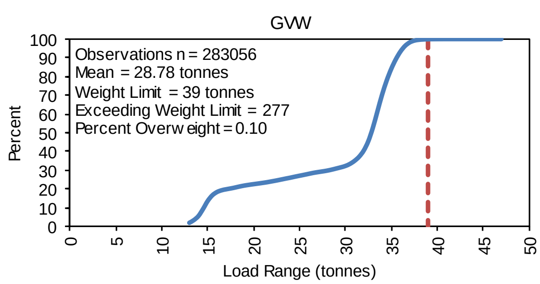


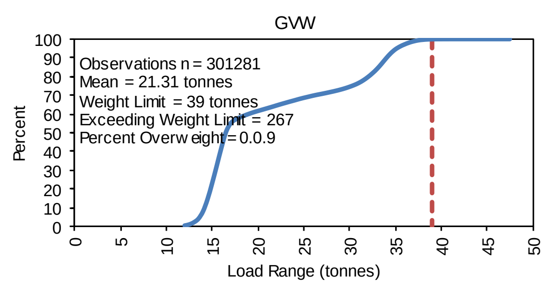












* Subject to tolerance policy/practice

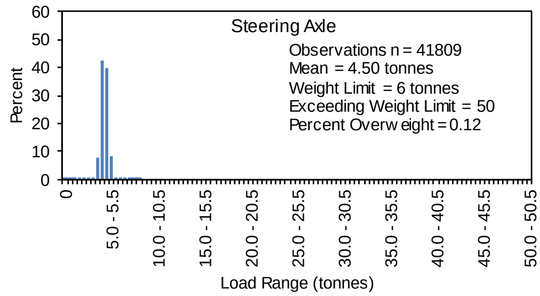
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

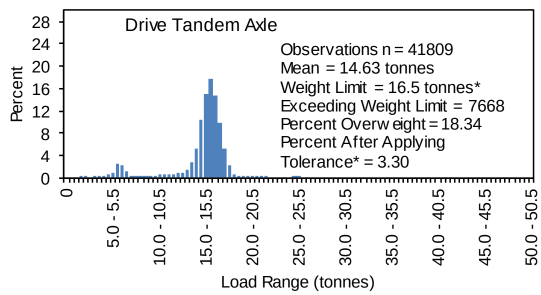
Station Location: **Búfalo, Costa Rica**

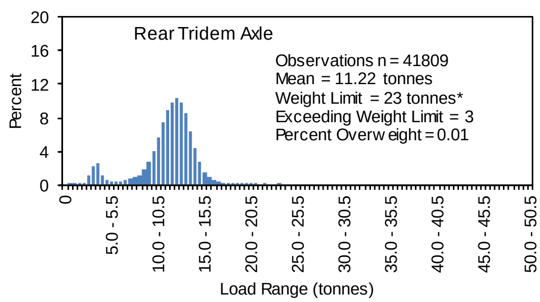
Vehicle Type: **T3-S3**

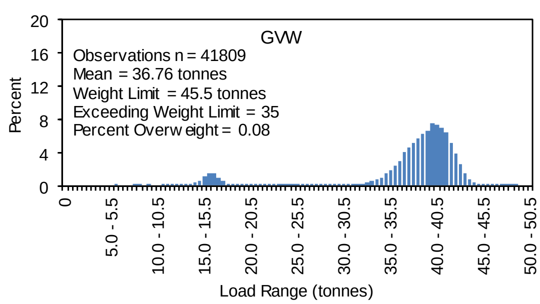
Data from 01/01/2010 to 31/12/2010

Highway 32 Eastbound (San José-Limón)

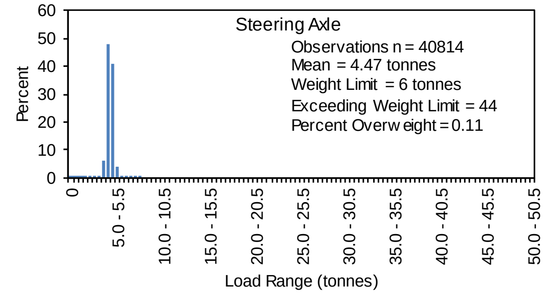


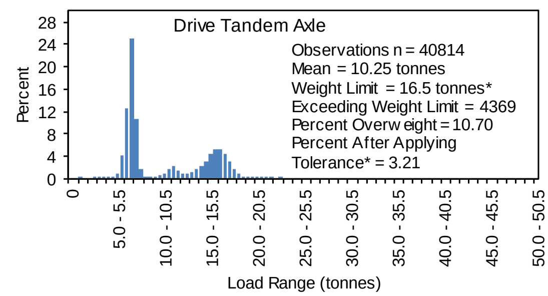


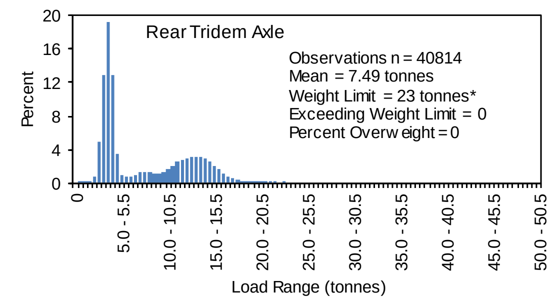


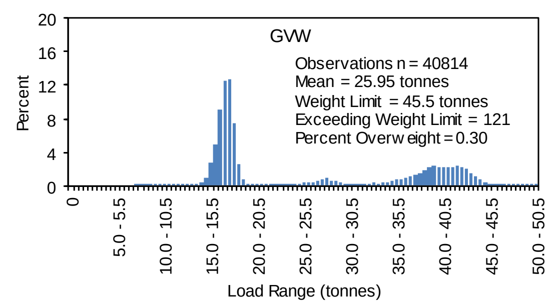


Highway 32 Westbound (Limón - San José)









* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

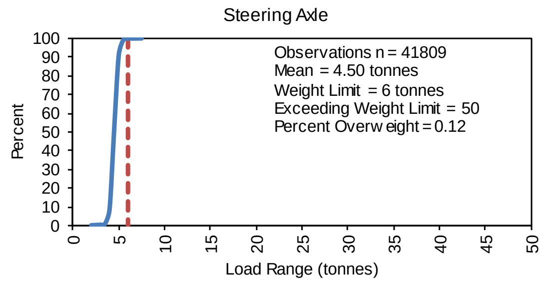
Station Location: **Búfalo, Costa Rica**

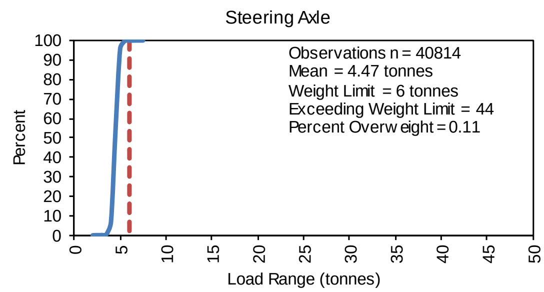
Vehicle Type: **T3-S3**

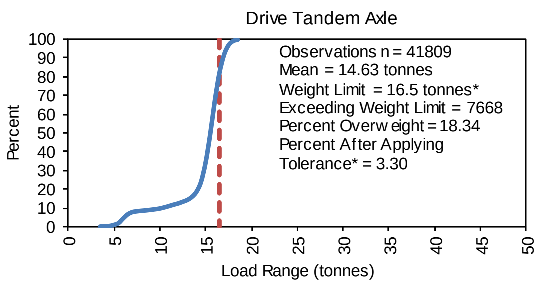
Data from 01/01/2009 to 31/12/2009

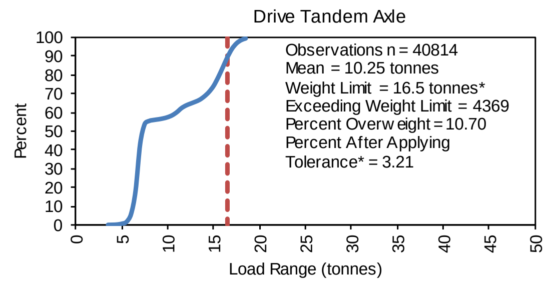
Highway 32 Eastbound (San José-Limón)

