BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA
FACULTAD DE ECONOMÍA
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ROAD FREIGHT TRANSPORT, LOGISTICS AND CO2 EMISSIONS: CASE STUDY OF TABASCO, MEXICO

T E S I S

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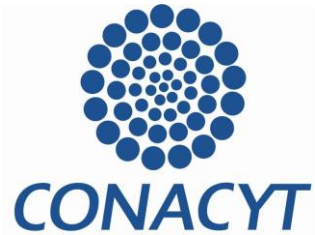
P R E S E N T A

ITZCOATL ANGELES TAH

COMITÉ DE TESIS
DR.YVES DANIEL BUSSIÈRE (BUAP)
DR. CHRISTOPHE RIZET (IFSTTAR)
DR. *SALVADOR PEREZ MENDOZA*
DR. ENRIQUE BUENO CEVADA



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I thank first my parents and friends, who have given all the effort to help me finish this stage of my life, and thank them for supporting me in all the difficult moments of my life such as happiness or sadness, they have always been with me and thanks to them, I am what I am now and with the efforts of them and my effort can now be a great professional and will be a great pride for them and for all those who trusted in me. I also thank my professors who always trusted in me and helped me in my academic life of this Master, and also important to thank CONACYT for my scholarship that let me study and research, VIEP to support my investigation travels and the administration of the Master in Economic at BUAP, which always helped me in my academic life and research stays. Finally but not least important, I thank the Government of the state of Tabasco, SCT and the firm LOGIT of Puebla help me with all the information and statistics for my research.

Master´s Thesis at the Faculty of Economics

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Road Freight Transport, Logistics and CO2 Emissions:

Case study of Tabasco, Mexico

by Itzcoatl Angeles Tah

Co-directors: Yves Daniel Bussière (BUAP); Christophe Rizet (IFSTTAR)

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Salvador Perez Mendoza (BUAP); Enrique Bueno Cevada(BUAP)

Transport is an important source of CO2 emissions, around 30% in developed countries and 20% in many emerging countries, such as Mexico. In European cities, the part of freight transport in transport-related CO2 emissions is estimated at 25%, a third of transport-related NOx and half of transport-related particulate matter (Rizet & Dablanc, 2014).

The objective of this thesis is to study to what exlatent technological choices and improvement in logistics can reduce CO2 emissions in the transportation of goods in Mexico, based on the case study of Tabasco where recent data (2014) was made available by the Government of the State of Tabasco, and the consulting firm LOGIT of Puebla, for academic purposes. The main source of data are 1- A road survey with a large sample in the Eastern axis of Mexico of freight transport indicating the type of transport, the type of merchandise, its origin and destination. Preliminary results show that around 50% of trucks travel empty when a satisfying level would be closer to 15%.

Based on this case study, the objective is to analyze how different kinds of freight transport have a different effect on the production or emissions of carbon particles into the environment, also find feasible ways to reduce CO2 emissions by improving technology (type of vehicle, type of fuel, ...) and by a better logistic to optimize the supply and demand chain in the transportation of goods.

Road Freight Transport, Logistics and CO2 Emissions:

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Chapter I: Introduction.

Road Freight Transport, Logistics and CO_2 Emissions:

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I.- Chapter I: Introduction.

a. Background

Like many other countries, developing and emerging countries in particular, México has to face many problems. Corruption, poverty, and bad use of public spending are some of them; on top of that, Mexico is also affronting the climate change challenge. The objective is to limit the average world temperature increase to 2º C. However, we are already experiencing different effects related to temperature rising in our environment, such as ice melting, the rising of sea levels and land erosion. Such effects produce climate changes variations reflected in droughts, loss of crops and death of animals in different parts of the world which directly affect humankind and our food needs.

At this moment the level of pollution is high. According to The World Bank, México is producing 3.9 metric tons per capita of CO_2 as well as other contaminants.

Table I.1 Contaminants in fossil fuels

Gas	CO	HC	NOx	CO_2	CH_4
EF g/litre	117.69	13.75	9.03	2,081.7	0.72

Source: René Rodríguez Lara, Jorge Raúl Gasca Ramírez, Luis Leobardo Díaz Gutiérrez . (Agosto 2014). "FACTORES DE EMISIÓN PARA LOS DIFERENTES TIPOS DE COMBUSTIBLES FÓSILES QUE SE CONSUMEN EN MÉXICO". Dirección de Servicios de Ingeniería Gerencia de Servicios en Ingeniería Región Centro- Norte, Primer Informe , 1-62.
*EF: Emission Factor

** G/Litre: Grams per litre at the liquid fossil fuels in México.

We can observe in Table 1.1 that Mexico produces many contaminants and most of them are from liquid fossil fuels, which we use for transport and to produce energy.

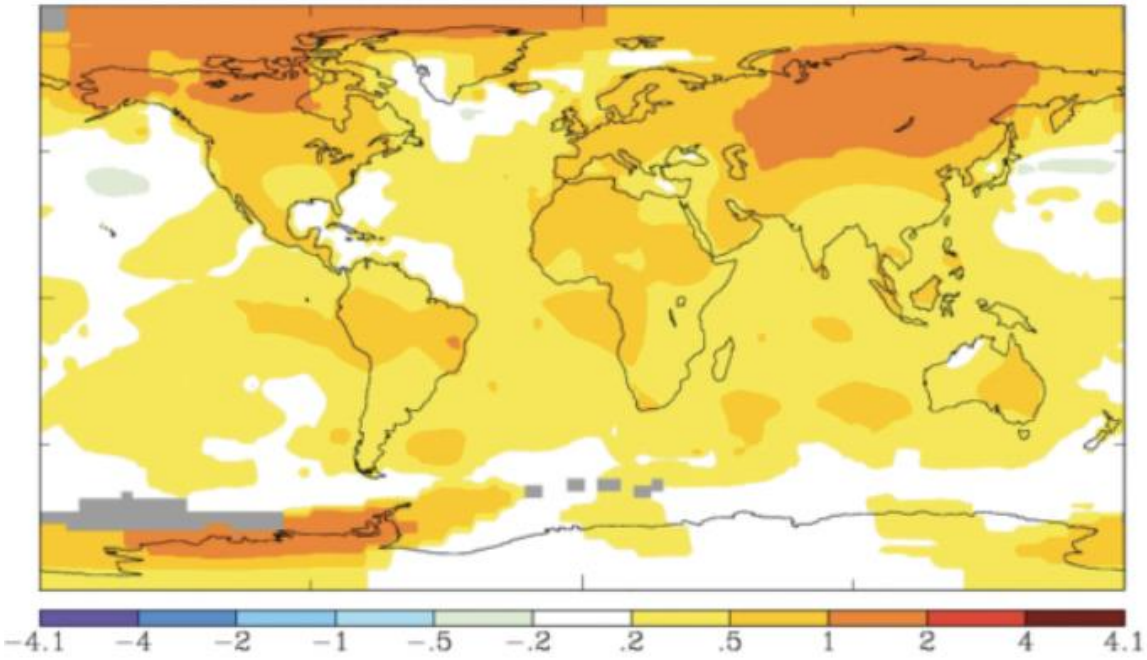
It is the purpose of this thesis to analyse CO_2 emissions of freight transport, one of the most important contaminant of the greenhouse effect. For the purpose of this thesis we will focus our review on the case of Mexico only.

To understand why it is important the study of CO_2 we first have to define it. The definition of the World Bank with the help of Carbon Dioxide information Analysis

Center, “Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.” In other words, CO_2 is what we produce when we use our cars or when we move from one place to another and use some transportation, which uses some kind of fossil fuel, for example gasoline, diesel or gas LP. Also when we use some kind of electrical device in México, we produce CO_2 because our electrical energy is produced basically by fossil fuels, 80% of all (SENER, 2014).

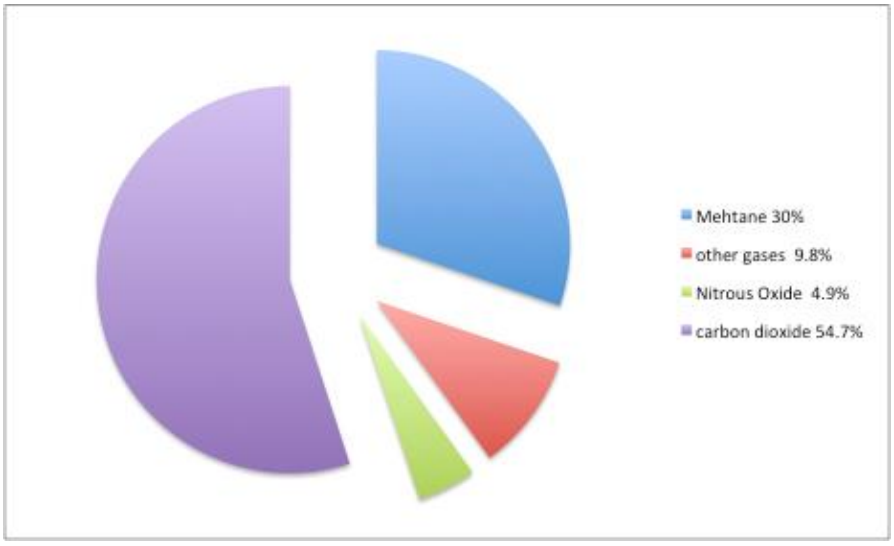
The greenhouse effect is one of the most dangerous facts that we are affronting in the actual times, this is because it causes extreme climate changes and the increase of the global temperature, but what causes the greenhouse effect and what does it do? According to the Environmental Protection Agency of U.S.A. (EPA) The Greenhouse gases keep the Earth warm through a process called the greenhouse effect and this effect is… *“The Earth gets energy from the sun in the form of sunlight. The Earth's surface absorbs some of this energy and heats up. That's why the surface of a road can feel hot even after the sun has gone down—because it has absorbed a lot of energy from the sun. The Earth cools down by giving off a different form of energy, called infrared radiation. But before all this radiation can escape to outer space, greenhouse gases in the atmosphere absorb some of it, which makes the atmosphere warmer. As the atmosphere gets warmer, it makes the Earth's surface warmer, too.”* The problem is that we are producing too much greenhouse gases and the planet is getting warmer. As shown in the image 1.1 below, we can observe the red zone of the picture is where temperature is growing in 2 degrees Celsius at least, so the planet is experiencing different facts like decreasing of the ice at the poles and increasing of oceans levels.

Image I.1 Global Warming



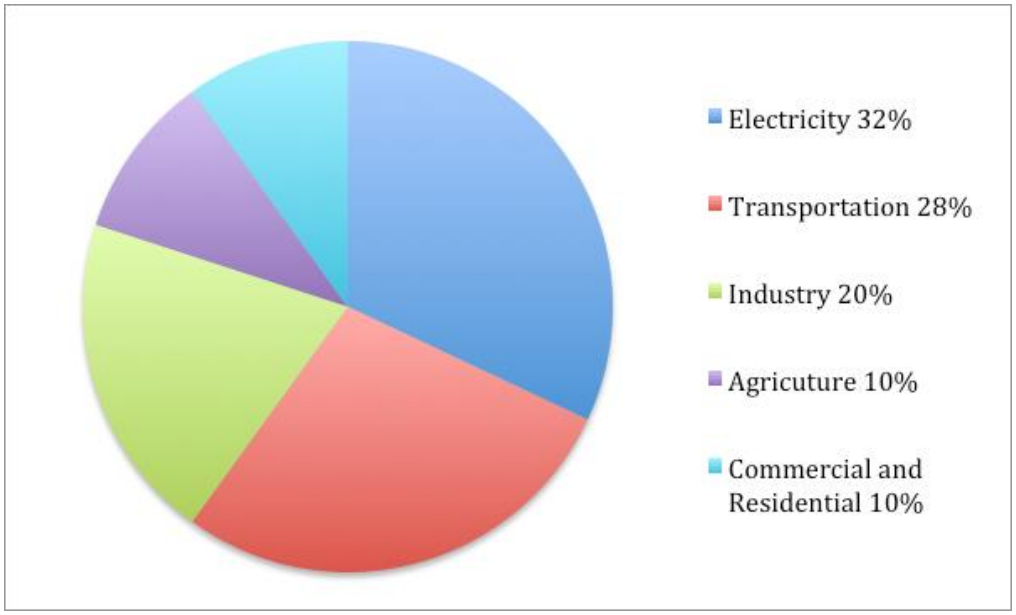
Climate anomaly from 1981 to 2012 against average temperature (ºC) between 1951 and 1958. Source: "GISS Surface Temperature Analysis". (s/f). EUA: Goddard Institute for Space Studies. Available

Graphic I.1. The greenhouses gases, México, 2014



Source: EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (2014).

