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COSTA RICA-RELATED TRUCKING IN THE PAN-AMERICAN CORRIDOR

Jane MacAngus, EIT
University of Manitoba Department of Civil Engineering
Winnipeg, MB
jane.macangus@gmail.com
(204) 474-8560

Jeannette Montufar, Ph.D., P.Eng.
University of Manitoba Department of Civil Engineering
Winnipeg, MB
montufar@cc.umanitoba.ca
(204) 474-6799

Jenny Chaverri, Ing., M.Sc.
University of Costa Rica Department of Civil Engineering
Laboratorio Nacional de Materiales y Modelos Estructurales
San José , Costa Rica
jenny.chaverri@ucr.ac.cr
(506) 2511-4996

ABSTRACT

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, Costa Rica faces large economic, social, and environmental pressures to create a more sustainable and livable place for its people and businesses. The productivity, safety, and efficiency of the trucking sector and its highways are fundamental to achievement of this goal. This paper has three objectives: (1) characterize the transportation operations and system in Costa Rica as they relate to trucks, (2) determine trucking activity in terms of truck and trade flows, and (3) identify demand-related developments to determine their likely impact on truck flows and characteristics in the region.

INTRODUCTION

The freight transportation system 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 with both Nicaragua and Panama. This paper is directed at increasing knowledge about trucking operations in Costa Rica and the surrounding region to help engineers, planners, and decision-makers make more effective choices about the sector, its development, and its highways. With the implementation of the Central American Free Trade Agreement (CAFTA), which aims to have regional economic integration, and which is expected to see significant growth in freight movement activity along the Pan-American Corridor, it is essential to keep this freight moving safely and efficiently. From an engineering perspective, it is necessary to clearly understand the characteristics and issues associated with each of the elements that impact truck safety and efficiency to be able to implement countermeasures to improve them throughout the region.

TRANSPORTATION SYSTEM AND OPERATIONS

The characterization of Costa Rica's transportation system includes the road network, railway network, major border crossings, and major ports. Costa Rica's road network is the primary and often only means of transporting freight throughout the country and to surrounding borders and ports. Because of this it is important to understand the road network to determine the extent of its role in freight movements.

A key consideration in road network operations with regards to the movement of freight is providing reliability and redundancy in the system to ensure efficient and dependable freight service. 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 Ministerio de Obras Públicas y Transporte (Ministry of Transportation or MOPT) highlights the importance of the road network in the transportation system on the whole and recognizes a need to concentrate efforts on replacement and maintenance initiatives to ensure the connectivity of activity centers in the country (MOPT 2010). 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) discusses some of the difficulties in regards to the current state of the transportation system in Central America (SIECA 2007). A significant issue raised is 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 which can in turn disrupt regular maintenance programs.

The transportation system in regards to trucks is defined through site visits to major highways, connecting links, and freight generators and attractors, 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 the focus of this research. These include the National highways 1, 2, 4, 10, 18, 21, 27, 32, 34, and 36. These highways represent ten of the nineteen primary highways in Costa Rica and each highway was visited during the course of this research to observe infrastructure and traffic conditions. The locations of the highways and key freight activity centres are presented in Figure 1. 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. In addition to the three international border crossings, Costa Rica has a total of seven international ports, five located on the Pacific coast and two on the Atlantic coast (MOPT 2010). These are also presented in Figure 1.