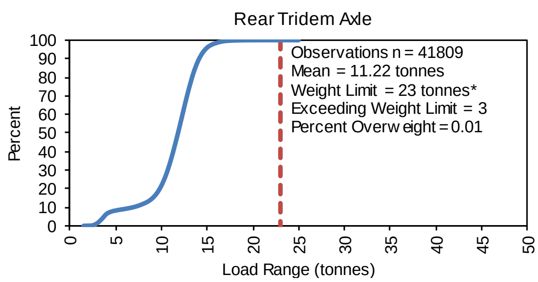
Highway 32 Westbound (Limón - San José)

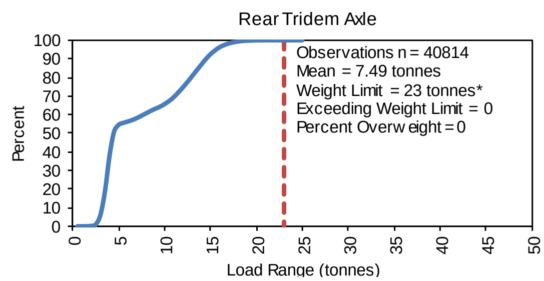


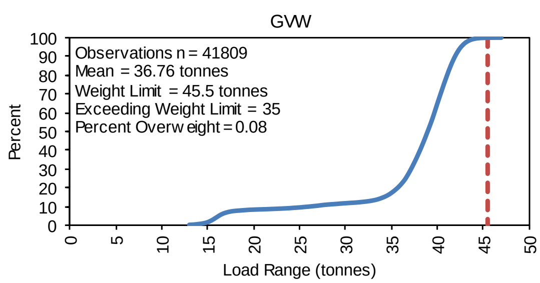


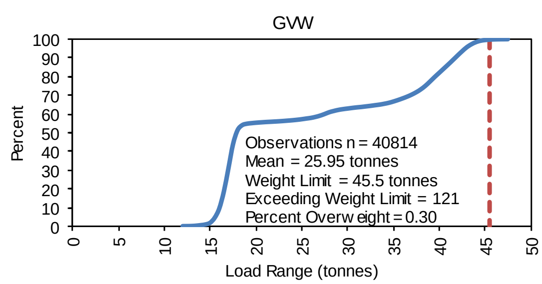












* Subject to tolerance policy/practice

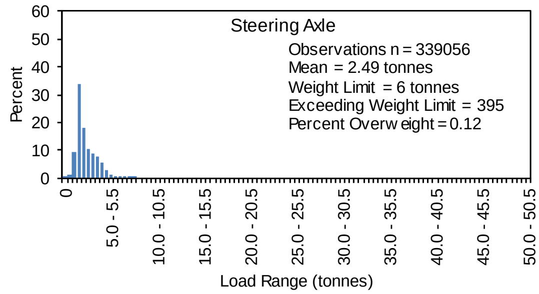
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

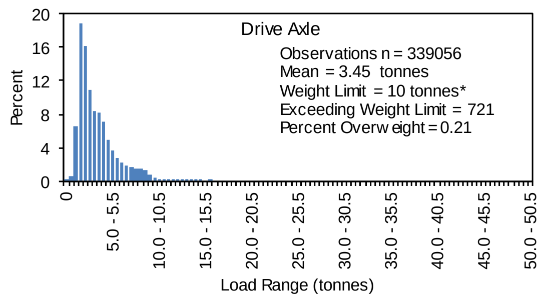
Station Location: **Ochomogo, Costa Rica**

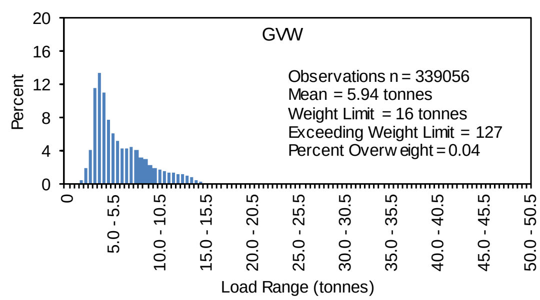
Vehicle Type: **C2**

Data from 01/01/2010 to 31/12/2010

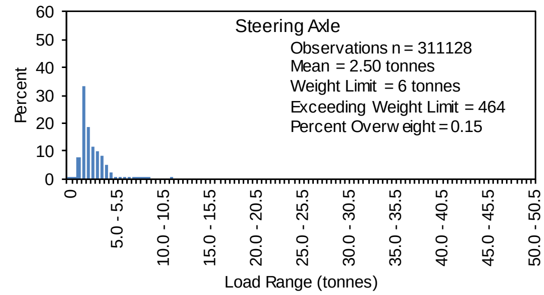
Highway 2 Northbound (San José - Cartago)

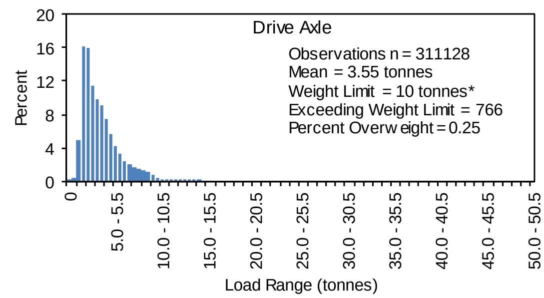


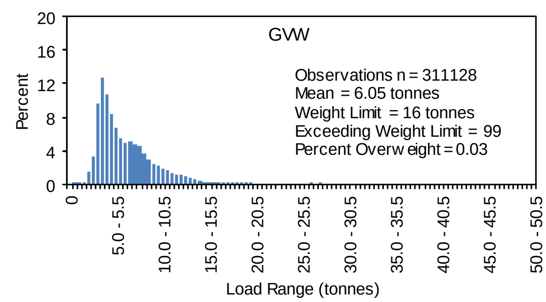




Highway 2 Southbound (Cartago - San José)







* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT

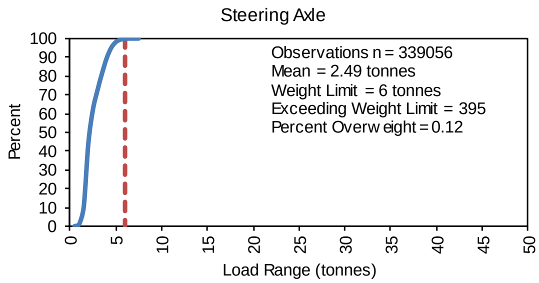
Source: MOPT

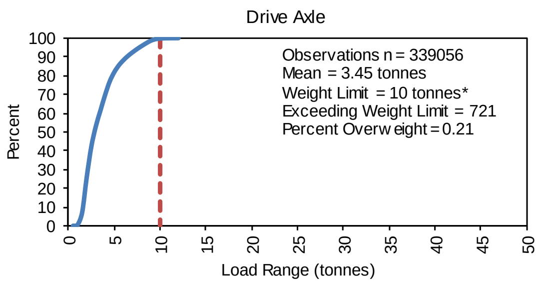
Station Location: **Ochomogo, Costa Rica**