Graphic I.2. Gas Production. Mexico, 2014.

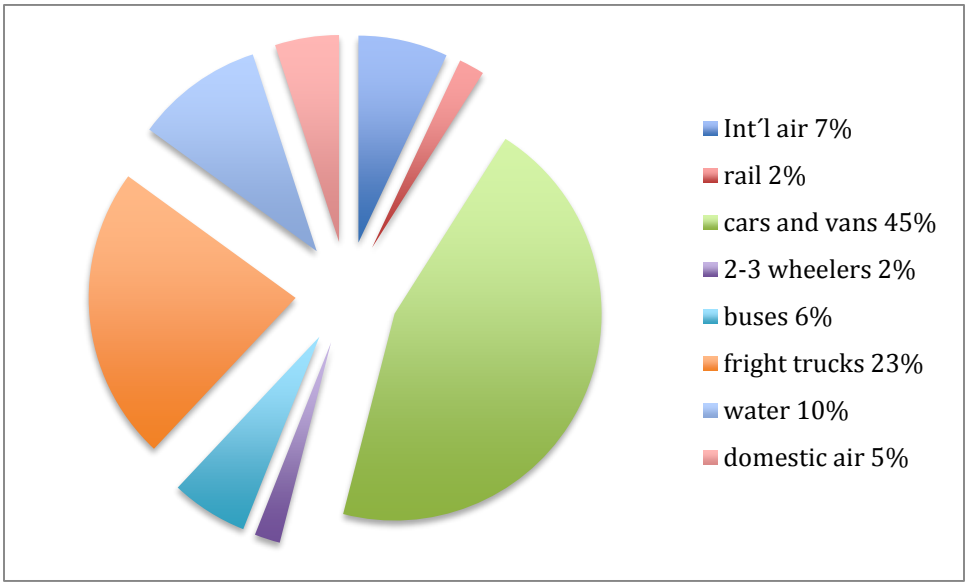


Source: EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (2014).

Graphic 1.1 shows that CO_2 is the most contaminant greenhouse gas with 54.7% of the total, and looking at graphic 1.2 it is possible to find that the first source of this contaminant is the production of electricity with 32% of the total and transportation in the second place with 28% of the total. Transport relates to cars and public transport; freight transport involves buses, wheelers, trucks to transport water, garbage, airplanes and others.

For the purpose of this thesis we will focus our analysis on freight transport. In graphic 1.3 we can see freight transport as the second biggest percent of the chart, with 23% of CO2 emissions of transport around the world. According to Intergovernmental Panel on Climate Change (IPCC) in 2012, 39% of CO2 is caused by Transport in Mexico, generally speaking, the Auto transport (freight transport, buses, etc.) represents 92% of the total percentage. However, reports of Transport in Mexico are not complete at the moment according to IPCC, the problem is there is no data to study all kinds of transport in the country and its pollution.

Graphic 1.3. Distribution of Freight Transportation around the world



Source: Stern Review (2007). The Economics of Climate Change.

In México we use and produce different kinds of fuels for example diesel, gas LP and in gasoline we have two kinds; premium and magna. Table 1.2 describes the production of the fuels in Mexico:

Table I.2 : Fuels in México, 2014

FUEL	PRODUCTION	IMPORTATION	EXPORTATION	SELLS
Queroseno	60.81		1.21	62.24
Turbosina	60.81			62.24
Diésel	309.76	107.11	0	391.71
Pemex Diesel	217.68			
Pemex Diesel UBA	92.08			
Diésel industrial				44.80
Diésel marino				13.75
Gasóleo doméstico				0.67
Combustóleo	268.81	31.32	95.17	189.29
Combustóleo pesado	268.81			188.00
Intermedio 15				1.29
Combustóleo ligero				0.00

Coque de petróleo	60.73	ND	ND	47.83
Gasolina (total)	437.07	375.50	0	787.27
Pemex Magna (total)	417.23			667.65
Pemex Magna	360.48			
Pemex Magna UBA	56.75			
Pemex Premium	19.84			119.16
Gasavión				0.46

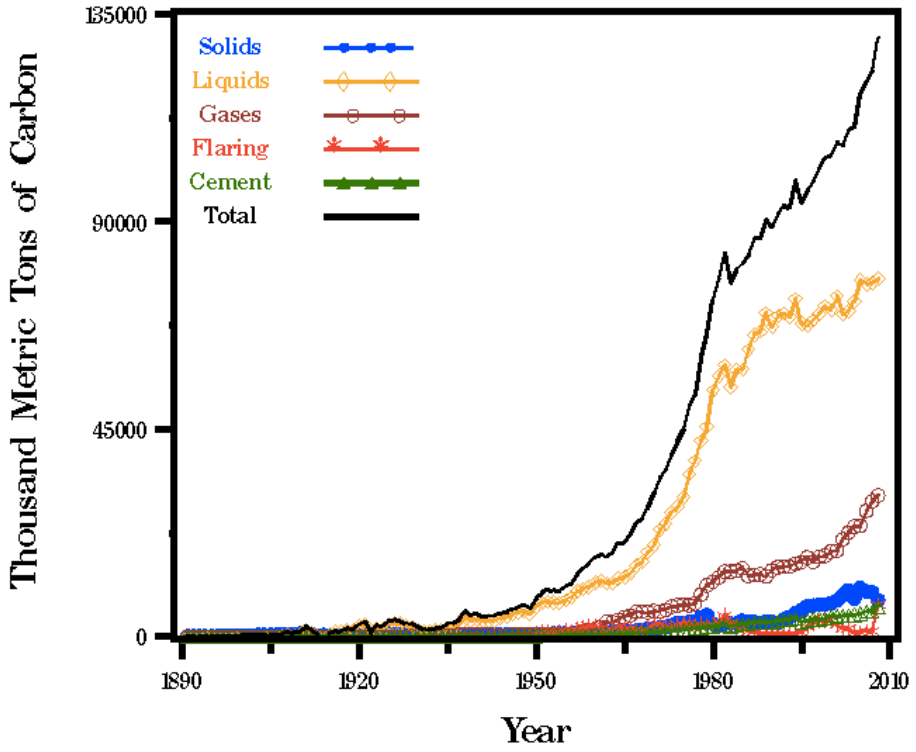
Source: Base de Datos Institucional de Pemex 2014.

* All Data is in thousands of barrels of oil.

** The balance could not close because of variety of inventories, self-consumption and statistical differences.

As we mentioned at the beginning of this thesis, CO_2 comes from the burning of fossil fuels, which is shown in Table 1.2. Furthermore, Graphic 1.4 shows the impact in metric of tons of CO_2 produced by solids and liquids fuels, gases, flaring and cement.

Graph I.4: Pollution of the fuels in México (CO2), 2014



Source: http://cdiac.ornl.gov/trends/emis/mex.html.

Having seen rapidly how transport in general is polluting our environment, let´s look at why freight transport is so important for the economics and in particular for Mexico's

economics. Freight transport will assure the link between location of production and location of market, or client. Therefore it is important to ask, where do firms locate? It is near the area of production or near the consumer? And to answer this, Lösch gives us some clues:

- In General

Rational location decisions:

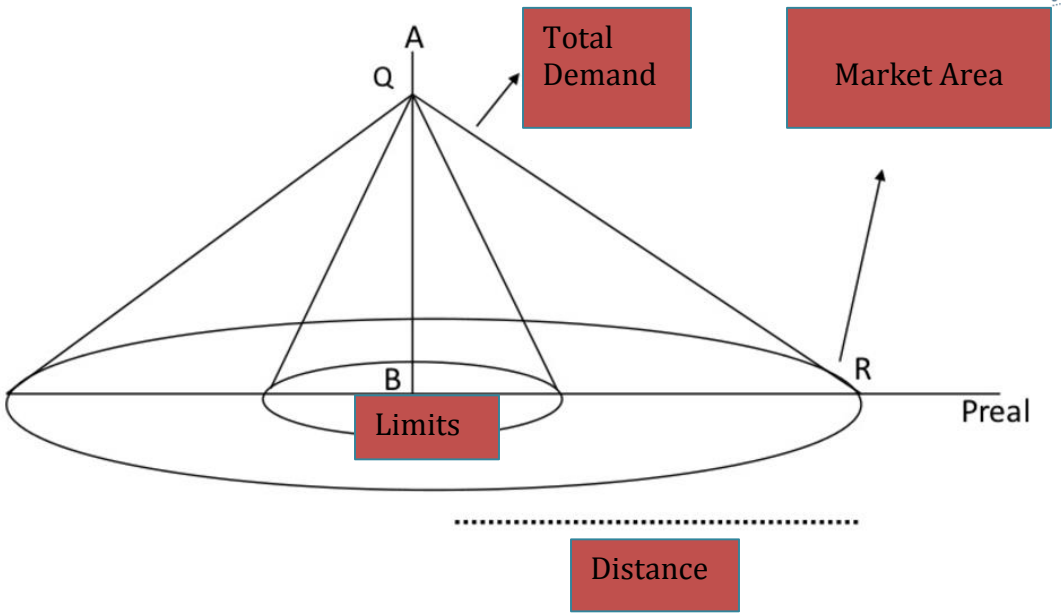
- Influence between products "The decisions of some are not independent with respect to others "
    - In visible cases as in the automotive industry, the decision to locate in a certain area or to produce any auto-part in any specific location, relates to a sales approach. In other words, companies decide to locate near bigger clients or markets that will require their products.
- We should consider the relationship between producers and consumers of such goods, as well as between different producers.

With the last points we can have an idea of why we use freight transport in our economy and why we have to add it in our final prices. The following points provide a deeper look into it:

- Location depends on the number of competitors, which we can find.
- The relationship between immediate submarkets and producers of homogeneous goods is a major feature on location.

The limitation of the location uses the general rule of location:

- Producers are grouped around a consumer or consumers. Imagine there are two circles, one inside another. In the inner circumference we can find the consumers and at the foreign circumference are the producers.



Two kinds of positions:

- Regions of offer/supply: they involve agricultural activities.
    - These regions are taken from Von Thünen model. This model examines the gaps of income on the market, where the central idea is income varies with the distance from the market.
    - Von Thünen used a unique variable: The distance from the farm to the central town of trading. If agriculture could be concentrated like industrial production does, it would be placed near the market and the distance would be a insignificant cost in the product price.

- Regions of demand: they refer to non-agricultural activities.
    - Industry, and in this case, demand for canned agricultural products and processed food.

Smith (1776) gave great importance to transportation costs. For him, the division of labor was closely linked to the level of population and the market expansion, but also it depends on transport routes and difficulties transferring the products from one place to another. Smith thinks that the value, not the price, of property varies in relation to the spatial differences in the elements that affect the cost of production (wages, profits and rents paid to productive factors). However, Ricardo (1817) would include transport

costs in the total cost, the theoretical differences between Ricardo and Von Thünen is the origin of the separation between classical and location theory.

The central idea of "The theory of minimal cost" is that the companies know how to choose where to settle or locate, also know the demand that they can cover and at what prices. Then, the optimal location is one that minimizes the total costs, including the production and transportation. Von Thünen's successors determined the existence of natural laws in the spatial evolution of economic structures. Until 1882 Laundhart moved von Thünen analysis to an industrial one, and instead of concentrating on an entire industry, he focused directly on the case of an individual company. He showed that the optimal location is determined by costs of transport, and also they are in function of the locations of the production centers, raw materials and consumer markets. Also he solved Laundhart`s problem of market areas, considering the case of two sellers, whose locations are given by some distance between them, establishing the laws of supply of the consumer areas. The contributions of Launhardt provide a basis for the development of the theory of minimum cost, on one hand, and the locational interdependence on the other.