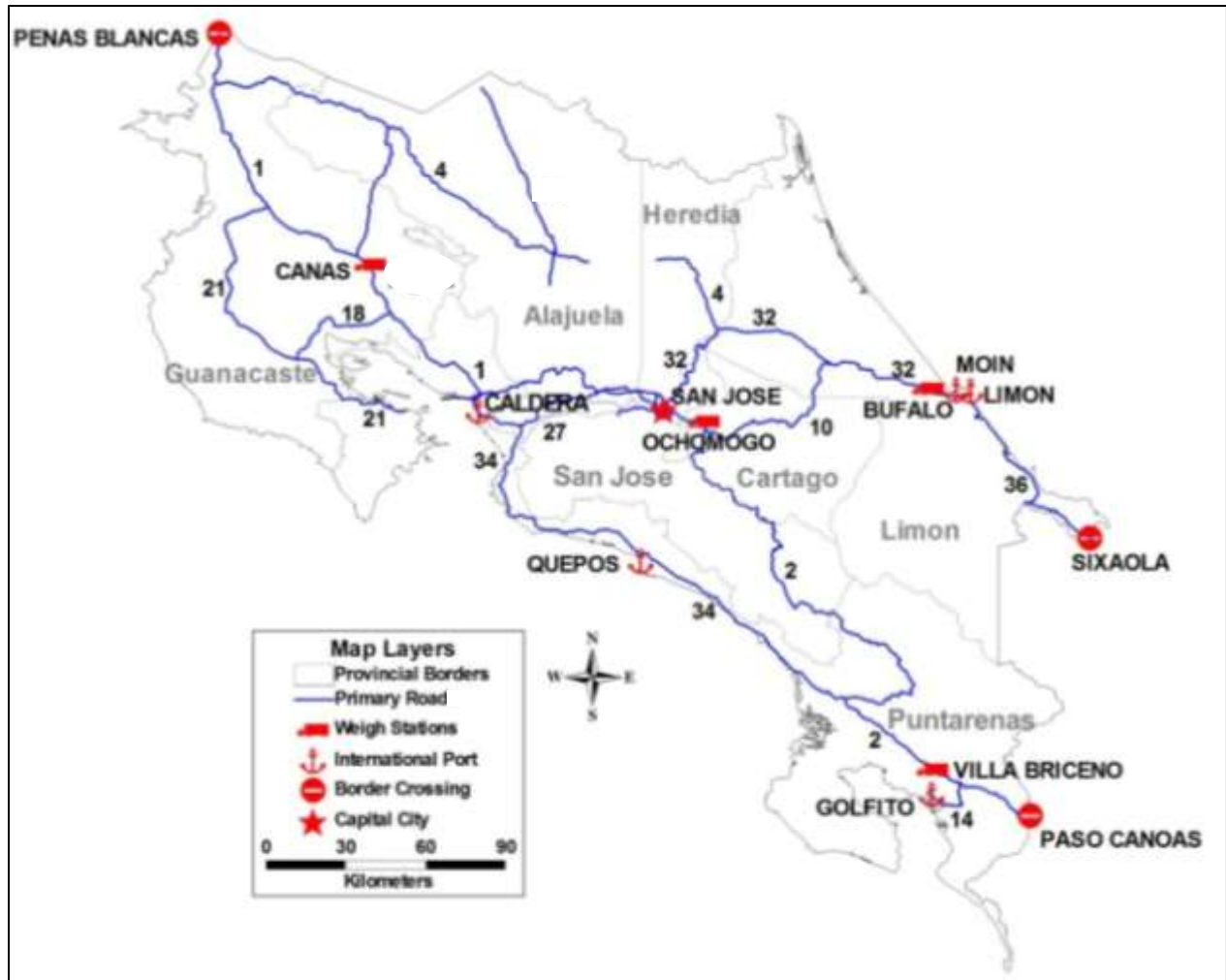


Figure 1: Selected Major Highways in Costa Rica

Data Sources

Three data sources were utilized in the research leading to this paper to understand truck fleet characteristics in terms of vehicle volumes, vehicle classification, and truck body styles and their operations throughout the freight transportation network in the country. The data sources comprise: (1) permanent weigh stations, (2) temporary automatic vehicle classifiers counts, and (3) manually collected counts. The permanent weigh stations provide the most robust data set as they count year round, 24 hours a day. Data from the temporary vehicle classifiers consist of a series of 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 as the weigh stations and temporary automatic vehicle classifiers do not collect this type of information. These data sets are described in more detail in the following sections.

Permanent Weigh Stations: Four weigh stations are administered by the Consejo Nacional Vial (CONAVI), an acting council of MOPT, on three primary highways in Costa Rica. These stations are located at Cañas, Búfalo, Ochomogo, and Villa Briceño. An additional weigh station is located at Esparza, however, this station operates under different conditions and data is unavailable. The locations of the weigh stations are presented in Figure 1, along with Costa Rica's primary highways and some key freight activity centers.

The weigh stations collect data 24 hours a day for the full year. The data used in the analysis is for the period between January 1, 2010 and December 31, 2010. The Cañas station is an exception to this with a data collection period from January 19, 2010 to November 30, 2010. 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 the technician, not automatically. The entire weigh station data set for 2010 consists of 2,050,186 records.

Temporary Automatic Vehicle Classifiers Counts: Automatic vehicle classifiers were installed at ten locations on primary highways in Costa Rica as part of this research. 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 so counts were collected in this manner. To achieve this, two counters were used at each site for more accurate results. The count data presents traffic characteristics in terms of vehicles by classification, hour of day, and direction of travel.

The FHWA classification Scheme F was selected as the classification scheme for the counters. Scheme F was selected due to its similarities to 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 and are further described later in this paper.