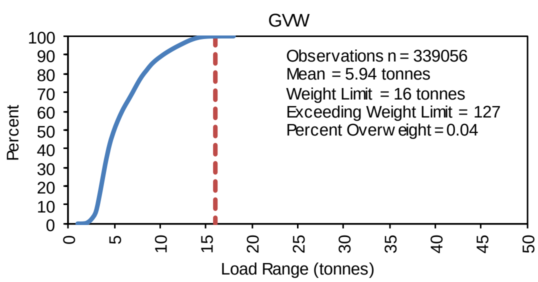
Vehicle Type: **C2**

Data from 01/01/2010 to 31/12/2010

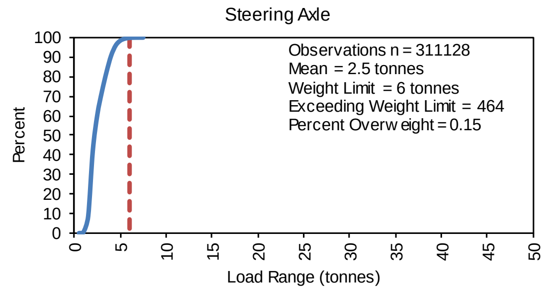
Highway 2 Northbound (San José - Cartago)

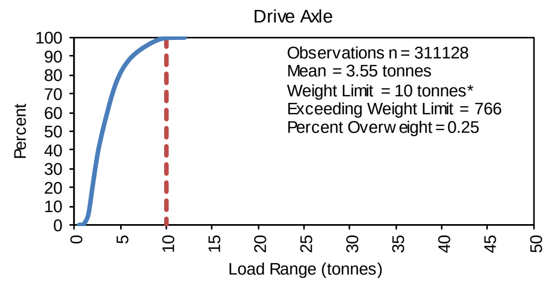


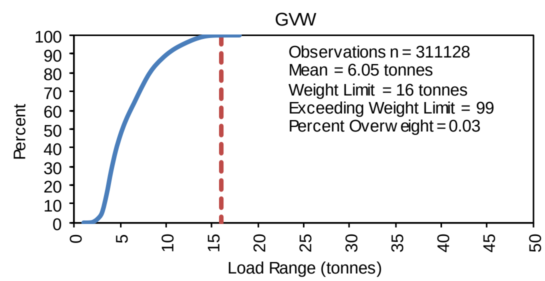




Highway 2 Southbound (Cartago - San José)







* Subject to tolerance policy/practice

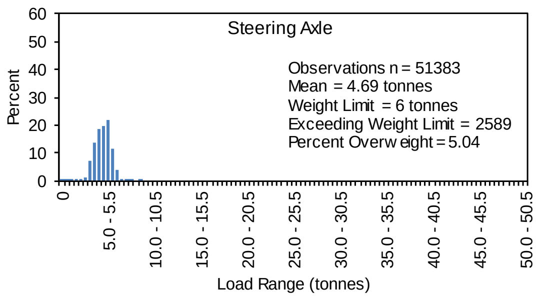
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

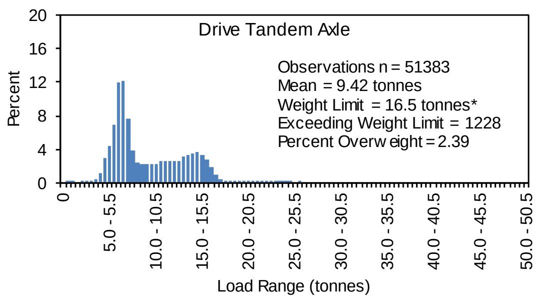
Station Location: **Ochomogo, Costa Rica**

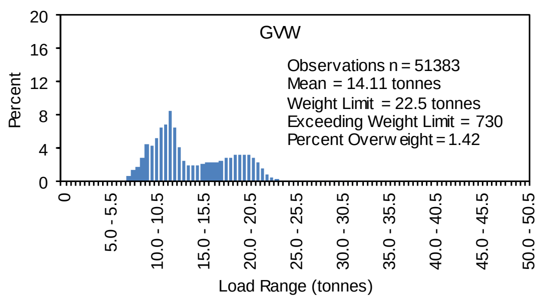
Vehicle Type: **C3**

Data from 01/01/2010 to 31/12/2010

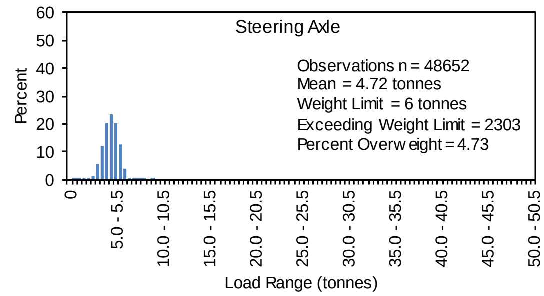
Highway 2 Northbound (San José - Cartago)

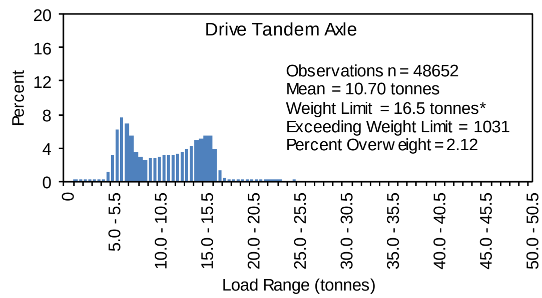


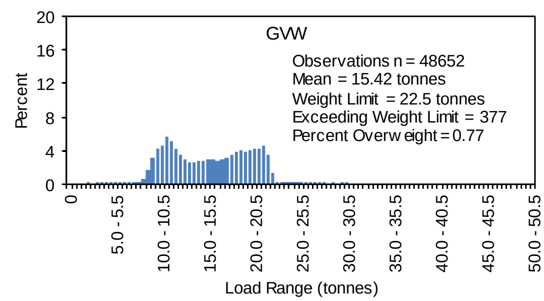




Highway 2 Southbound (Cartago - San José)







* Subject to tolerance policy/practice

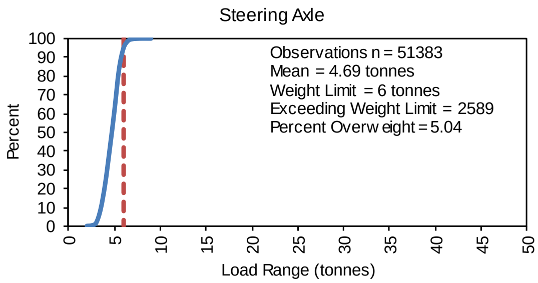
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

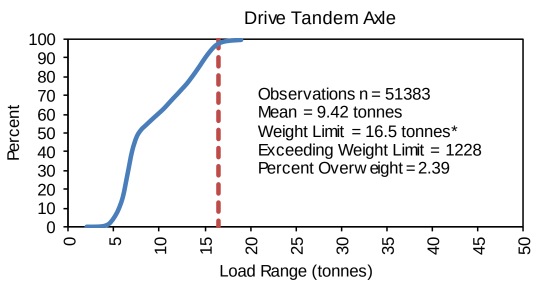
Station Location: **Ochomogo, Costa Rica**