In 1909, Weber offers a general theory of localization of economic activities. Transport costs were regarded as the basic determinant of the location, but far to considering them directly, he contemplates the cost of transport are depending on the weight of the goods and the distance that must be covered to transport them. Weber showed the derivation of the minimum cost of transportation, from a concept that was introduced by Launhardt years earlier, the locational triangle. Weber introduced also other concepts that are now used in the location theory, agglomeration.

We can understand Weber logic as: With the given consumption points and procurement of raw materials, companies seek to find the point where it will locate the production unit to minimize transport costs. A classic example of Weber of the optimal location depending on the cost of transport, is a triangle, it considers two sources of supply, one is the raw materials and the other is the consumers center (Market). Imagine that they are joined by straight lines representing the distances between them, from this figure, we look for the point that minimizes transport costs, using weight of goods and the attraction of each vertex of the triangle, and then we find the ideal location. Also,

Weber distinguishes the source of pure raw materials and the localized ones. The first, as they can be obtained at any point of, they are only affected by the weight of the final goods, so that reinforce attraction of the consumers center. The located raw materials, Webber separated them by pure and processable feedstock, for the last ones, they lose weight in the process productive, so they are reinforcing the attraction of sources of supply. The combination of all the elements determines the locational decision of each company.

Taking the line of Weber`s work, the Swedish Palander (1935) attempted to develop a theory of spatial general equilibrium. Mainly he concentrated on studying the effects of prices on extensions market where companies can sell their products when the location, the competition conditions, the costs of factors and freight rates are given. Palander concluded that the benefits are based on the maximum distance that the company can expand its market. Hoover (1937) developed a model that is related to a spatial demand and marginal revenue, showing that there is an increasing price trend when transport unit costs grows, introducing the analysis of the spatial price discrimination.

Now we see why there is in one point of production and on the other extreme we have a selling point or a market, and we need to use some sort of transportation to get from one point to another.

b. Objectives.

- To elaborate a methodology to measure the CO_2 emissions of the freight transport using a case study. We will use, with the kind authorization of the Department of Transportation of Tabasco, data from surveys made in Villahermosa - Tabasco in 2014 on the eastern corridor of México by the consulting firm LOGIT of Puebla.
- To analyze how different kinds of freight transport have a different effect on the production or emission of carbon particles into the environment.
- Finally, to look for different ways on how to improve the logistic of Mexico's eastern corridor with the purpose of reducing CO_2 emissions of freight transport in this country.

c. Instruments to use.

In order to calculate the emissions of CO_2 we need some variables. For this paper, we are using some variables taken from LOGIT surveys for the case of Villahermosa, Mexico; and for the rest of the cases are calculating the emission with the help of each case's data.

Required data:

- Origin-Destination
    - Distance traveled in kilometers
- Truck model
    - Empty weight in kilograms.
- Weight of the shipment to transport in kilograms
- Empty travel or with a load.
- Frequency of the travel (daily, weekly, monthly)

Data to calculate:

- Average weight: statistic calculus of the average weight.
- Distance of full travel.
- Consumption of Diesel (C) liters of fuel, all the energy consumed for the shipment travel.
- Kg of CO_2 per liter of diesel used.
- Kilograms of CO_2 per all kilometers of full travel
- Annual tons of CO_2.

Statistical packages used:

Stata is a general-purpose statistical analysis package created and maintained by StataCorp LP. Its capabilities include a broad range of statistical analyses, plus data management, graphics, simulations, and custom programming.

Microsoft **Excel** is a spreadsheet developed by Microsoft for Microsoft Windows, Mac OS X, and iOS. It features calculation, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications.

d. Methodology.

Methodology to calculate the CO_2 emissions of the freight transport

There are many ways to calculate CO_2 emissions in the atmosphere of the planet. For example in México, according to SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales) we use the following measures:

Table I.3 Methodologies to calculate CO_2 in México

• **Passive sampling**: This method collects a specific contaminant through the adsorption and/or absorption in a selected chemical substrate. After exposure by a suitable sampling period, which can vary from one hour to a few months or even one year, the sample returns to the laboratory where the desorption of the contaminant will be analyzed by its quantitative performance. The equipment used is known as passive samplers, presented in different shapes and sizes, mostly in form of tubes or discs.
• **Sampling Bioindicators**: This method generally involves the use of living plant species, such as trees and plants, which serve as a receiving surface for contaminants. However, despite that scientists have developed guidelines on these methods, there are still unresolved issues in terms of standardization and harmonization of these techniques.
• **Active sampling**: For this method we need power to suck the air to be sampled through a physical or chemical collection process. The additional volume of air sampled increases sensitivity, so we can obtain average daily measurements. The assets are classified as bubblers samplers (gas) and impactors (particles); among the latter, the most used currently is the high volume sampler "HighVol" .
• **Remote optical sensing method**: The optical remote sensing method is based on spectroscopic techniques. Transmitting a light ray of a certain wavelength to the atmosphere and the absorbed energy is measured. With them it is possible to measure in real time, the concentration of various pollutants.

Source: http://www.gob.mx/semarnat/documentos/inventario-de-emisiones

In table 1.2 it is possible to observe the different methods to calculate pollution in the atmosphere in Mexico, but we need to know something more specific such as the

pollution produced by freight transport. Therefore, by using some physics and chemistry laws we can find out the method used and developed by Professor Cristophe Rizet in Oct 2014, in his document "Quantification of freight Transport GHG emissions".

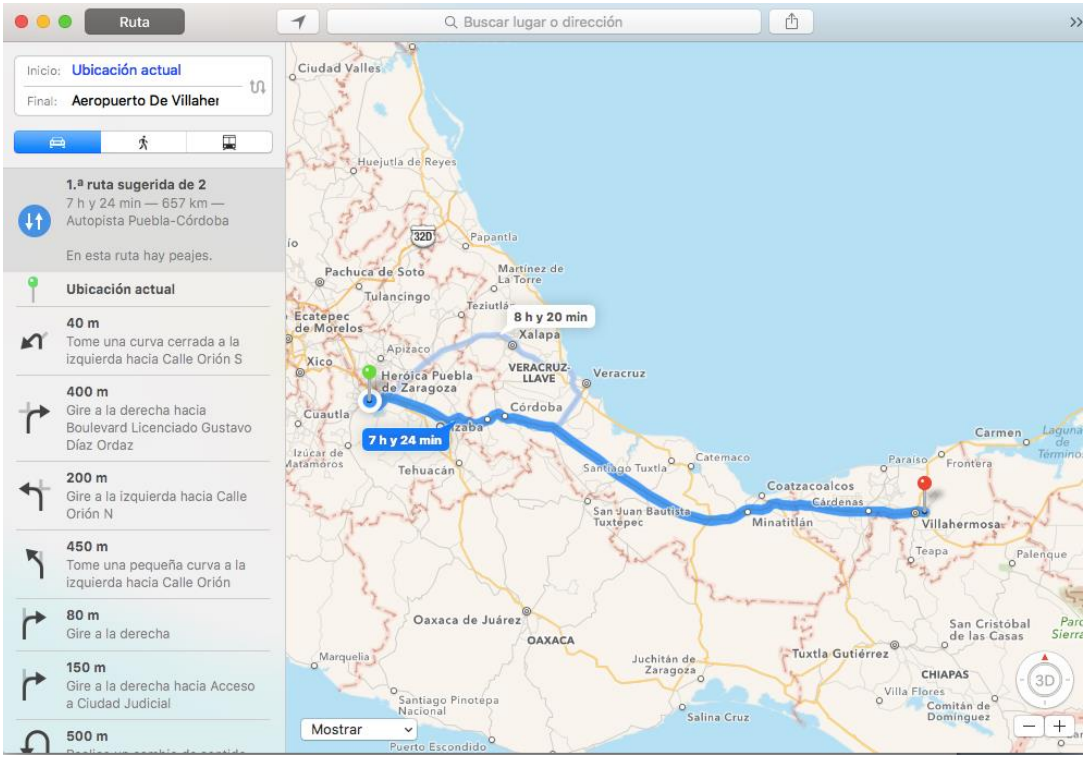
Now that we have the necessary or required variables for the calculation of CO2 emissions we will continue to perform the steps for calculating these emissions:

i. - Step 1. Calculate the distances of transportation; this calculation was performed using the following equation:

arc(AB) = 6371 * ArcCOS(COS(RADIANS(90-latB)) * COS(RADIANS(90-latA)) + SIN(RADIANS(90-latB)) * SIN(RADIANS(90-latA)) * COS(RADIANS(longD-longA)))

Source: **Christophe Rizet, Cécilia Cruz et Mathieu de Lapparent. (2014). Quantification des émissions de CO2 du transport de fret à partir de la base ECHO. En CO2-ECHO(1-29). MARNE-LA-VALLÉE (PARIS-FRANCIA): IFSTTAR.**

However, technology helps us, making us our life easier, facilitating the calculation of the variable through the tool of Google: " Google Maps"



ii.- Step 2. Calculating the average load is a statistical calculation of the freight transportation, to take into our knowledge the round trip considering if it is full or empty, to have the statistical model, you can get the average load of the missing section of the journey replacing the data required in the following equation:

$$\text{Average load} = 0.7087e^{0.1882*\text{empty weight (truck with out cargo)}}$$

Source: Own elaboration.

We can observe all the steps in the next diagram:

iii. - Step 3. Calculation of liters of fuel consumed, in our case it will be done for all the vehicles which use Diesel. This consumption is calculated considering that there is a production of CO2 since the fossil fuel extraction, processing or refining to a useful fuel, transportation to distribution centers and finally to the vehicles to transport the products. The equation describing this consumption in liters is:

$$\textit{Consume of Diesel liters per every 100 kilometers (C)} = 3.5 \times (\textit{Total Weight in kilograms} + 4)^{0.65}$$

*** Total weight in kilograms, is the weight of the empty vehicle plus the weight of the cargo or products.**

****In the case that we have an empty truck, we use the calculation of "Average weight" plus the weight of the empty truck, to calculate the total weight in kilograms.**

IV.- Step 4.- Calculation of $C0_2$ kilograms per liter of consumed Diesel.

1 liter of Diesel produces X number of kilograms of CO2 = 3.67 x 0.72 = 2.64 kg

This equation means that of every liter of Diesel is 0.72 Kilograms of Carbon and when it combust in a motor of internal combustions, it produce 3.67 kilograms of CO_2 and for every liter of Diesel used we obtain 2.64 kilograms of CO_2.