Sites were selected based on their relevance to the freight transportation system in Costa Rica. Locations near weigh stations were avoided as data is already available at these sites. Counters were dispersed widely throughout the country to give a comprehensive look at the traffic characteristics on Costa Rica's primary highways. The counter sites are presented in Figure 2.

Manually Collected Counts: Manual counts and classification data were recorded while driving portions of Costa Rica's primary highways. Counts took place on 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 including both weekdays and weekends. A total of 2,047 trucks were manually classified through the course of this research. These counts provide a general overview of the truck fleet operating on Costa Rica's primary highways in terms of vehicle classification and body type.

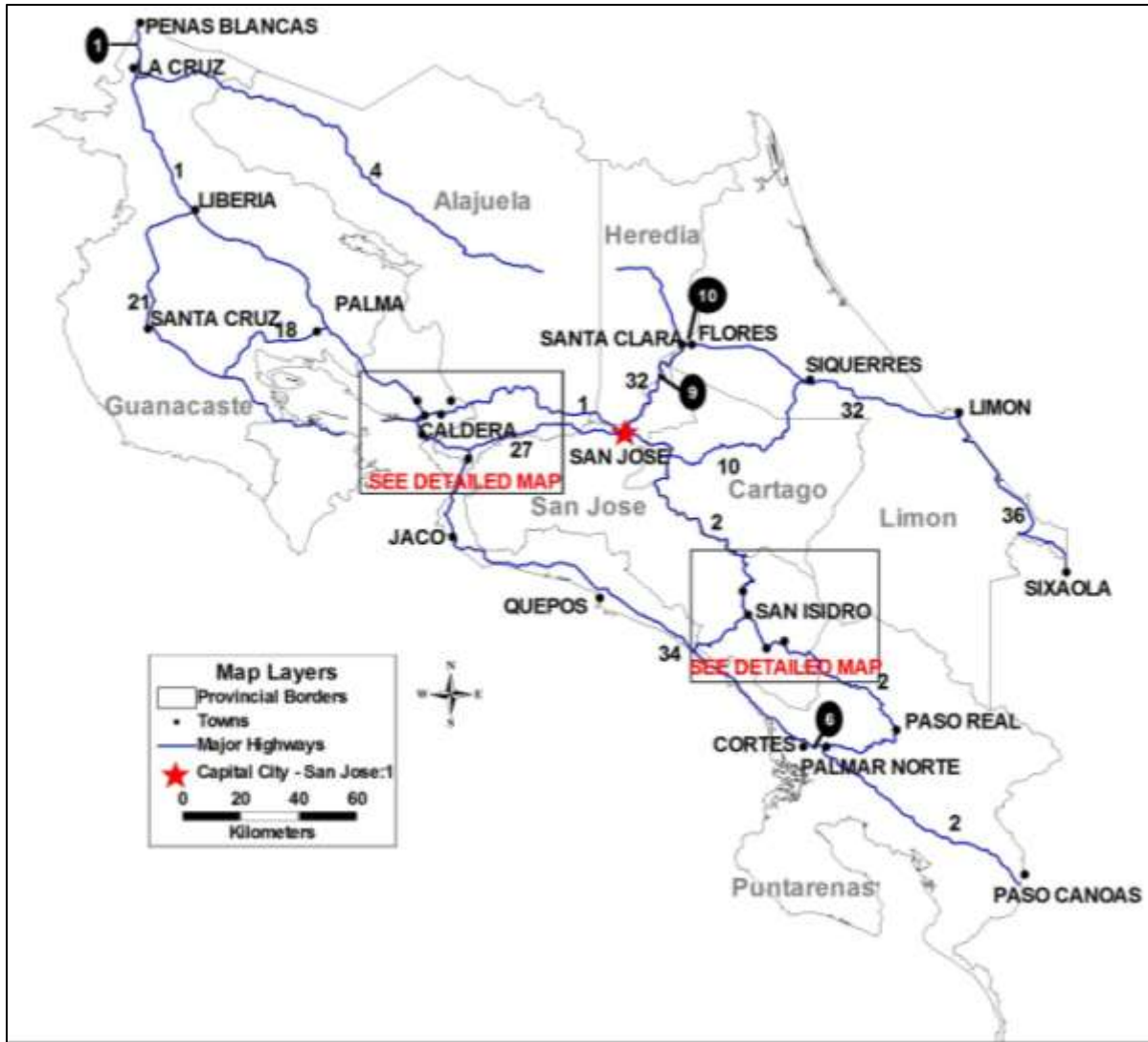


Figure 2: Locations of Automatic Vehicle Classifiers

Road and Railway Network Operations

Costa Rica has two national railways: (1) Atlantic Railroad, and (2) Pacific Railroad. A small portion of the Atlantic Railroad is used for freight transportation, and a few miles of both the Atlantic and Pacific railroads are used for passenger/tourist travel. The railroad network is extensive, however, only a small fraction is in use (MOPT, 2010). Due to the current low utilization of the railways in Costa Rica they are not the focus of this research as the road network is the primary means for transporting freight by land. The roads selected for this research serve the freight transportation network in Costa Rica in various capacities. Although ten primary highways were visited during this research eight are the focus in this paper as they were found to be the most significant with respect to the freight transportation network in the country. Field visits to each of these segments were conducted between February 15, 2011 and May 19, 2011. The national road inventory database was provided by MOPT and also utilized in this portion of the research.

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 east coast 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. The speed limit on this highway ranges from 70 to 75 kilometres per hour.



Figure 3: Highway 1 Peñas Blancas Border (2011)

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 vehicles (tractor semi-trailers with five or more axles) while nine percent of all traffic is classified as heavy vehicles 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. Peñas Blancas is the only border crossing location between Nicaragua and Costa Rica and handles 80 percent of exports and 85 percent of imports in terms of weight by land (Carvajal, Fernández and Salazar 2008). Trucks queue prior to crossing the border with a waiting period of up to three days. There is insufficient truck parking facilities at the border location resulting in trucks parking directly on Highway 1. 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 Highway 1 due to increased challenges with road geometry making passing slower moving vehicles difficult, in addition to general congestion issues near the urban centre of San José.

Highway 2 is a portion of the Pan-American Highway and begins South of San José connecting to the main border crossing with Panama at Paso Canoas. Although Highway 2 is a part of the Pan-American Highway there has been a recent shift in traffic to Highway 34 for those vehicles

traveling south-east to Paso Canoas as this link has recently been completed. Highway 2 is a two lane undivided highway with a speed limit ranging from 50 to 80 kilometres per hour.