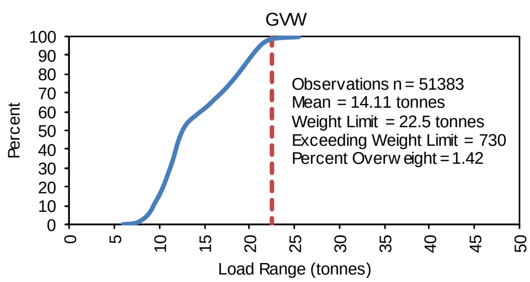
Vehicle Type: **C3**

Data from 01/01/2010 to 31/12/2010

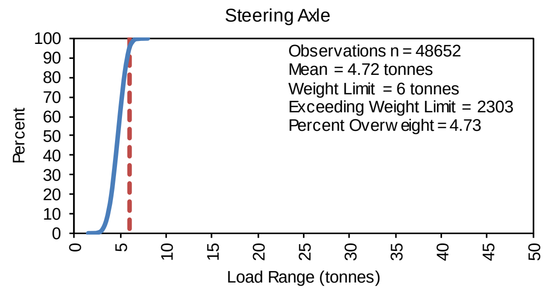
Highway 2 Northbound (San José - Cartago)

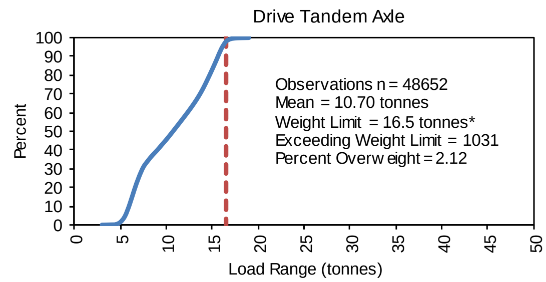


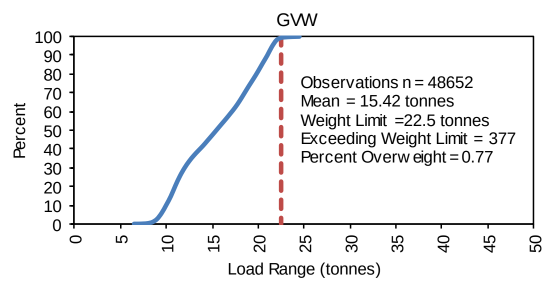




Highway 2 Southbound (Cartago - San José)







* Subject to tolerance policy/practice

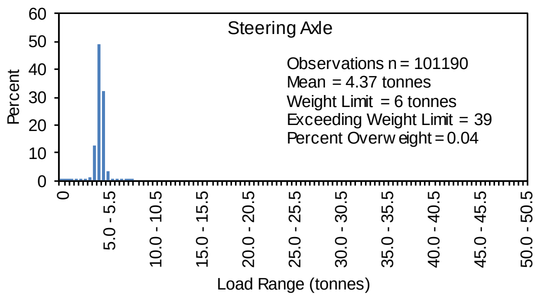
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

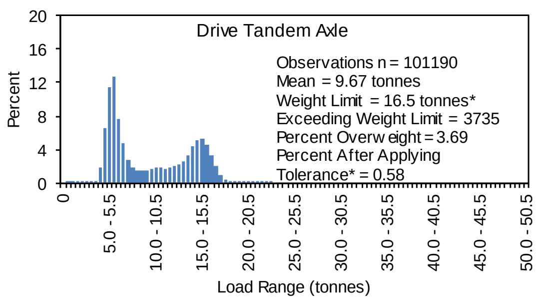
Station Location: **Ochomogo, Costa Rica**

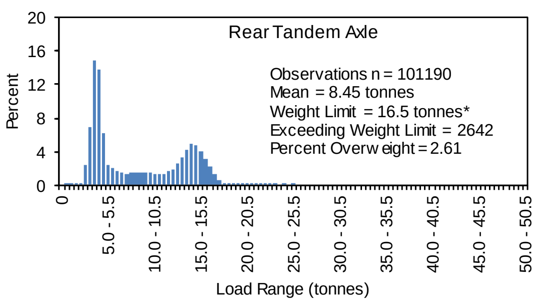
Vehicle Type: **T3-S2**

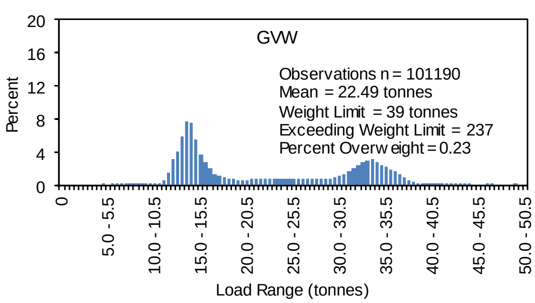
Data from 01/01/2010 to 31/12/2010

Highway 2 Northbound (San José - Cartago)

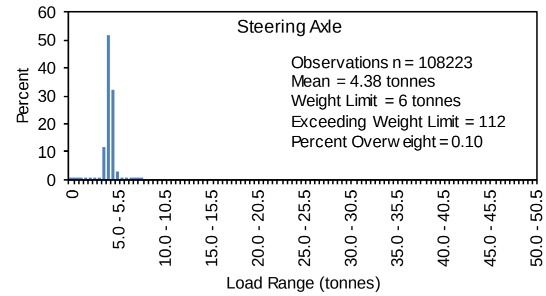


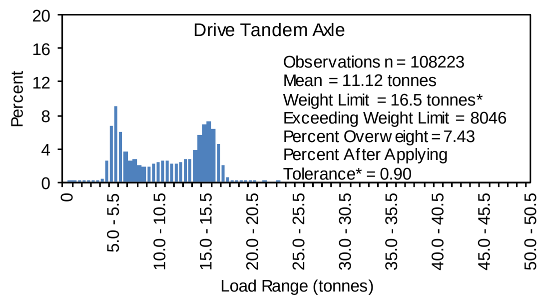


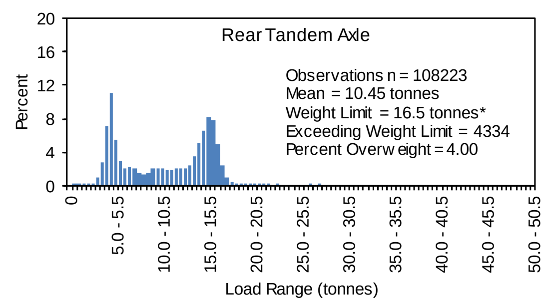


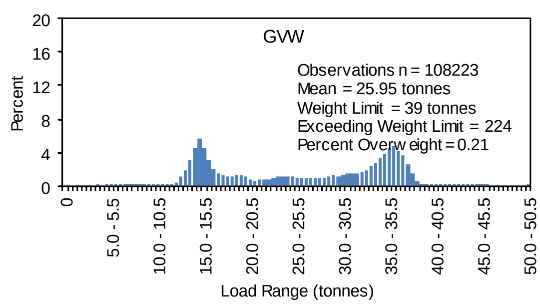


Highway 2 Southbound (Cartago - San José)