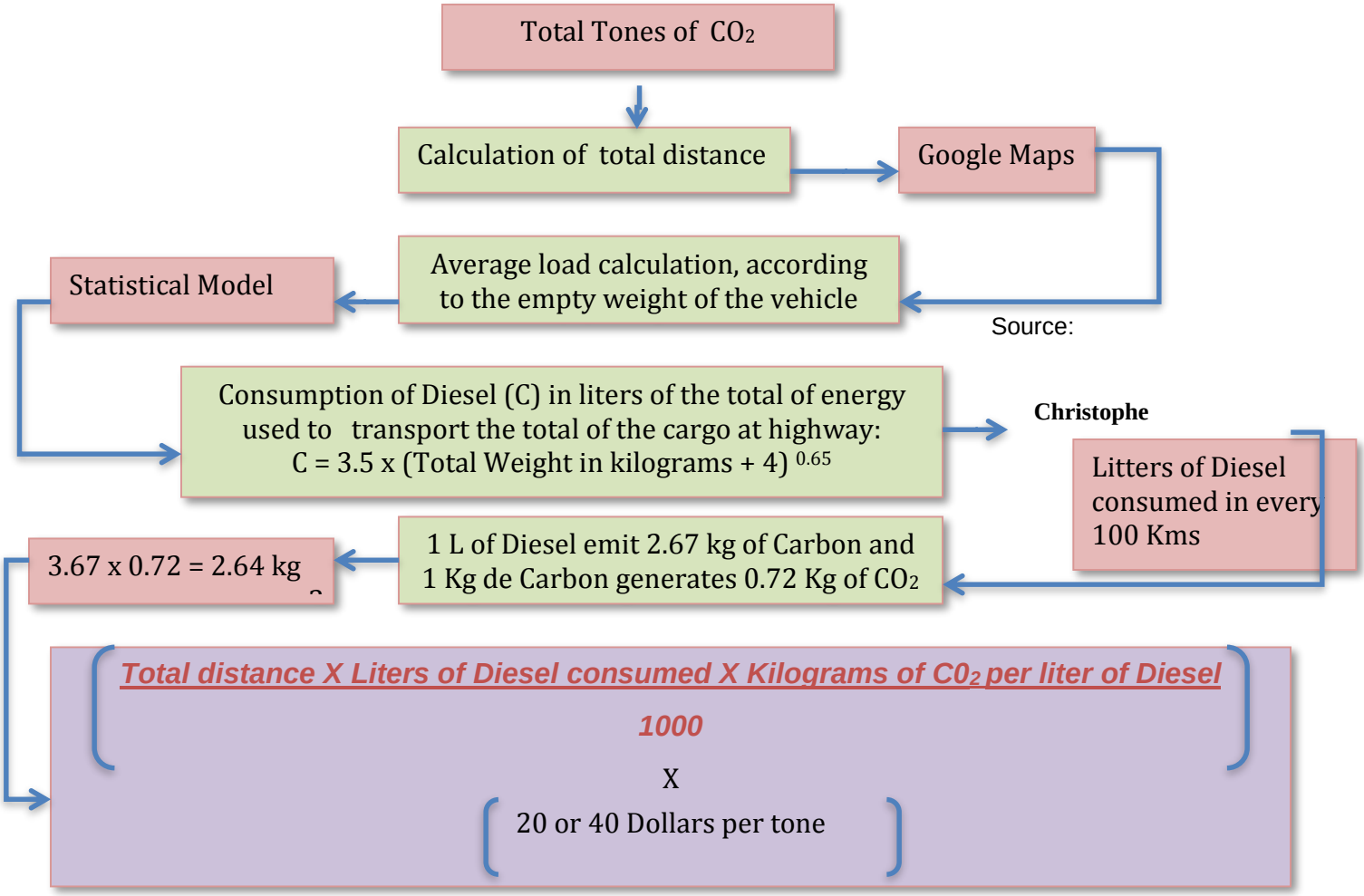
V.- Step 5.- To calculate the CO_2 tons emitted or produce on a route of freight transportation, we only calculate the next:

$$\frac{\textit{Total distance X Liters of Diesel consumed X Kilograms of } C0_2 \textit{ per litter of Diesel}}{1000}$$

and finally we obtain the total emitted tons of CO_2 in a route of freight transportation.

VI. - Step 6.- And finally to obtain the total tones of CO_2 in a year, we only made the multiplication of the total tones of CO_2 emitted in a route of freight transportation to the frequency of the journeys of this route in a year.

Diagram I.1: Methodology to calculate CO_2 emissions



Rizet, Cécilia Cruz et Mathieu de Lapparent. (2014). Quantification des émissions de CO2 du transport de fret à partir de la base ECHO. En CO2-ECHO(1-29). MARNE-LA-VALLÉE (PARIS-FRANCIA): IFSTTAR

Chapter II: The best methods of logistics in the world (Road freight transport).

Road Freight Transport, Logistics and CO2 Emissions:

Case study of Tabasco, Mexico

Chapter II: The best methods of logistics in the world (Road freight transport).

In this chapter we are going to describe the best methods of logistics in developed countries, but first we have to understand why the companies who are able to compete in domestic and international markets, face two big challenges; greater efficiency and lower costs, that's why they are seeking access to the best supplies, no matter if they are in the domestic market or outside. They differentiate their products and services through the processes they use to deliver the goods to the final customers. Under the new conditions of high competitiveness, proper management of the supply chain and logistics play a very important role for companies, either for those who export or producing for the local market. The development of information technology has meant higher levels of productivity and less time and transaction costs, which has forced companies to rethink logistics management, to maintain and / or improve their competitiveness.

Now, what is supply chain and logistics management? To understand better this concept we will describe what they are:

The supply chain management: is the process for positioning and exchanging materials, services, semi-finished products, finished products, logistic of operations post- finishing, after-sales and reverse logistics, as well as information of integrated logistics, like procurement and procurement of raw materials, delivery and delivering finished products to the final consumer.

The strategic planning of the supply chain, not only considers the final consumer, in other words, it doesn´t just consider the person or company who use a product or if the service is personal or a component to use to create other products, it also should consider intermediates, customers and it has to consider distributors and retailers.

So it is important to know that the most important goals of the supply chain are:

- Improve the productivity of operational logistic systems.
- Increase the services level for customers.
- Implement actions to get better management of operations.

We just mentioned how to improve logistics administration with strategic planning of the supply chain, but what is logistic? For Jean-Paul Rodrigue in his third edition of the geographic transport system, logistic is: "**It** involves a wide set of activities dedicated to the transformation and distribution of goods, from raw material sourcing to final market distribution as well as the related information flows. Derived from Greek logistikos (to reason logically), the word is polysemic. In the Nineteenth century the military referred to it as the art of combining all means of transport, revictualling and sheltering of troops. In a contemporary setting, it refers to the set of operations required for goods to be made available on markets or to specific locations."

In simple worlds, logistic is the link between the market and the operational activity of the company; it covers the entire organization, from management of raw materials to finished product delivery. This involves the management of information flow, cash and product-service. The principal activities of logistics are classified in two:

Key activities
- Level of client services
- Order processing
- Inventory management
- Transport

Support activities
- Storage
- Goods handling
- Packing
- Purchases
- Information management
- Information processing

In the present time, the trend for companies is to contract specialized logistics operators for tasks like: inventory management, warehousing and distribution, in an integrated manner. The main contribution of the outsourcing is that when they perform this task for several companies, simultaneously; they achieve significant improvements on the economies in the above activities (warehouse management, inventory management and

consolidation in transportation). Outsourcing services can be an alternative to improve the competitiveness of enterprises. This practice provides benefits that allows them to focus the companies energy to its reason for being (whatever they produce), leaving aside all those activities for which they are not specialists. Some reasons that outsource logistics services are important:

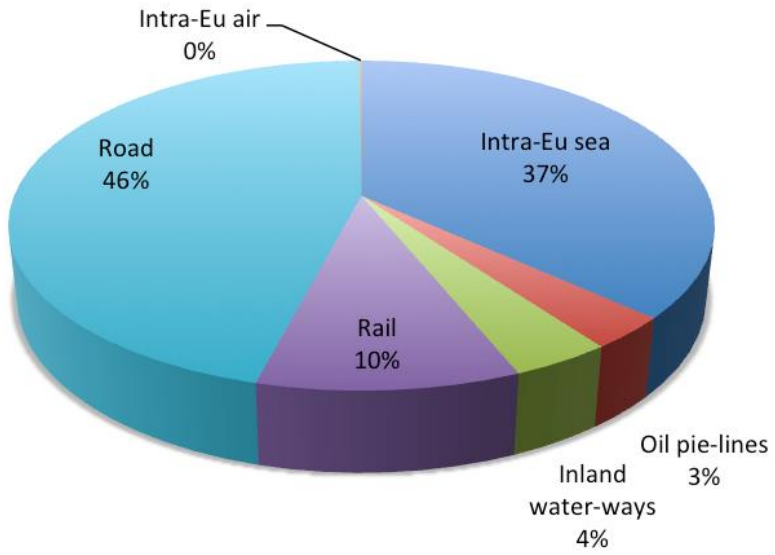
- Concentrate in base activities.
- Invest fewer resources in support activities.
- Facilitate access to technology and equipment for moving freight, warehousing and information systems.
- Low operating cost by the logistics operator.
- Access to a better understanding of the distribution of goods
- Access to qualified and specialized human resources.
- Reduce or control spending of operations.

There are a lot of topics to analyse and study but for the interest of this investigation what is important is the logistic of freight transport. To understand better the freight transport we are going to study the best examples of it, in Europe we can find some of the best examples of freight transport, without frontiers to stop every time they cross a country, they have one of the best freight transport examples.

a. Europe. (EU)

As we mentioned before, Europe is one of the best examples of freight transport, as the European Commission of Mobility and Transport let us know that the principal objective of the European Union's land transport policy is promote a mobility that is efficient, safe, secure and environmentally friendly, also create fair conditions for competition to promote safer and more environmentally friendly technical standards, to guarantee that road transport rules are applied effectively and without discrimination. According to the "Road Transport, A change of gear" of the European commission we can know that the road transport is the most important of the freight transports in de European Union, with 45.9% of the total of the goods transport in 2010, we can find it and the rest of the transport in the next graphic:

Graphic II.1: Distribution of the freight transportation in EU, 2010



Source: Road Transport a change of gear report, 2010

For the European Union, the internal market of freight transportation by road has been open since December 2011; the EU has been establishing a set of rules to ensure fair competition between road transport operators. The open internal market created the possibility for transport companies to supply services across national borders. To do it, they must respect all the common regulations, for transportation of goods or passengers between countries members of EU. All the National authorities are carrying out regular checks to ensure that transport companies are attempting the next four criteria:

Table II.1: Criteria for the road transport companies, 2011.

1	Good repute: professional operators must meet adequate ethical and entrepreneurial standards. Failure to apply or respect EU rules will mean exclusion.
2	Sound financial standing: each year, operators need to show capital assets equivalent to €9 000 for the first vehicle and €5 000 for each additional vehicle.
3	Professional competence: operators must pass a standard exam to assess their practical knowledge and aptitude.
4	Establishment: operators must demonstrate that they have an effective and stable establishment in an EU Member State.

Source: Road Transport a change of gear report, 2010

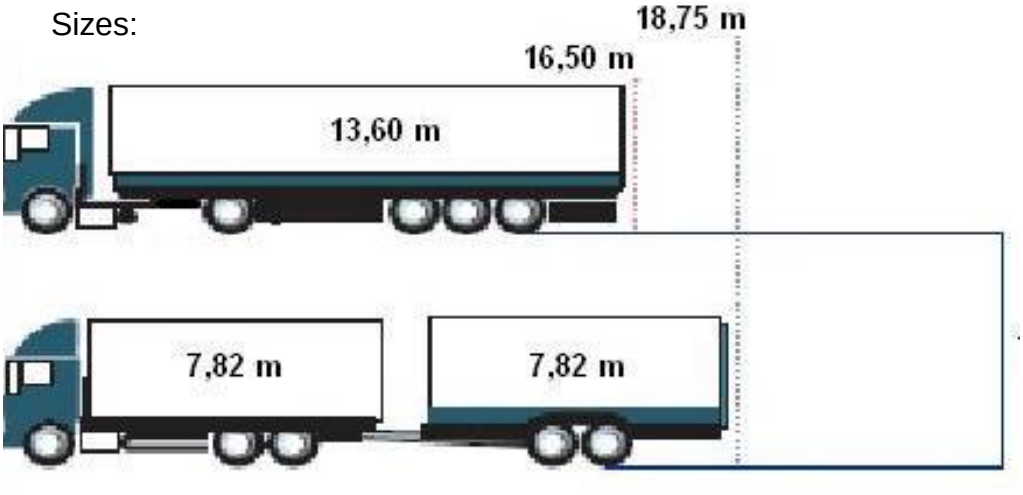
Also for operation, all companies need to have a permission or license to have their vehicles or operate them in the European Union; they call it community license from their own Member State, which allows them to carry out cross-borders transport through al the European Union. They have to carry certified copy of the community license in every of their vehicles. Drivers from non-EU countries must carry a certificate, which proves that they are legally employed by a licensed EU road operator.