Highway 2 is mainly located in a mountainous region with challenging geometry such as steep grades and tight horizontal curves. 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 in this region, 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) (Carvajal, Fernández and Salazar 2008). The MOPT operates a weigh station near the Panama border crossing that processes approximately 160 trucks per day. Another weight 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 straight trucks), likely due to its more urban setting. This is also not a primary through fare for heavy trucks traveling to or from the countries international ports.



Figure 4: Highway 2 (2011)

Highway 4 is a future alternative route for trucks traveling to or from Nicaragua and connecting with the ports of Limón and Moín on the east coast. At this time the connection is incomplete although there are plans to complete this route in the future to avoid instability in the road network caused by adverse weather conditions resulting in closures on Highway 32. With the completion of this link in the freight transportation network, the capital city of San José can be avoided in addition to Highway 32. Highway 32 is currently the primary route to the east coast ports that handle approximately 73 percent of all cargo processed through Costa Rican ports in terms of weight (Carvajal, Fernández and Salazar 2008).

Highway 10 is an alternative route to Highway 32 connecting San José to the east coast ports of Limón and Moín. When a closure occurs on Highway 32 vehicles proceed on Highway 10. Highway 10 is typically restricted for large trucks due to its challenging geometry and is only used for large 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.



Figure 5: Highway 10 (2011)



Figure 6: Highway 27 (2011)

Highway 27 is a toll road connecting San José to the west coast port of Caldera and is operated under a concession. It is an alternative and significantly faster option to Highway 1. Highway 27 is a two-lane undivided highway with the presence of shoulders at most locations and frequent 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 some operational concerns.

Highway 32 is crucial to the freight movement in Costa Rica due to its connection with the east 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.



Figure 7: Highway 32 West (2011)



Figure 8: Highway 32 East (2011)

Around eleven percent of the traffic on this highway consists of heavy vehicles. The MOPT operates a weigh station directly on Highway 32 that is open 24 per days, 365 days a year that weighs trucks in both directions of travel. The weigh station processes around 2,270 trucks per day. Trucks are typically traveling from the Nicaragua border, San José, or nearby farmland that is rich in fruit production, particularly bananas for export. There is an issue with traffic within 20 kilometres of the city of Limón due to increased population density and the confluence of several routes serving the Limón and Moín ports. The MOPT estimates that trucks move 800,000 TEUs per year in this area in the form of port traffic and general cargo (MOPT 2010). This

situation is further aggravated by the presence of sixteen parking terminals within 10 kilometres of Limón and Moín. These terminals are typically used for loading and unloading trucks directly from ships and vice versa. These facilities help to alleviate the lack of current space on the docks of Limón and Moín; however, they contribute largely to the traffic congestion experienced on Highway 32 near the ports.