* Subject to tolerance policy/practice

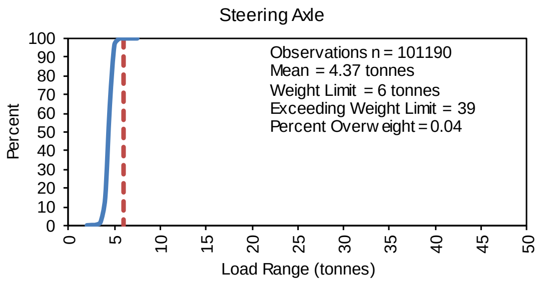
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

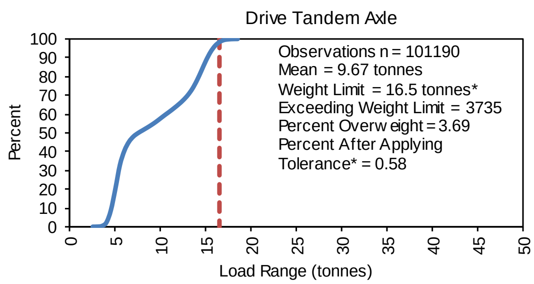
Station Location: **Ochomogo, Costa Rica**

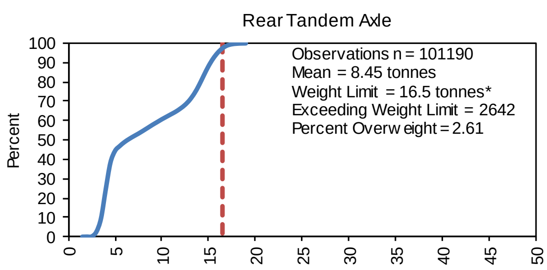
Vehicle Type: **T3-S2**

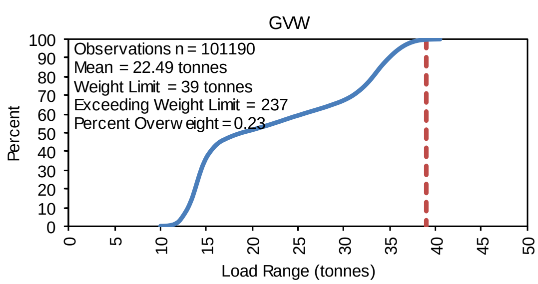
Data from 01/01/2010 to 31/12/2010

Highway 2 Northbound (San José - Cartago)

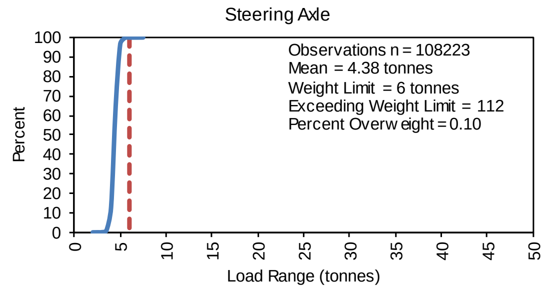


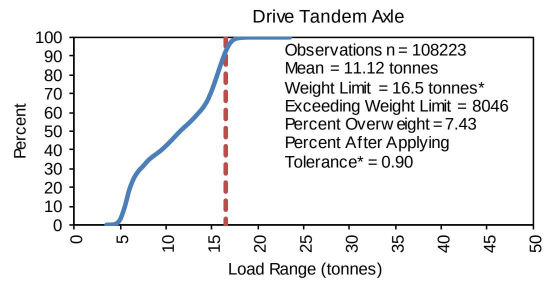


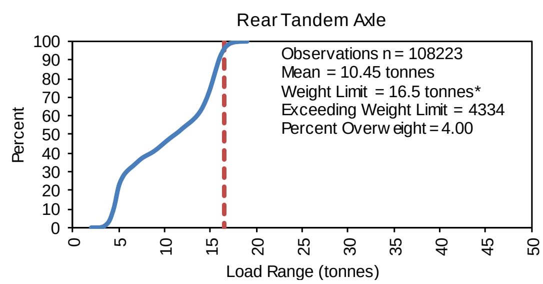


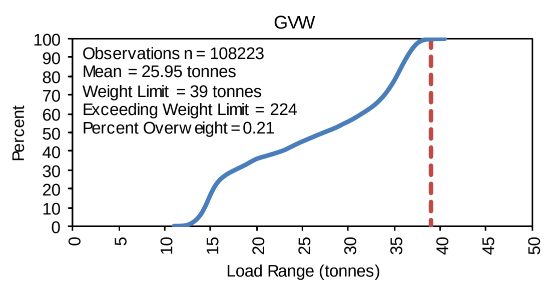


Highway 2 Southbound (Cartago - San José)









* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

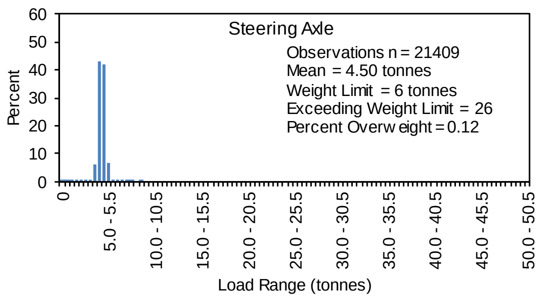
Station Location: **Ochomogo, Costa Rica**

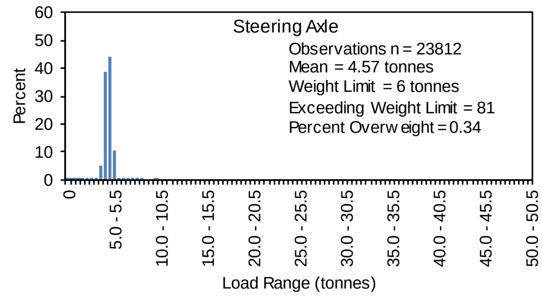
Vehicle Type: **T3-S3**

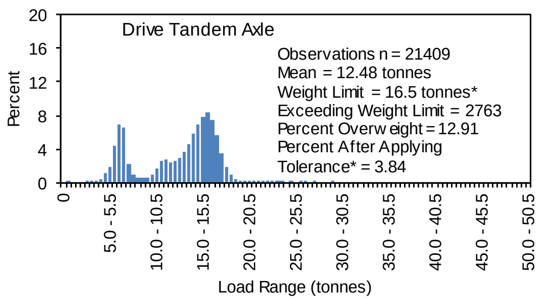
Data from 01/01/2010 to 31/12/2010

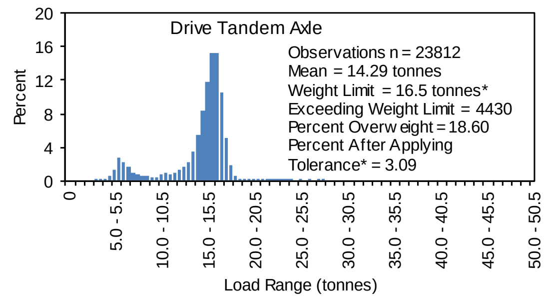
Highway 2 Northbound (San José - Cartago)

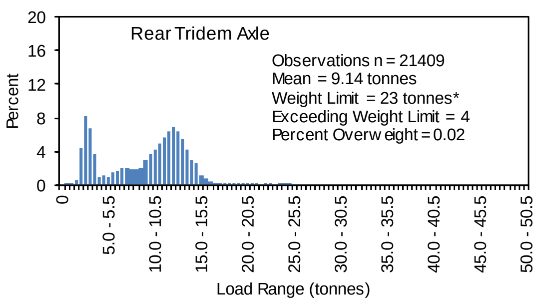
Highway 2 Southbound (Cartago - San José)