They standardized the type of vehicles for freight transport; they set limits for weight and dimensions for heavy-duty vehicles in Europe, and this is to prevent damage of the roads bridges and any kind of infrastructure, and principally to ensure safety on the roads, at the next table we are going to find the permit weight the cargo in freight transport:

Heavy goods vehicles come in different sizes:

- Starting with small vehicles with load capacity from 3.5 tons to a maximum permissible of 6 tons
- Smaller heavy goods vehicles are those with a maximum weight of up to 20 tons
- Big vehicles are those with a maximum weight is between 20 to 40 tons or 44 tons when the vehicle is carrying a container for combined transport operations

Sizes:

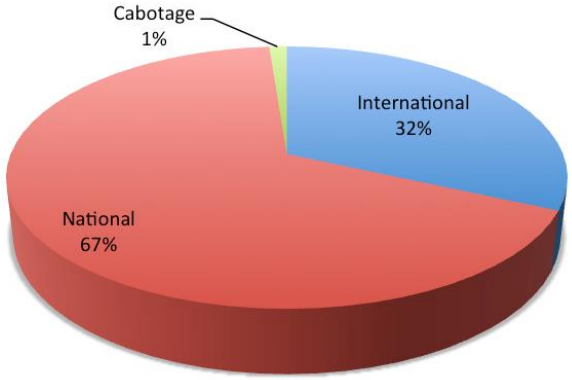


Classification of freight transport vehicles.

In the European Union they are trying to improve their logistics and then decrease their empty vehicle travels, for that they are using the method of Cabotage. It is one way to reduce congestion and increase their freight transport efficiency. Cabotage allows all drivers from one country to transport goods to another country on a temporary basis when they are making international deliveries. In other words, if the truck has to deliver in some places, lets say Paris, and it is from a Brussels truck and it has to drive empty to

pick up a return load in Strasbourg, it can carry goods from Paris to Strasbourg. Operators from all the Member States are free to carry out temporary cabotage cargo.

Graphic II.2: EU road freight transport by type of operation in 2010



Source: Road Transport a change of gear report, 2010

Another way to improve the logistics in Europe, is using some technology like an interoperable electronic tolling service; this technology is a compatible national electronic tolls systems and it is a legal requirement since 2007; it helps to reduce delays and congestion. The EU legislation provides an European electronic toll service (EETS), that's why road users can subscribe to a single contract with one service provider, and using a single on-board unit to pay tolls electronically through all the EU. The elimination of cash transactions at tollbooths, traffic flows would be improved and congestion will decrease.

Technology can help to improve an efficient use of infrastructures, transport management and a smaller carbon footprint. Also smart logistics can help to reduce the number of empty journeys made by trucks, which still account for nearly 25% of the total, according to the European Commission of mobility and transport. Galileo, the European satellite navigation system, and other navigational technologies are also helping to reduce journey times, provide real-time information to reduce congestion and offer track-and-trace monitoring for vehicles and cargos, also helping preventing cargo theft and rapid assistance to motorists involved in a collision and then they are increasing road safety, real-time traffic and multimodal travel information services.

We just analysed what is happening in the European Union; in this continent we can find out that the performance of the logistics is really good, according to de World Bank and its Logistics Performance Index (LPI) we know that the index of Europe is 3.32 units,

where 1 is low (Bad logistics) and 5 is high (Good logistics), this index is based "on a worldwide survey of operators on the ground (global freight forwarders and express carriers), providing feedback on the logistics "friendliness" of the countries in which they operate and those with which they trade. In this index, they combine knowledge of the countries in which they operate with informed qualitative tasks of other countries where they trade and experience global logistics environment. Feedback from operators is supplemented with quantitative data on the performance of key components of the logistics chain in the country of work. The LPI consists of qualitative and quantitative measures and helps build profiles of logistics friendliness for these countries. It measures performance along the logistics supply chain within a country (World Bank, 2016).

According to LPI, we observe that one of the highest performances is Germany with 4.12, then Belgium with 4.04, United States of America with 3.92, France with 3.85 units (this country grew from 3.76 units in 2007, so they are improving all the time to have better logistics on their transport).

Now we can observe how the freight transport in France is in the last years:

Table II.2: Distribution of modal of land freight transport (% of Tons-Kilometres

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Transport ferroviaire	11.9	10.6	10.3	10.3	10.2	9.3	8.4	9.5	9.5	9.3	9.5
Transport routier	80.9	81.9	82.2	82.7	82.6	82.8	84.4	83.6	83.9	85.0	85.0
Navigation fluviale	1.9	2.0	2.0	1.8	1.9	2.2	2.3	2.2	2.3	2.3	2.3
oléoducs	5.3	5.4	5.6	5.1	5.3	5.7	4.9	4.8	4.4	3.4	3.3
Tous modes (Gt-km)	**389.5**	**384.5**	**399.9**	**412.4**	**396.5**	**343.7**	**356.8**	**361.3**	**343.9**	**343.5**	**339.6**

Sources: SOeS d'après Eurostat, DGEC, VNF

With this table it is easy to note that freight transport by truck is more common than the other types.

b. America

In America we have two countries with great logistics, United States of America and Canada, with a LPI of 3.92 and 3.76 respectively, in USA the industry of logistics and transportation is highly competitive. In the United States, they are investing in this sector; multinational firms position themselves to improve the flow of goods through all the world market, international and domestic companies benefit from a highly skilled workforce, low costs and cargos regulation.

USA spends in logistics and transportation a total of $1.45 trillion in 2014, and it

represents 8.3 percent of annual gross domestic product (GDP). They have supply chain network links producers and consumers through multiple transportation modes, including air, freight rail, maritime transport, and truck transport, this last one is of our interest. Over the road cargo transportation is provided by motor vehicles over short and medium distances. In USA, the trucking associations report that their vehicles move 9.2 billion tons of cargo and is the predominant modal of all cargo domestically transported.

According to the U.S. department of transportation, the Federal commercial vehicle maximum standards on the Interstate Highway System are:

Single Axle:	9070.84 Kilograms
Tandem Axle:	15420.428 Kilograms
Gross Vehicle Weight:	36283.36 Kilograms

Table II.3.Federal Commercial Vehicle Size Limits on the National Network

Overall vehicle length	No federal length limit is imposed on most truck tractor-semitrailers operation on the National Network. **Exception:** On the National Network, combination vehicles (truck tractor plus semitrailer or trailer) designed and used specifically to carry automobiles or boats in specially designed racks may not exceed a maximum overall vehicle length of 19.82 meters, or 22.86 meters, depending on the type of connection between the tractor and trailer.
Trailer length	Federal law provides that no state may impose a length limitation of less than 14.63 meters (or longer if provided for by grandfather rights) on a semitrailer operating in any truck tractor-semitrailer combination on the National Network. (Note: A state may permit longer trailers to operate on its National Network highways.) Similarly, federal law provides that no state may impose a length limitation of less than 8.5344 meters on a semitrailer or trailer operating in a truck tractor-semitrailer-trailer (twin-trailer) combination on the National Network.
Vehicle width	On the National Network, no state may impose a width limitation of *more or less* than 2.5908 meters. Safety devices (e.g., mirrors, handholds) necessary for the safe and efficient operation of motor vehicles may not be included in the calculation of width.
Vehicle height	No federal vehicle height limit is imposed. State standards range from 4.15 meters to 4.45 meters.

Source: U.S. Department of Transportation, Federal Highway Administration. Federal Size Regulations for Commercial Motor Vehicles. (Washington, DC: 1996).

Like in Europe, USA uses a multimodal model for their freight transportation; having seen how they have their regulation for vehicles of road transport, we can understand

why it is so important to study this kind of transport and why they are making so much efforts to improve it, in the next table we can find how the freight transport by truck is more used than the others, with 40.24% of the total, according to the estimates of the Bureau of Transportations Statistics the distribution of the freight transport is:

Table II.4.; Distribution of the freight transport in USA, 2011.

Mode of Freight Shipments	2011 Ton miles (in billions)	Percent of Total
Truck	3761.03	40.24%
Rail	2442.98	26.13%
Water	698.45	7.47%
Air & Air/Truck	17.70	0.19%
Pipeline	1638.31	17.53%
Multiple modes	786.97	8.43%
Other & Unknown	149.67	1.60%
Total	9345.44	100%

Source: Estimates by the Bureau of Transportation Statistics, 2011

One of the principal characteristics of the freight transport in USA, is that they know that the majority of their merchandises is transported by truck, they are trying to improve not only their logistics at the road, they are also doing it at their warehouses, developing new techniques for the logistics but the most important idea is that they are getting better use of the solar energy, using it to energize warehouses and helping the environment, accelerating their processes of logistics using some technology to improve and automatize the processes. Solar system are used by FedEx in Woodbridge, N.J.. The solar power project is the third between a FedEx operating company and BP Solar and the fifth solar power project for FedEx. The 2.42-megawatt solar power system covers approximately 3.3 acres of roof top space with approximately 12,400 solar panels.

Another case to study in America is Canada, with a LPI of 3.86; they have 1.3 million two-line of roads, this case is interesting because is a really large country and it is not so populated, with 35 749 600 habitants and 9 984 670 km² of surface, Canada has a great logistics so it is remarkable to mention it.

In December 2014, there were 62,805 businesses whose primary activity was trucking transportation. It includes many small for-hire carriers and owner-operators, and some medium and large for-hire companies that operate fleets of trucks and offer logistic services. The trucking industry can be divided into three main types of trucking activities:

- For-hire trucking services is to classifications: Less-than truckload (LTL), and Truckload (TL) and for-hire carriers can be further grouped as: Intra-provincial (operating exclusively within a provincial jurisdiction) and Extra-provincial (beyond provincial and national boundaries).
- Courier operators, who specialize in transporting parcels.
- Private carriers, where businesses maintain a fleet of trucks and trailers to carry their own goods. These carriers' activities are not tracked, as they are part of companies whose main line of activity is not trucking for example Wal-Mart, Costco.

Their regulations according to The Federal-Provincial-Territorial Memorandum of Understanding on Interprovincial Weights and Dimensions are:

Table II.4. Heavy Truck Weight and Dimension Limits for Interprovincial Operations in Canada

Classification	Its length, including load, does not exceed:	Its Gross Combination Weight does not exceed:
Category 1: Tractor Semitrailer	23 metres	46 500 kg
Category 1A: Tridem Drive Tractor Semitrailer	23.5 metres	52 300 kg
Category 2: A Train Double	25 metres	53 500 kg
Category 3: B Train Double	27.5 metres	62 500 kg
Category 4: C Train Double	25 metres	58 500 kg
Category 5: Straight Truck	12.5 metres	24 250 kg
Category 6: Truck - Pony Trailer	23 metres	45 250 kg
Category 7: Truck - Full Trailer	23 metres	53 500 kg
Category 8: Intercity Bus and Recreational Vehicles	14 metres	24 250 kg

Source: The Federal-Provincial-Territorial Memorandum of Understanding on Interprovincial Weights and Dimensions, 2014

We know their regulations but with long distances to drive, why are they so safe-and have a great logistics? An answer this question is that since 2014, the Government of Canada amended the *Motor Vehicle Safety Act* to further strengthen Canada's vehicle safety regime. These amendments included doubling criminal financial penalties and giving the

Minister of Transport the authority to order vehicle manufacturers to issue notices of defect or non-compliance. This helped to ensure Canadians are informed of any safety or non-compliance issues with their vehicles. In 2013, Canada upgraded the *Motor Vehicle Tire Safety Regulations* with stricter tire safety standards, aligning its tire safety regulations with the U.S. to create and reduce costs for manufacturers and consumers, this is according to the Overview report of transportation in Canada by the minister of transport, 2015.

At the beginning of this chapter we described what is the supply chain and logistics, now we have seen that freight transport is an important part of the logistic of the supply chain, industry needs to transport goods from one place to other and to do it as we showed during this chapter they use freight transport by truck, with the analysis of the last cases we know that the freight transport by truck is the most used and important type of transportation in the developed countries of the world economy.

Chapter III: Logistics, road freight transport in México and its problems.

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In the first quarter of 2016, Mexico grew at an annual rate of 2.6 % according to the first revision of GDP of INEGI (National Institute of geographic statistics information), also in the last 5 years México increased the exportations of its manufacturing by 6.2% according to the same institute, because of the world slow economy México is experimenting a decrease of its exportations by 1.7 % in the last months.

Table III.1. Total exportations and importations by classification of transport, 2006 and 2015.