Highway 34 runs along the west coast of Costa Rica connecting San José to west 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 without shoulders. The speed limit ranges from 30 to 80 kilometres per hour. Heavy vehicles comprise around five percent of the traffic on this highway.



Figure 9: Highway 34 (2011)



Figure 10: Highway 36 (2011)

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 a speed limit ranging from 40 to 70 kilometres per hour. There is a high presence of pedestrians and cyclists travelling 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).

The freight transportation network throughout Costa Rica is diverse in terms of infrastructure and traffic characteristics. The freight traffic characteristics are largely dependent on activity centers such as ports, border crossings, and agricultural production regions. Some of these freight activity centres are briefly described in the following sections.

Major Border Crossings

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 (851,486 tonnes) and 85 percent of imports (450,125 tonnes) in terms of weight by road (Carvajal, Fernández and Salazar 2008).

Major Ports

Costa Rica has seven international ports, three of which 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 around 150 kilometres from Costa Rica's capital city, San José, and six kilometres from the Limón Port. The Caldera Port is located on the Atlantic coast around 80 kilometres from San José. These are presented in Figure 1.

When considering metric tonnes of cargo moved by all ports in Costa Rica, the number of international twenty-foot equivalent units (TEU) with an average payload of 9.3 tonnes for each

TEU is around 1,462,509 TEUs per year (Royal Haskoning 2008). This is approximately 4,000 TEUs per day throughout all of Costa Rica. Based on container traffic data from 2005-2007 at the Limón and Moín ports, Royal Haskoning estimates the ratio of downloaded full containers of 40 foot in relation to 20 foot containers is 1.74 TEU/container. Applying this to the total TEUs moved in Costa Rica on average there are roughly 2,303 containers moved by Costa Rica's ports daily.

The largest commodity moved by Costa Rica's ports in terms of weight is bananas in containers (2,289,431 tonnes) followed by petroleum and derivatives (2,238,342 tonnes) and fruit containers (1,521,468 tonnes). Costa Rica's largest export by sea is bananas in containers (2,289,431 tonnes) followed by fruit containers (1,505,693 tonnes). Costa Rica's largest import by sea is petroleum and derivatives (2,238,342 tonnes) followed by iron (434,969 tonnes) (Carvajal, Fernández and Salazar 2008).

When comparing freight movement by road and sea in Costa Rica, the ports handle approximately nine times more freight than the border crossings in terms of weight. The ports handled 13,601,333 metric tonnes in 2007 while the border crossings handled 1,514,636 metric tonnes in 2007 (Carvajal, Fernández and Salazar 2008).

TRUCKING ACTIVITY IN TERMS OF TRUCK AND TRADE FLOWS

The trucking activity in Costa Rica is characterized by the types, volumes, and travel patterns of trucks within, departing, and arriving in the country. This section of the paper describes the analysis procedures used for quantifying these characteristics that provide a general picture of the current trucking activity in 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 designated by the national truck size and weight regulations. Although these four classes account for around 95 percent of the truck fleet there are 30 possible classifications. The details of the four most common vehicles types are presented in Table 1.

Costa Rica's C3 classification is similar to the FHWA Scheme F Class 6 vehicle (three-axle single unit); the T3-S2 is comparable to the Class 9 (five-axles, single trailer), and the T3-S3 to the Class 10 (six or more axles, single trailer). The C2 vehicle classification poses some issues in terms of standardization. There is great variability in terms of the sizes of two-axle single unit vehicles in Costa Rica. These vehicles make up nearly 40 percent of the truck fleet as observed in the weigh station and manually collected data. This is not reflected in the automatic vehicle classifiers as some of these vehicles would be counted under FHWA Scheme F Class 3 (two-axles, four-tire single unit) or Class 5 vehicles (two-axle, six-tire single unit).

During the analysis of the three data sources it was found that the truck fleet varies distinctly across different regions depending on the unique economic activities of the region. The distribution of vehicle classifications was determined across all four weigh stations individually. The results were then combined to better understand the truck fleet in Costa Rica as a whole. Figure 3 depicts the distribution of vehicles for each station and the distribution across the four stations combined. Ninety-five percent of vehicles were classified in one of four main categories: C2, C3, T3-S2, and T3-S3. All other remaining vehicles were grouped together to form the "other" category. Figure 11 presents the distribution of the truck fleet according to classification and weigh station.