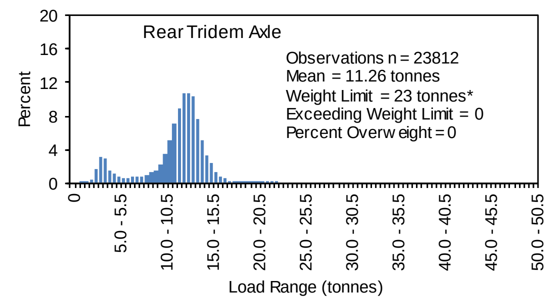


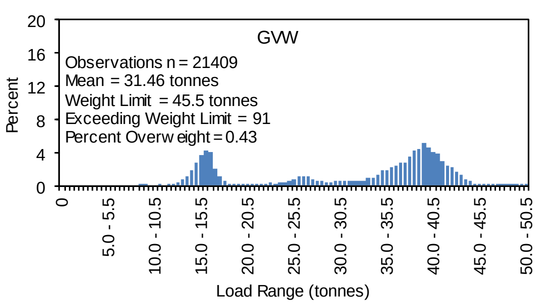


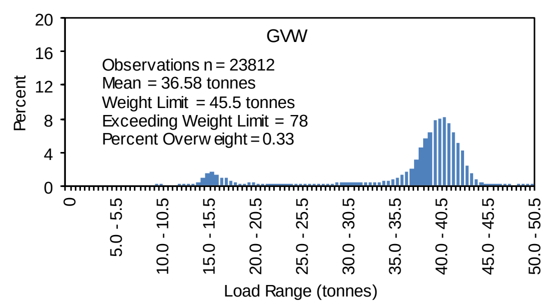












* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT

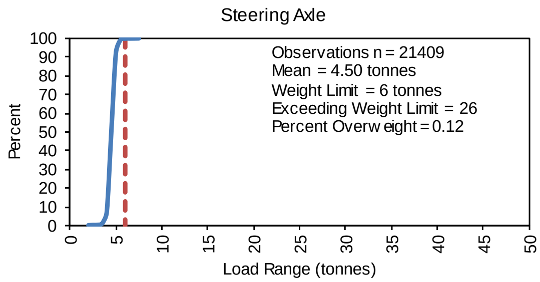
Source: MOPT

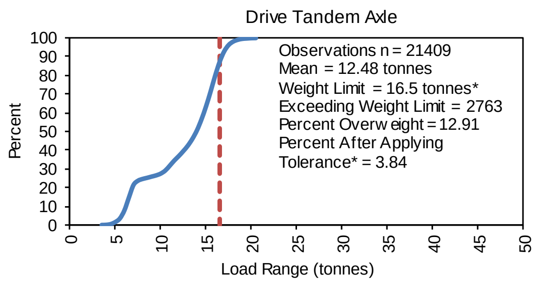
Station Location: **Ochomogo, Costa Rica**

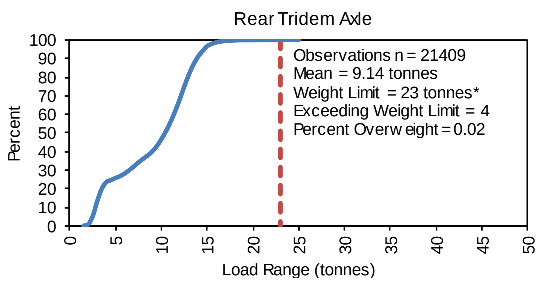
Vehicle Type: **T3-S3**

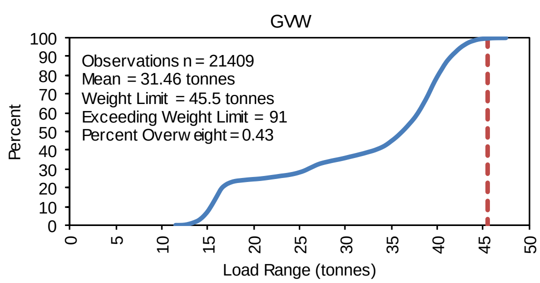
Data from 01/01/2010 to 31/12/2010

Highway 2 Northbound (San José - Cartago)

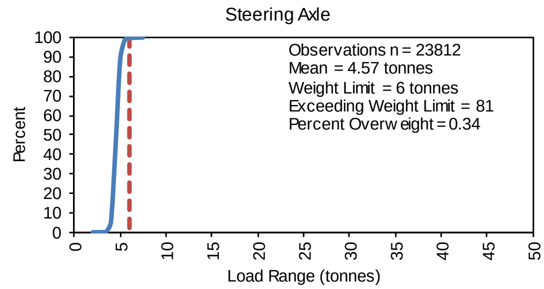


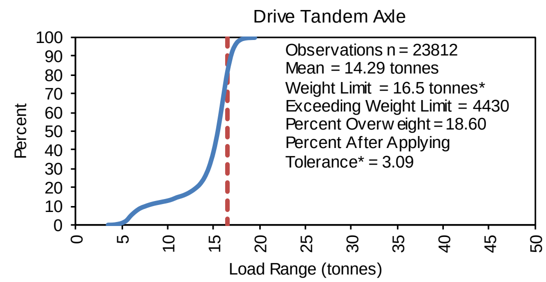


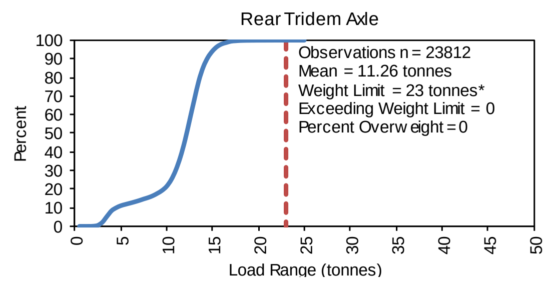


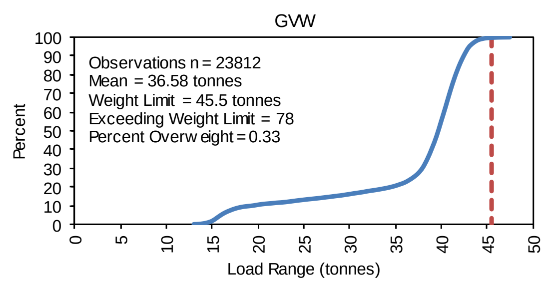


Highway 2 Southbound (Cartago - San José)









* Subject to tolerance policy/practice

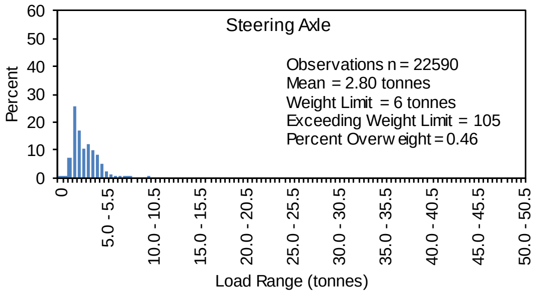
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

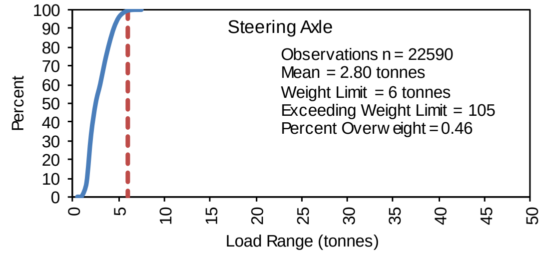
Station Location: **Villa Briceño, Costa Rica**