	2006		2015	
	Millions of Dollars (USA)	% Of Total	Millions of Dollars (USA)	% Of total
		By Air		
Exportations	8,693	3.5%	8,663.6	4.4%
Importations	20,954	8.29%	16,8893.5	9.4%
		By Water		
Exportations	59,544	23.8%	35,123.2	19%
Importations	55,269	21.6%	59,178.2	31.1%
		By road		
Exportations	153,736	61.5%	117,302.2	62.2%
Importations	139,415	54.49%	97,687.8	50%
		By train		
Exportations	25,254	10.1%	26,978.8	14.1%
Importations	15,350	6.0%	16,144.4	8%
		Others		
Exportations	2,770	1.1%	520.3	0.3%
Importations	25,142	9.8%	2686.2	1.5%

Source: Own elaboration with data of INEGI 2015

With the last table we see that the trade of products has been decreasing by water transportation in the last years, exclusively the exportations, and increasing the transportation by air, train and road.

Mexico is also receiving a lot of companies to produce in its territory, principally Transport manufacturing companies, for example; KIA, BMW, AUDI and others, with

more manufacturing production in the Mexican territory, it is necessary to have a great logistics of freight transport by truck.

a. Logistics of road freight transportation in México.

According to the Mexican Institute for Competitiveness (IMCO), Mexico is ranked 61th of 144 countries in the Global competitiveness index, 2014-2015, this is bad for our country, the position of Mexico in 2013-2014 was the 55, which means that we retreated 5 positions in one year.

The LPI of Mexico is 3.13 with this index we can figure how far México is from the best logistics of developed countries, this indicator let us analyze the next points:

- Level of efficiency in the process of customs clearance by border agencies.
- Quality of transport infrastructure and information technology in the logistics field.
- Practice of foreign trade in terms of cost and feasibility transport.
- National Competition in the logistics sector.
- Ability to trace and track international shipments.
- Domestic logistics costs, transport category.
- Times of destination.

Table 3.2. LPI per study area in México.

	Place/144 countries	Points/(1 min, 5 max)
Frontiers (Customs)	60	2,5
Infrastructure	53	2,68
International shipments	53	2,91
Logistic competence	57	2,8
Pacification and following of goods delivery	48	2,96
Logistic Costs	101	2,79
Times	51	3,4

Source: Own elaboration with World Bank data.

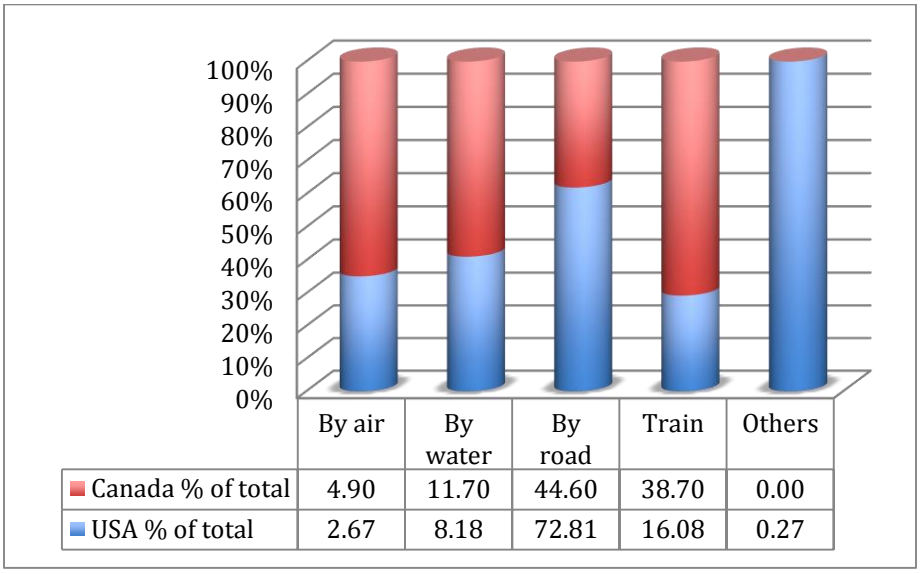
Also the analysis of AT Kearney in their article “Agenda de competitividad en logistica 2008-2012” shows that Mexican freight transport has 88 percent of cases with on-time deliveries of goods; against 97 in the US and 98 percent in European countries. In other point, safety in freight transportation, Mexico only has 89 percent of cases that

complete their destination, while in the United States and Europe the average is 97 percent.

Mexico as many other countries in Latin America, the road network is the most important and used transport infrastructure, the national road network, communicates almost all regions and cities. Mexico has 378,923 km of roads, for highways, federal roads, rural roads and others that allow connectivity between almost all populations in the country, in other worlds, there is a connection for people that has economic relevance, to every place.

Our principal destination is USA and Canada, because of the North American Free Trade Agreement (NAFTA), so we have to know how do we import and export our products from those countries, at the next graphics we will analyze the traffic by the type of transport that we use to trade products.

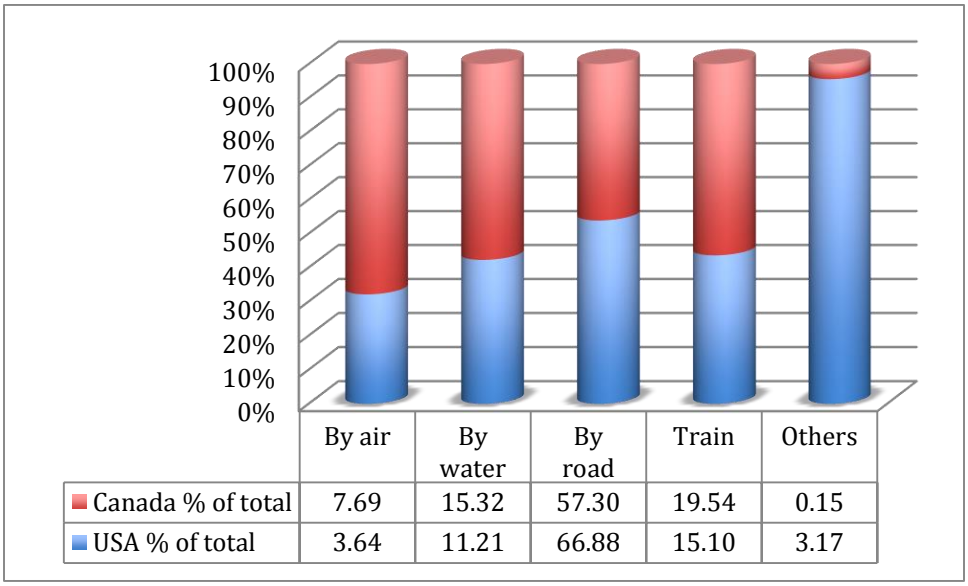
Graphic III.1. Exportations of NAFTA by classification of freight transport (% percent of the total)



	By air	By water	By road	Train	Others
Canada % of total	4.90	11.70	44.60	38.70	0.00
USA % of total	2.67	8.18	72.81	16.08	0.27

Source: Own elaboration with data of INEGI 2015

Graphic III.2. Importations of NAFTA by classification of freight transport (% percent of the total)



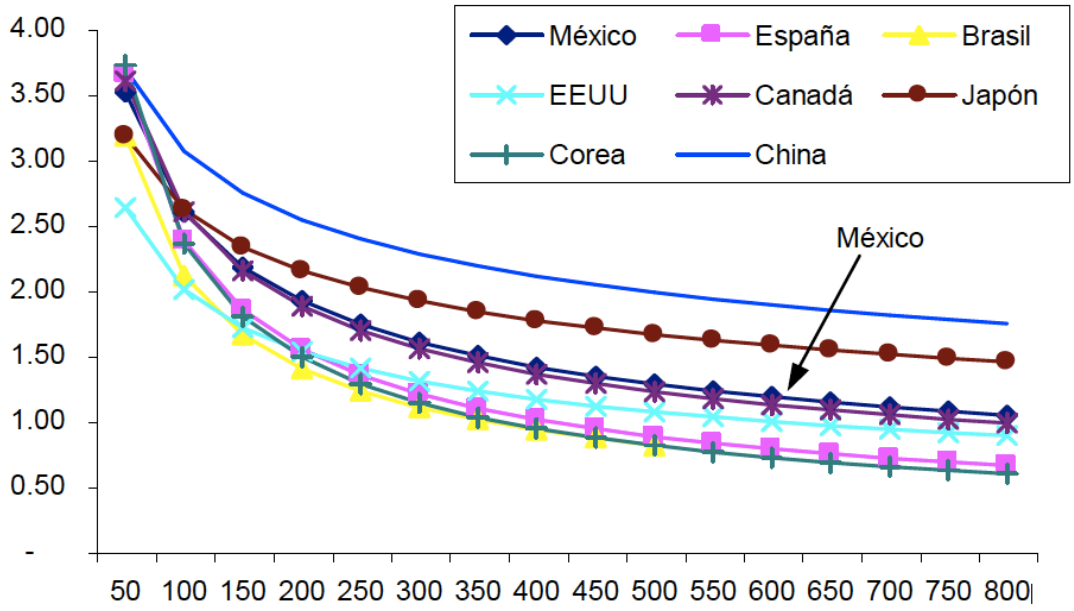
	By air	By water	By road	Train	Others
Canada % of total	7.69	15.32	57.30	19.54	0.15
USA % of total	3.64	11.21	66.88	15.10	3.17

Source: Own elaboration with data of INEGI 2015

According to the graphics 3.1. And 3.2. We can find out that the exportations and importations of products to those countries are mostly by truck or road freight transportation, the second type of transportation is by train and closely to this one is by shipments or water. Mexico to get better logistics and improve the supply chain to those countries has to study and analyse what is doing good and wrong, this is because we already know that the logistic of México is not to good, as we mention earlier the LPI of México is not really high so we know that is necessary to improve it.

We have to know what are the regulations of the road freight transport in México and the characteristics of the infrastructure for the road freight transport. We already know how long are the roads of México, and they connect almost every place in México but we have to know how much they cost for the freight transport, according to the graphics 3.3. We can observe that for small distances they cost more than when there is a long distance, with a cost of 3.75 Dollars per kilometer of the first 50 kilometers, but long distances, lets say a distance of 800 kilometers, every kilometer costs 0.6 dollar.

Graphic III.3. Curve of road transport cost, (Inside the countries, kms-Dollars)



Source: Own elaboration with of Database A.T. Kearney, Displays over 10,000 points.

We have seen that every kilometer has different costs according to the distance to travel, our next step is to know which are the most used corridors in México, according to the Secretary of communications and transport of Mexico (SCT), at the table 3.3. We can note that the most used corridors are those which go out from the principal states of México, like Mexico, Jalisco, Nuevo Leon, but the most important of them are the corridors which involves México city, from this city goes most of the travels to any place to the country.