Table 1: Primary Truck Classes in Costa Rica

Class	Configuration	Axes and Tires	Example
C2			
C3			
T3-S2			
T3-S3			

Source: CONAVI

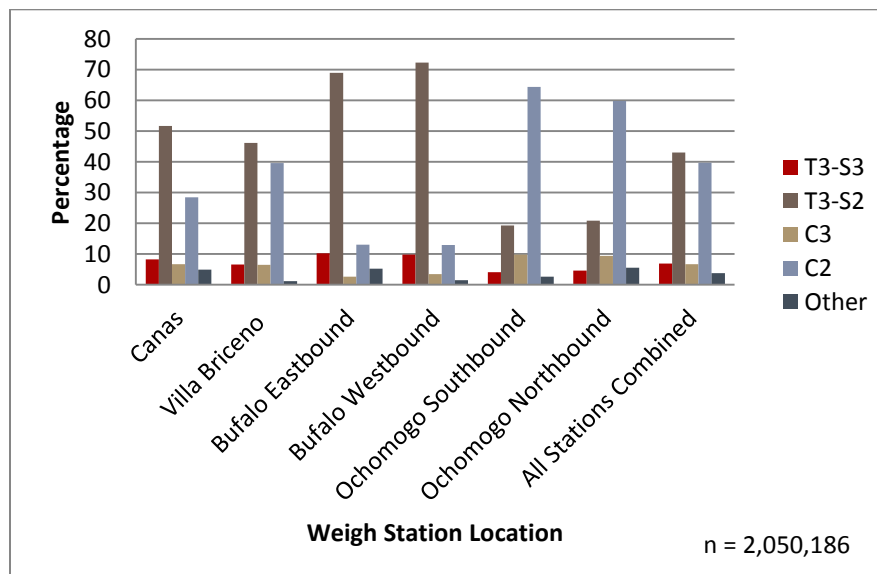


Figure 11: Percentage of Trucks by Classification and Weigh Station (2010)

The distribution shows that at the Búfalo station, located near the ports of Moín and Limón, the majority of truck traffic comprises of T3-S2s (69 and 72 percent eastbound and westbound, respectively) with a limited number of C2s (13 percent). This location sees a higher percentage of longer haul, heavy truck trips carrying goods to and from the ports of Moín and Limón. The Ochomogo station located near San José has different truck fleet characteristics when compared to Búfalo. Ochomogo has a higher percentage of C2 vehicles (light trucks) (64 and 60 percent southbound and northbound, respectively), likely carrying smaller loads over smaller distances due to its more urban location. The weigh stations at Cañas and Villa Briceño, both located near international border crossings exhibit a greater variety in terms of heavy and light trucks.

Overall, when weigh stations are combined, approximately 40 percent of the truck fleet consists of C2 vehicles and 40 percent of T3-S2 vehicles. The C3 and T3-S3, and all other classes comprise the other twenty percent of the fleet.

The weigh stations collect vehicle classification data by manually assigning vehicle classes to each 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: (1) C3 (FHWA Class 6), (2) T3-S2 (FHWA Class 9), (3) T3-S3 (FHWA Class 10), and (4) all other trucks (FHWA Classes 5, 7, 8, 11, 12, and 13).

In terms of truck fleet mix at different locations throughout Costa Rica, the majority of stations saw a greater percentage of T3-S2s (between 35 and 52 percent) than any other configuration. Counter location seven was the only exception to this (see Figure 2 for location). Counter seven is located on Highway 2 near San Isidro which is characterized by mountainous terrain. This station likely has a higher percentage of C2 vehicles or generally smaller trucks. The highest percentage of T3-S2s is seen at counter location 10 located on Highway 32 (52 percent). This is not surprising as this highway serves a primary freight activity center at the ports of Moín and Limón. Figure 12 outlines the details of the truck fleet mix at the counter locations.