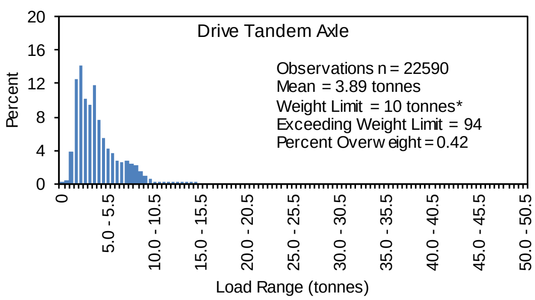
Vehicle Type: **C2**

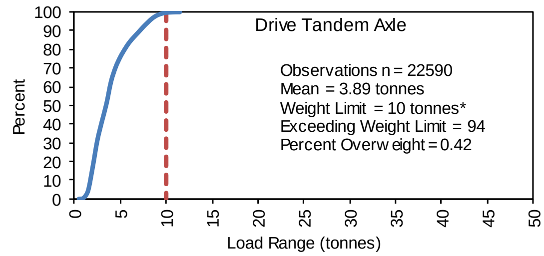
Data from 01/01/2010 to 31/12/2010

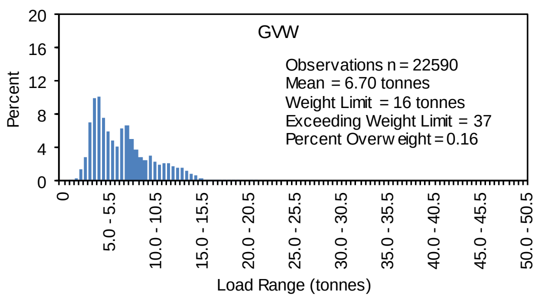
Highway 2 Westbound

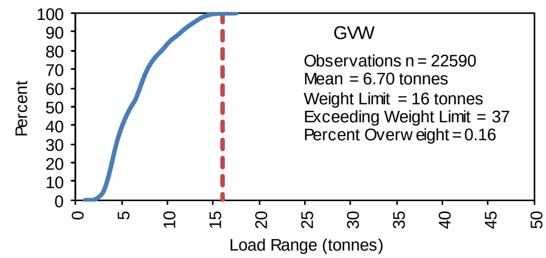












* Subject to tolerance policy/practice

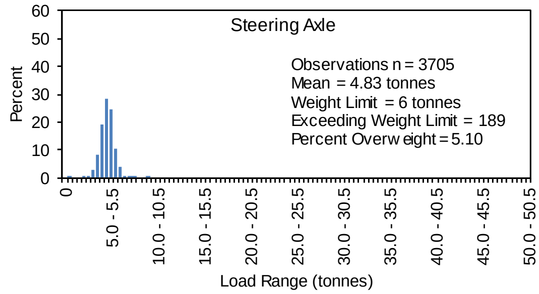
Prepared by: Jane MacAngus B.Sc., EIT   Source: MOPT

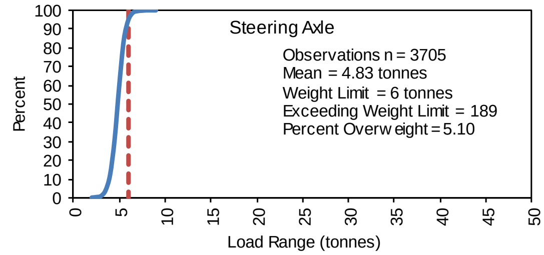
Station Location: **Villa Briceño, Costa Rica**

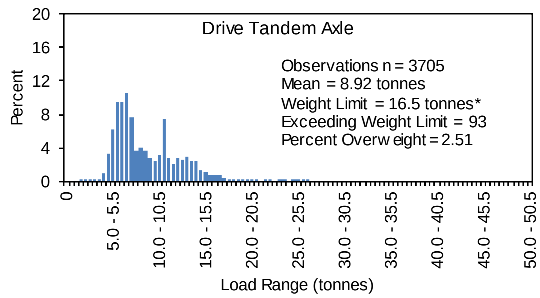
Vehicle Type: **C3**

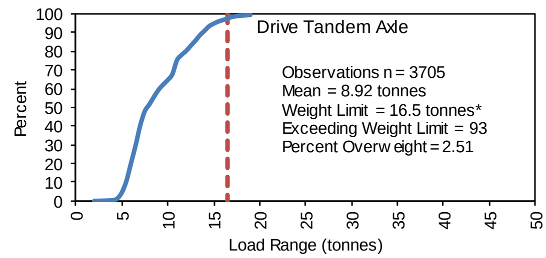
Data from 01/01/2010 to 31/12/2010

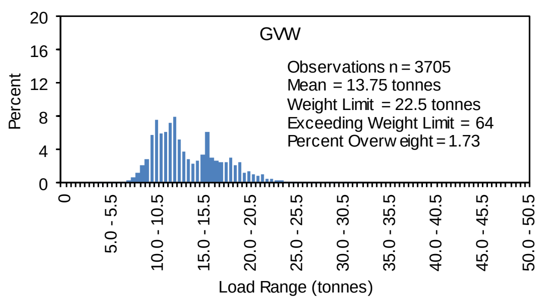
Highway 2 Westbound

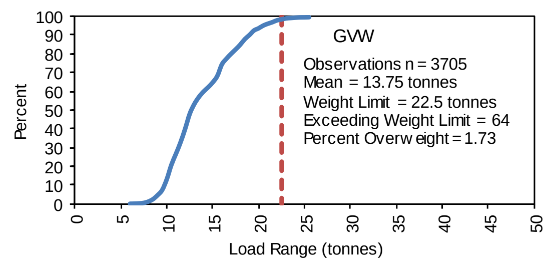












* Subject to tolerance policy/practice

Prepared by: Jane MacAngus B.Sc., EIT

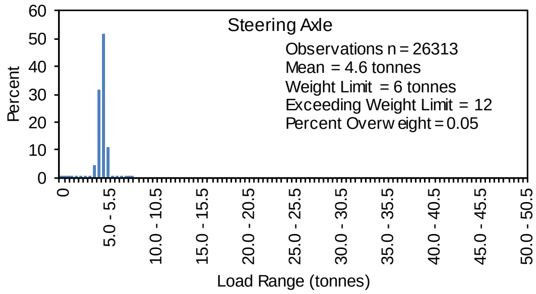
Source: MOPT

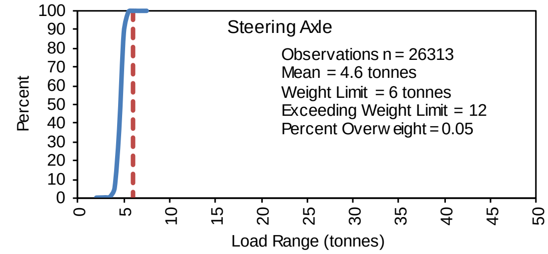
Station Location: **Villa Briceño, Costa Rica**