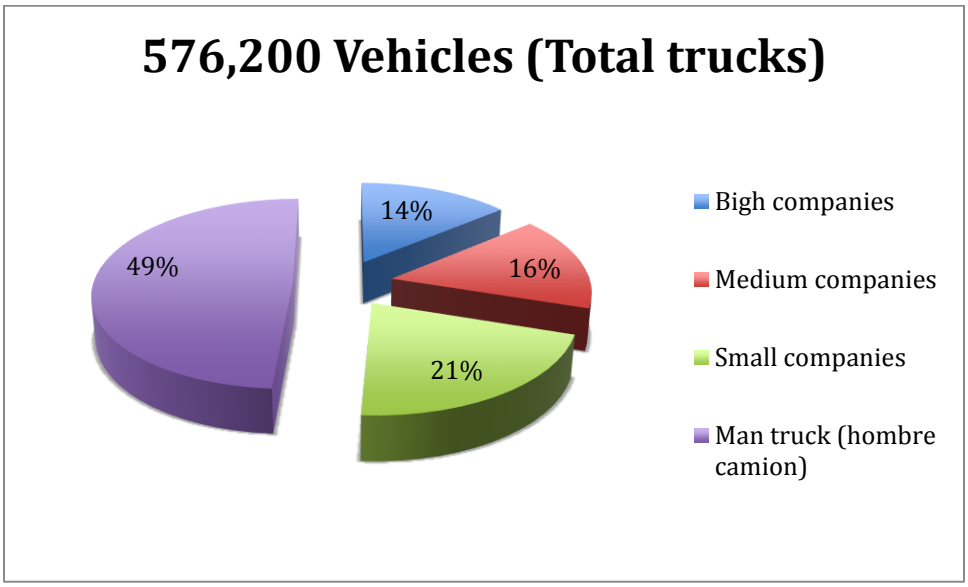
Table III.3. Principal corridors of road freight transport, 2014 (Average of tons per day)

Corridors	Daily Average Tons			Corridors	Daily Average Tons		
	Go	Back	Total		Go	Back	Total
Baja California - Baja California	33,261		33,261	Jalisco - Sonora	502	274	776
Sonora - Sonora	15,796		15,796	Tabasco - Quintana Roo	523	191	714
Chihuahua - Chihuahua	15,745		15,745	Veracruz - Campeche	621	76	697
Tabasco - Tabasco	12,410		12,410	Tabasco - Puebla	340	304	644
Veracruz - Tabasco	4,897	4,361	9,258	Distrito Federal - Quintana Roo	464	161	625
Sonora - Baja California	3,562	2,528	6,090	Distrito Federal - Chihuahua	345	279	624
Distrito Federal - Baja California	3,56	1,591	1,591	Baja California Sur - Baja California	317	238	555
Sonora - Chihuahua	2,099	1,923	4,022	Durango - Chihuahua	304	187	491
Distrito Federal - Tabasco	2,191	1,055	3,246	Distrito Federal - Campeche	197	161	358
Sonora - Sinaloa	1,973	1,110	3,083	Baja California - Mexico	344		344
Tabasco - Campeche	1,664	755	2,419	Mexico - Yucatan	275		275
Yucatan - Tabasco	1,075	1,062	2,137	Chihuahua - Sinaloa	168	91	259
Distrito Federal - Yucatan	901	821	1,722	Puebla - Yucatan	189	69	258
Jalisco - Baja California	1,098	612	1,710	Nuevo Leon - Tabasco	207	51	258
Nuevo Leon - Chihuahua	1,234	333	1,567	Jalisco - Chihuahua	236		236
Nuevo Leon - Baja California	855	633	1,488	Jalisco - Yucatan	217		217
Coahuila - Chihuahua	871	575	1,446	Queretaro - Baja California	203		203
Sonora - Nuevo Leon	853	534	1,387	Chihuahua - San Luis Potosi	109	71	180
Chihuahua - Baja California	852	472	1,324	Yucatan - Chiapas	168		168
Tabasco - Chiapas	574	525	1,099	Yucatan - Nuevo Leon	161		161
Sinaloa - Baja California	685	354	1,039	San Luis Potosi - Sonora	52	36	88
Distrito Federal - Sonora	647	354	1,001	Mexico - Chihuahua	78		78
Yucatan - Veracruz	505	423	928	Coahuila - Sonora	44		44
Quintana Roo - Veracruz	782		782				0

Source: Own elaboration with data of Technical document No. 48 "Estudio Estadístico de Campo del Autotransporte Nacional".

SCT has some control of the registration of vehicles; they approximately counted 576200 vehicles in total for road freight transport, they classified them for the type of company in the country.

Graphic III.4. Classification of vehicles and percentages of the total of vehicles in Mexico, 2010



Source: Own elaboration with data of SCT, 2011.

****Man truck: person who owns a vehicle and rent his or her services to companies for freight transport or who ever pays them for the travel.**

In the last graphic we can find out that Mexico has a lot of Man truck, and it is a big problem, they don´t have coordination with the companies and the supply chain so they don´t have good logistics. With this notification we can understand why the age of the vehicles in Mexico is a little critical, according to the SCT the average age of the vehicles is 15.5 years old.

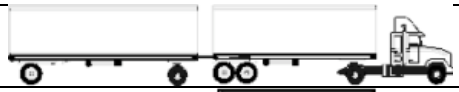
The maximum sizes and weights are important to know, because with them we can analyze better the behaviour of the freight transport in México. In the next tables we describe the types of vehicles in Mexico:

Table III.4.a Classification, Maximum length and weights of road freight transport vehicles (México, 2014)

Vehicular classification	Number of axes	Number of wheels	GVWR (tons)	Dimensions			
				Large (m)	Width (m)	Height (m)	Figure
C2	2	6	19,0	23	2.6	4.25	
C3	3	8	24,0	23	2.6	4.25	
C3	3	10	27,5	23	2.6	4.25	
C2-R2	4	14	37,5	31	2.6	4.25	
C3-R2	5	18	44,5	31	2.6	4.25	
C3-R3	6	22	51,5	31	2.6	4.25	
C2-R3	5	18	44,5	31	2.6	4.25	
T2-S1	3	10	30,0	23	2.6	4.25	
T2-S2	4	14	38,0	23	2.6	4.25	

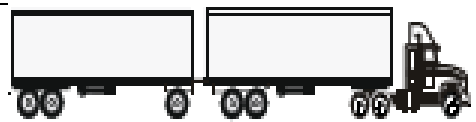
Source: Own elaboration with statistics of SCT.

Table III.4.b Classification, Maximum length and weights of road freight transport vehicles (México, [illegible])

Vehicular classification	Number of axes	Number of wheels	GVWR (tons)	Dimensions			
				Large (m)	Width (m)	Height (m)	Figure
T3-S2	5	18	46,5	23	2.6	4.25	
T3-S3	6	22	54,0	23	2.6	4.25	
T2-S3	5	18	45,5	23	2.6	4.25	
T3-S1	4	14	38,5	23	2.6	4.25	
T2-S1-R2	5	18	47,5	31	2.6	4.25	
T2-S1-R3	6	22	54,5	31	2.6	4.25	
T2-S2-R2	6	22	54,5	31	2.6	4.25	
T3-S1-R2	6	22	54,5	31	2.6	4.25	
T3-S1-R3	7	26	60,5	31	2.6	4.25	

Source: Own elaboration with statistics of SCT.

Table III.4.c Classification, Maximum length and weights of road freight transport vehicles (México, 2014)

Vehicular classification	Number of axes	Number of wheels	GVWR (tons)	Dimensions			
				Large (m)	Width (m)	Height (m)	Figure
T3-S2-R2	7	26	60,5	31	2.6	4.25	
T3-S2-R4	9	34	66,5	31	2.6	4.25	
T3-S2-R3	8	30	63,0	31	2.6	4.25	
T3-S3-S2	8	30	60,0	31	2.6	4.25	
T2-S2-S2	6	22	51,5	31	2.6	4.25	
T3-S2-S2	7	26	58,5	31	2.6	4.25	

Source: Own elaboration with statistics of SCT.

With the last table we see that there are many classifications in México for the vehicles of road freight transport, not because they are so different, it is because of the number of axes and wheels at the axes, those two things help for the stability, tractions and cargo distribution, of the vehicles of road freight transport. The lengths, hights and widths are similar, the only variable which changes is the first one, and it is because of the extra cargo.

b. Common problems of freight transportation in México.

Mexico has a lot of problems with the freight transportation by truck; some of them are caused by bad coordination of the companies of freight transport with the industry, or just between transport companies drivers and warehouses. In this country one of the biggest problems is the classification of freight transport named man truck, according to the graphic 3.4 they are more vehicles like that than the vehicles of transport companies. For man truck it is easy to just drive and provide their services for some amount, the problem is that they don´t have the technology and organization to comply correctly the times and specifications of a contract, and the penalties are low for this kind of transport.

Next, here are the most common problems in Mexico:

- The cost of the travel does not depend every time on the distance and the weight of the cargo, in Mexico the problem is that the price depends on the zone, if it is problematic or dangerous it costs a lot more than in other zone, and of course the insurance of the cargo costs more.
- Highways are expensive, unsafe and in bad condition, most of the time.
- Often the road freight transportation companies don´t have the right equipment for the transportation of the cargo, most of the time they have bigger dimensions and that increases the price of the travel.
- The warehouses have not the right size for all the cargo of an average day, and sometimes the receiving company doesn't even has a warehouse, so the vehicle has to wait a long time parking outside and the companies have to pay extra time.
- Vehicles are old and they break down in the middle of the travel.
- Companies pay to use the toll highways but drivers use the free roads.

- Bad logistics to unload the cargo of the truck, if the drivers travels at night, whey they arrive to the destination they just park and sleep and then they unload the cargo until noon.

In conclusion, Mexico must think about the logistics of the freight transportation, because with a simple analysis we can find that there are a lot of problems with the organization of logistics, the technology of the vehicles and null technology and organization for a safe travel of the driver and the cargo to arrive at destination.

Chapter IV: Method to calculate carbon emissions

4. - Chapter IV: Method to calculate carbon emissions.

As seen in chapter 1, in México we have various methods to calculate the production or the emission of CO_2 in the country. In this chapter we are going to analyze the most common variables for the calculation of CO_2 emissions of the freight transport in México in the Tabasco corridor. In this particular case we can observe different logistic routes and search how the freight transport from different origins and destinations have typical or untypical behaviour.

d) Variables to use to calculate carbon emissions.

First, we have to know which variables we are able to work with.

Required data:

- Origin-Destination
    - Distance traveled in kilometers.
- Model of truck.
    - Empty weight in kilograms.
- Weight of the shipment to transport in kilograms.
- Empty travel or with products.
- Frequency of the travel (Daily, weekly, monthly).

Data to calculate:

- Average weight: statistic calculus of the average weight.
- Distance of full travel.
- Diesel consumption (C) litters of fuel, all the energy consumed of the shipment travel.
- Kg of CO_2 per litter of Diesel used.
- Kilograms of CO_2 per total kilometers of full travel.
- Annual tons of CO2.

With the data of the case of Tabasco we have to prepare the variables for the calculation of CO_2 emissions of the freight transport.

Diagram IV.1. Methodology of the variables

To order my variables
Find out which variable is useful and erase those whose are not

Step 1: Order by final destination
A: By State
B: Every State by City

Step 2: Order by origin.
Using the last classification of step 1.
A: Order by State
B: Every State order by City

Step 3: Search in Google Maps the distance of the road

Step 4: Calculate the weight of the cargo.
A: Order the variables by type of cargo.
B: Use the classification of units of cargo.

Type of Cargo	Equivalent in Kgs
Cubic Meters	250
Liters	1
Pieces	20
Boxes	20
Paper bale	200
Scaffold	20
Water Container	20
Bulk Cement	20
Persons	70
Animals	600
Barrel	20

Table IV.1.1. Classification and weight of the cargo

Source: Own elaboration with data of LOGIT case of Tabasco

Step 5: Calculate frequency
A: Order all data by kind of frequency.
B: Calculate total frequency:
Total= Frequency of the road **X** Frequency of the period **X** Frequency of the year

Step 6: Create binary variable "Empty"
A: Order by empty or not
B: Empty: 0 = Not empty 1= Empty

Step 7: Weight of the empty transport.
A: Find out the model of the transport vehicle.
B: Use the table of classification of vehicle weights.