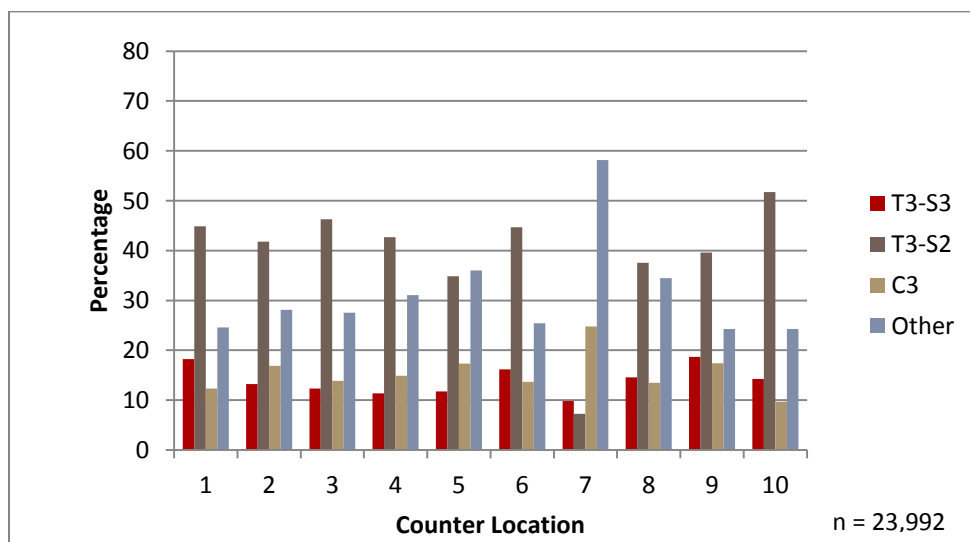


Figure 12: Percentage of Vehicles by Classification and Counter Location
Note: Reference Figure 2 for counter locations

The results of the analyses of the three data sources are presented in Table 2. The weigh station counts consist of a total of 2,050,186 records, manual counts consist of 2,047 records, and the automatic vehicle classifiers consist of 23,992 records. The percentage of C2s is consistent between the weigh station counts and manual counts. Again, it was not possible to classify C2 vehicles using the automatic classifiers. The T3-S2 class is consistent between all data sources at approximately 40 percent. The T3-S3 and C3 classes are more variable across the three data sources. The “other” category is significantly larger in the automatic vehicle classifier data which is likely due to many C2 vehicles classified under this category.

Table 2: Comparison of Weigh Station Data, Manual Counts, and Automatic Vehicle Classifiers

Vehicle Class	Weigh Station Data (Percent)	Manual Counts (Percent)	Temporary Vehicle Classifiers (Percent)
C2	39.59	37.27	N/A
C3	6.68	8.60	14.92
T3-S2	42.97	40.40	42.09
T3-S3	6.89	12.07	14.07
Other	3.85	1.66	28.92
Total Number of Records	2,050,186	2,047	23,992

The manual counts were used mainly for collecting body type and classification data which cannot be collected through the other two data sources. The analysis of vehicle body types revealed that the majority of the truck fleet falls under one of six body type classifications: van, flat deck, container, tanker, box, or dump. Nearly 40 percent of vehicles had a van style body type followed by 20 percent with a container body type. Box and flat deck styles were also common. The results of the body type classifications analysis can be seen in Figure 13.

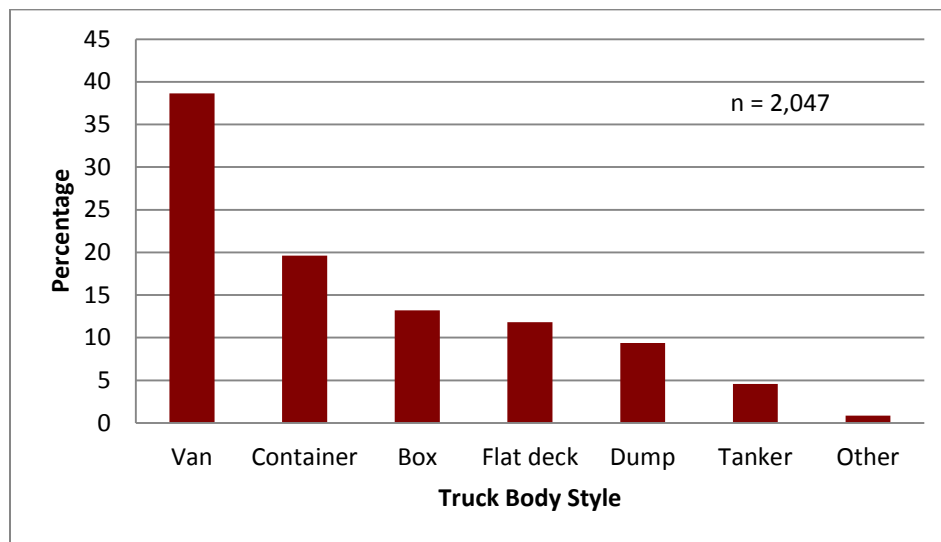


Figure 13: Percentage of Trucks by Body Type

The body types varied greatly between the four primary vehicle classifications. Figure 14 shows that the C2 classification is mainly composed of van body types followed by box body types. C3s are typically dump vehicles followed by van body types. T3-S2s are mainly either container carrying trucks or van style body types and T3-S3s consist largely of flat deck body types, containers and vans.