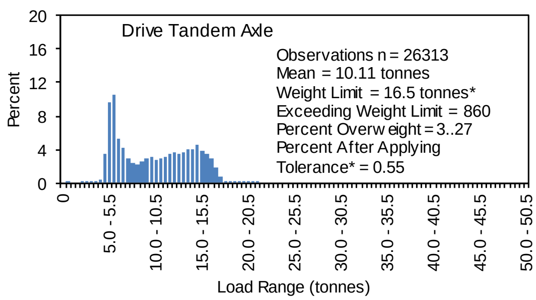
Vehicle Type: **T3-S2**

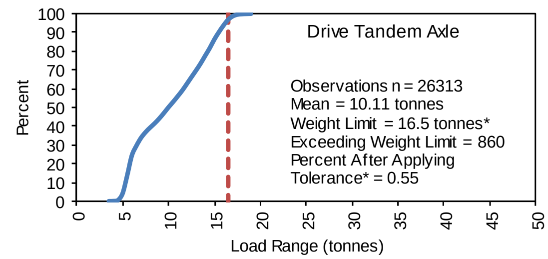
Data from 01/01/2010 to 31/12/2010

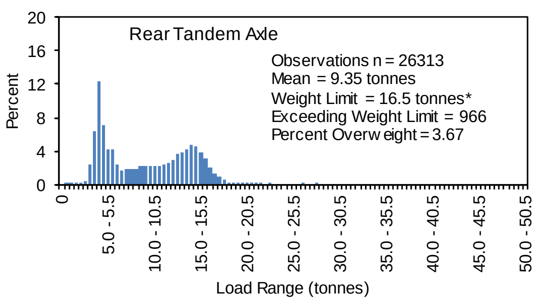
Highway 2 Westbound

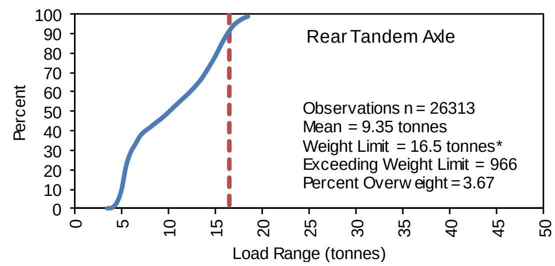


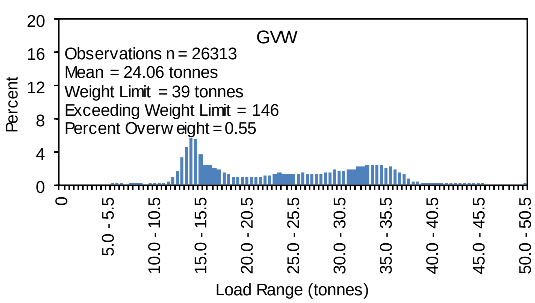


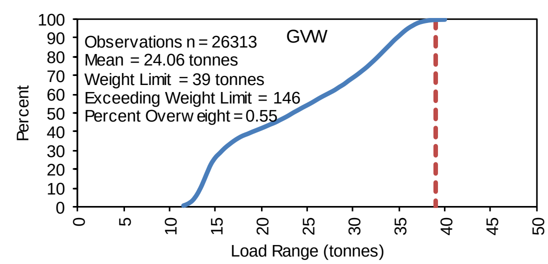












* Subject to tolerance policy/practice

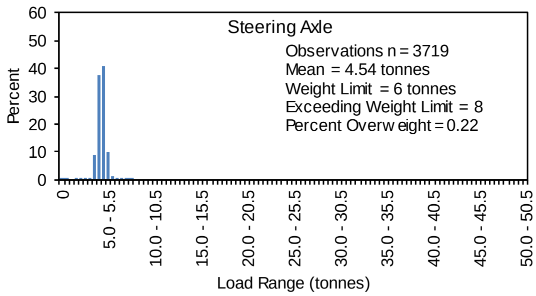
Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT

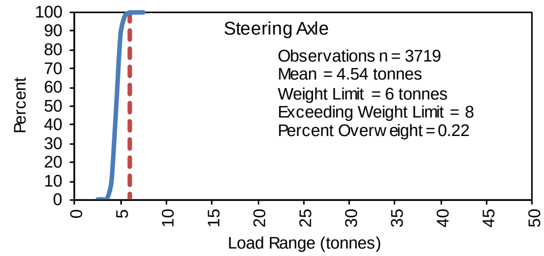
Station Location: **Villa Briceño, Costa Rica**

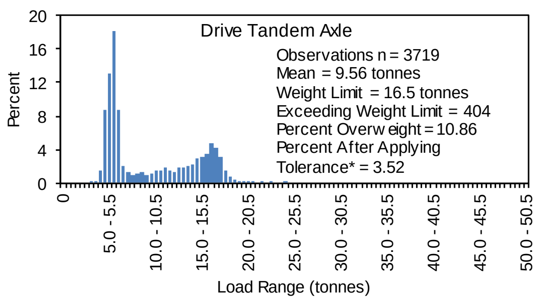
Vehicle Type: **T3-S3**

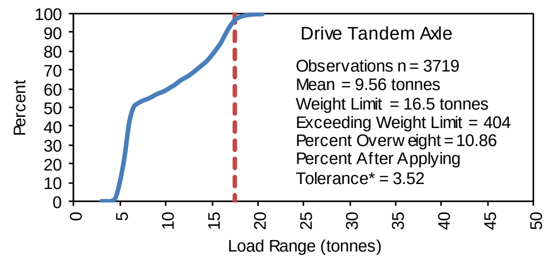
Data from 01/01/2010 to 31/12/2010

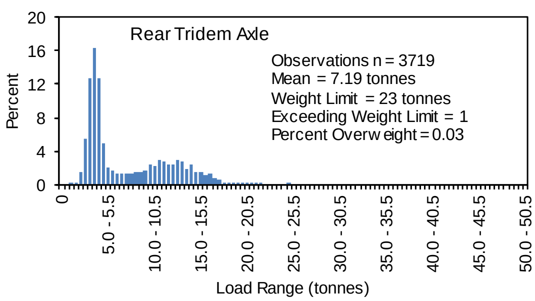
Highway 2 Westbound

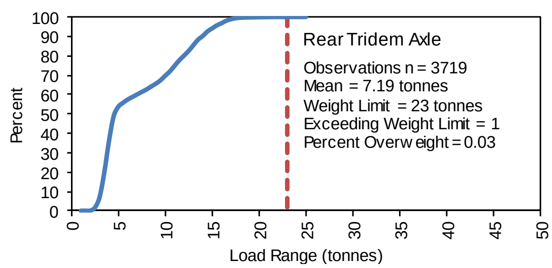


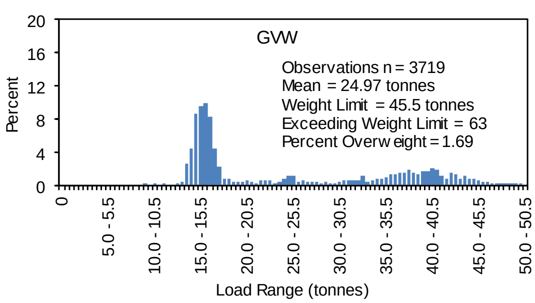


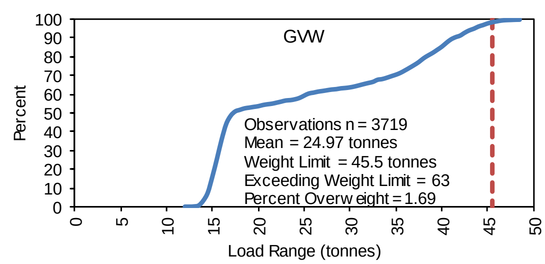












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Prepared by: Jane MacAngus B.Sc., EIT Source: MOPT