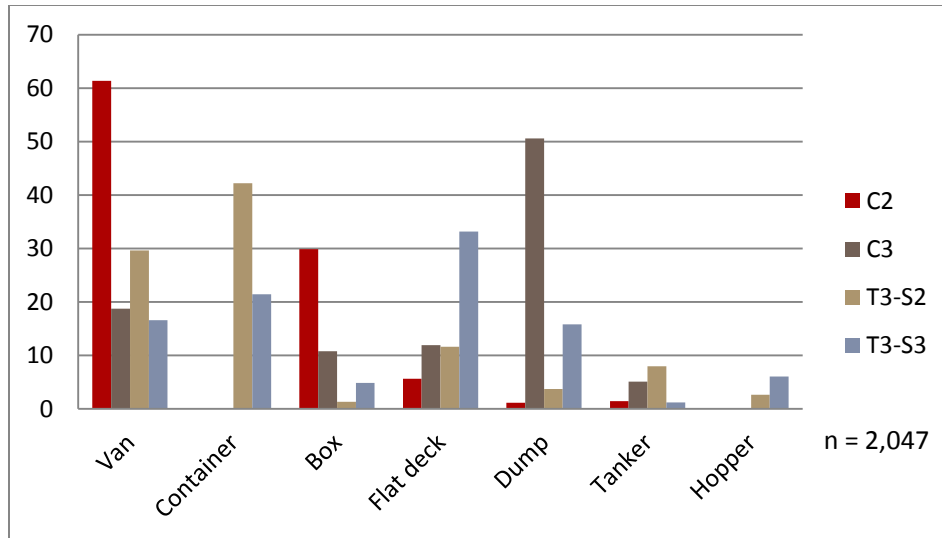


Figure 14: Percentage of Trucks by Body Type and Classification

DEMAND-RELATED DEVELOPMENTS AND IMPACTS ON TRUCK FLOWS

The details of major changes underway or anticipated in the demand-related system are used to determine how and to what extent these developments can be expected to significantly impact truck flows in Costa Rica and surrounding markets (e.g., Panama and Nicaragua). These developments are: (1) port developments; (2) Panama Canal developments; and (3) road developments. These system changes were 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.

Port Developments

There are plans for expansion at the Limón and Moín port 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 includes increasing the existing capacity of the infrastructure and tendering the concession and construction of a new port located to the west of the existing Moín port. Phase 2 includes 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).

The proposed expansion project will likely 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 sixteen nearby facilities currently used to handle excess cargo from the ports may not be as essential and in turn reduce the number of truck trips in the area around the port site.

Panama Canal Developments

After nearly a century in operation the current infrastructure of the 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 vessel the Panama Canal can maintain their present competitiveness with the Northeast Asia to US 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 will be 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 which increases usable water reserve capacity (Harrison, y otros 2010).

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.

Costa Rica's principal trading partners in 2010 at the Limón and Moín ports 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 at least a portion of the freight typically seen at the Moín and Limón ports may originate or be destined for the Panama region. With the expansion of the canal there may be opportunities to increase cargo at the Moín and Limón due to the expected increases in cargo in the Central American region from the Panama Canal expansion.

Road Developments

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

Additionally, they 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 experiences 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 may be opportunities to increase the freight transportation in this region.

CONCLUSION

Costa Rica's transportation system in terms of freight movement consists mainly of the national road network with very little involvement from the national railroads. The border crossings and ports play a key role in moving freight out of the country to international markets. Costa Rica mainly exports fruit products and imports petroleum and derivatives, and iron. The majority of the freight in the country is handled through the international ports rather than the border crossings with Panama and Nicaragua. The primary road network varies greatly throughout the country in terms of types and volumes of traffic and the markets that they serve in regards to freight activity centers such as ports, border crossings, and areas of productions (e.g., farmland).

The truck fleet in Costa Rica is mainly characterized by vehicles in the C2, C3, T3-S2, and T3-S3 vehicle classifications. Three sources collecting vehicle volume and classification data were combined to provide an overview of the truck fleet mix currently using Costa Rica's primary national highways. In general it was found that the truck fleet mix varied among different regions of the country serving different needs. This included a higher percentage of large trucks near freight activity centers such as international ports and borders, and a higher percentage of small trucks near urban centers. The types of trucks in terms of body type also varied throughout the country depending on the commodities that they haul and the markets they serve.

Costa Rica's economy is dependent on the movement of freight in to, out of, and through the country, similar to many other countries. Because of this, it is essential that the freight is moved in an effective and efficient manner which can be achieved through providing a transportation network that is both safe and reliable.

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