Table IV.1.2. Classification and weight of the cargo

Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)	Type of Vehicle	Weight of Vehicle (tones)
Pick-Ups		**2 AXES**		**3 AXES**		**4 AXES**		**5 Axes**		**6 a 9 Axes**		**Double Trailer**	
RANGER	3.2	MERCEDEZ B	4.96	INTERNATIO	6	INTERNATIO	23.4	INTERNATIO	23.4	INTERNATIO	43.431066	INTERNATIO	45.98842
TORNADO	4.2	SUZU	5.8	AVANZA	6	DINA	23.65	DINA	23.4	DINA	43.431066	DINA	45.98842
LINCOLN	4.5	STERLING	6.188	BREINLAI	6	CHEVROLET	17	CHEVROLET	23.4	CHEVROLET	43.431066	CHEVROLET	45.98842
DAKOTA	4.56	DINA	6.46	DINA	6.25	FANSSA, DIN	24.002	FANSSA, DIN	23.65	FANSSA, DIN	43.281066	FANSSA, DIN	46.1
NISSAN	5.39	METER VIN	6.5	CHEVROLET	17	FORD	8.848	FORD	17	FORD	17	FORD	1
SUPER DUTY	6.188	HONDA	6.8	FANSSA, DIN	6.602	FREIGH LINE	21	FREIGH LINE	24.002	FREIGH LINE	43.633066	FREIGH LINE	46.50
TOYOTA	6.2	VOLVO	7.2	FORD	8.848	HINO	16.2	HINO	8.848	HINO	8.848	HINO	8.84
FORD F350	6.2	FORD	7.352	FREIGH LINE	7.2	KEENWORTH	18.2	KEENWORTH	52.4	KEENWORTH	52.4	KEENWORTH	54.43
TOYOTA	6.2	GROVE	7.42	HINO	15	KODIAK	24	KODIAK	16.5	KODIAK	16.5	KODIAK	16.
DODGE	6.352	FORD SUPER	7.484	KEENWORTH	17	MERCEDES	15	MERCEDES	52.4	MERCEDES	52.4	MERCEDES	54.43
DODGE RAM	6.352	FORD 150	7.484	KODIAK	24	MITSUBISHI	7.5	MITSUBISHI		MITSUBISHI		MITSUBISHI	
FN 360	6.352	ISUZU	7.5	MERCEDES	15	NISSAN	3.8	NISSAN		NISSAN		NISSAN	
RAM 4000	6.352	HINO	7.5	MITSUBISHI	7.5	STERLING	21	STERLING		STERLING		STERLING	
RAM 2500	6.352	MITSUBISHI	7.5	NISSAN	3.8	TOYOTA	2.4	TOYOTA		TOYOTA		TOYOTA	
VOLKSWAGE	6.6	WORKER	7.6	STERLING	7.2	VOLVO	23.4	VOLVO	52.4	VOLVO	52.4	VOLVO	54.43
FROINTIER	8.42	KENWORTH	7.983	TOYOTA	2.4	WHITE	23.4	WHITE		WHITE		WHITE	
		INTERNATIO	8.319	VOLVO	6	CODIA	KODIAK	CODIA	23.4	CODIA	43.431066	CODIA	45.98842
		FREIGHTLINE	8.42	WHITE	6	COLUMBIA	FRIGHTLINER	COLUMBIA	23.4	COLUMBIA	43.431066	COLUMBIA	45.98842
		CHEVROLET	8.5			HYUNDAI	33	HYUNDAI	70	HYUNDAI	70	HYUNDAI	7
		AM	13.5352			GROVE	Gruas						
		DAVITA	14.6			ISUZU	10.4	ISUZU	14.2	ISUZU	14.2	ISUZU	14.
		KODIAK	15.426										
		H100	16.352										
		H100 DODGE	16.352										
		FANSSA, DIN	6.352										
		isuzu	10.4										

Source: Own elaboration with data of LOGIT case of Tabasco

Step 8: Calculate "Average Weight"
Use equation of Diagram 1 and calculate "Average Weight":
Average Weight = $0.7087e^{0.1882*\text{Empty Weight}}$
*Empty Weight: Weight of the Transport Vehicle without cargo.

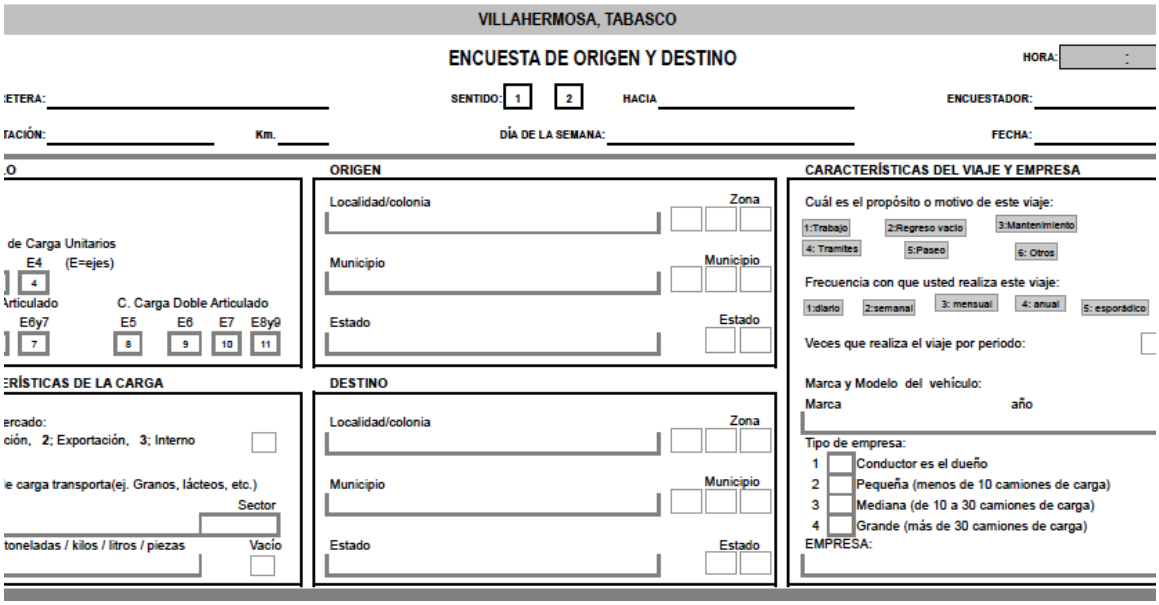
Step 9: Create "Empty Weight" Variable.
A: Order by Kind of transport:
B: Using the binary variable, order all data.
C: For data "Empty = 1" use the average weight for go and back road ("complete road")
D: For data "Empty = 0" use the average weight for go or back road plus the weight of the dat ("complete road")

Step 10: Calculate CO_2 Emissions of transport:
A: Use Diagram 1 for calculation.

Source: Own elaboration

These variables were taken from the survey of LOGIT, the case of Tabasco:

Figure IV.1. Survey origin destination.

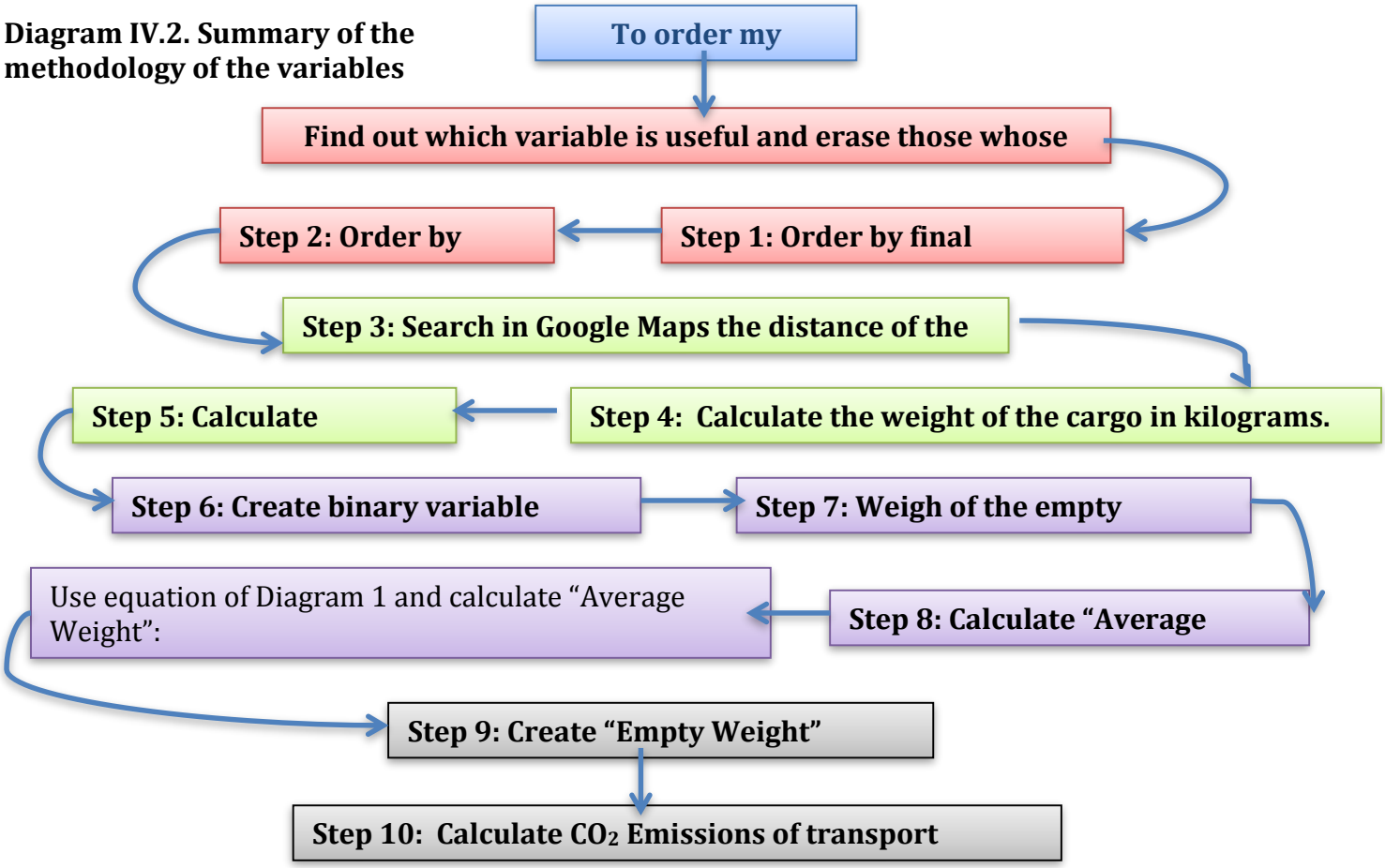


Source: LOGIT case of Tabasco

The road survey Origin-Destination of our case of study on freight vehicles has been taken at the eastern corridor of Mexico in the state of Tabasco, Mexico, in autumn of 2014, for during the week (sample of 3151 observations) and on weekend (sample of 2771 observations).

In the next diagram we can find an algorithm to facilitate the calculation of the emissions of CO_2.

Diagram IV.2. Summary of the methodology of the variables



Source: Own elaboration.

i. Description of data to use for the calculation of carbon emissions.

The data of the case of Tabasco was divided in two, "During the week" and" Weekends"

First we are going to describe the type of transport or vehicle.

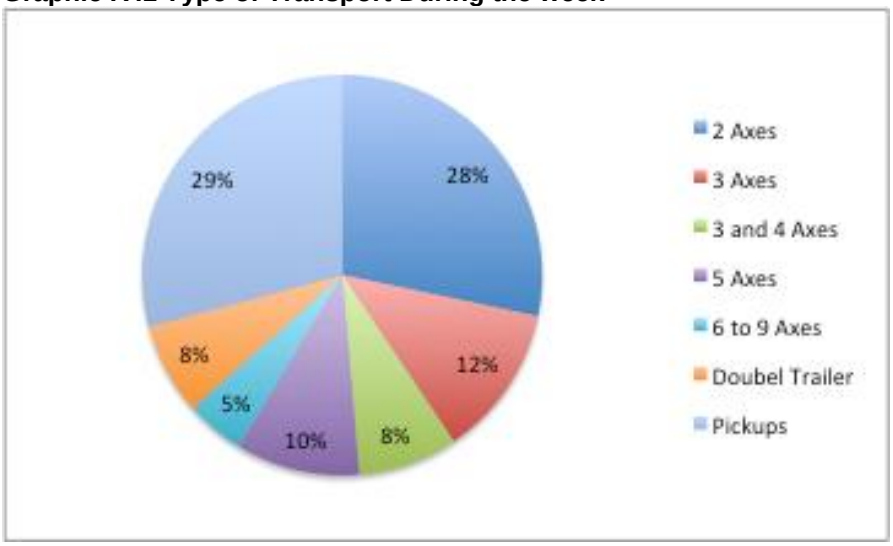
During the week:

Table IV.3. During the week Transportation

Type of Transport	Quantit	%
2 Axes	892	28.31
3 Axes	387	12.28
3 and 4 Axes	253	8.03
5 Axes	318	10.09
6 to 9 Axes	149	4.73
Doubel Trailer	233	7.39
Pickups	919	29.17
	3151	100.00

Source: Own elaboration with data of LOGIT, case of Tabasco

Graphic IV.1 Type of Transport During the week



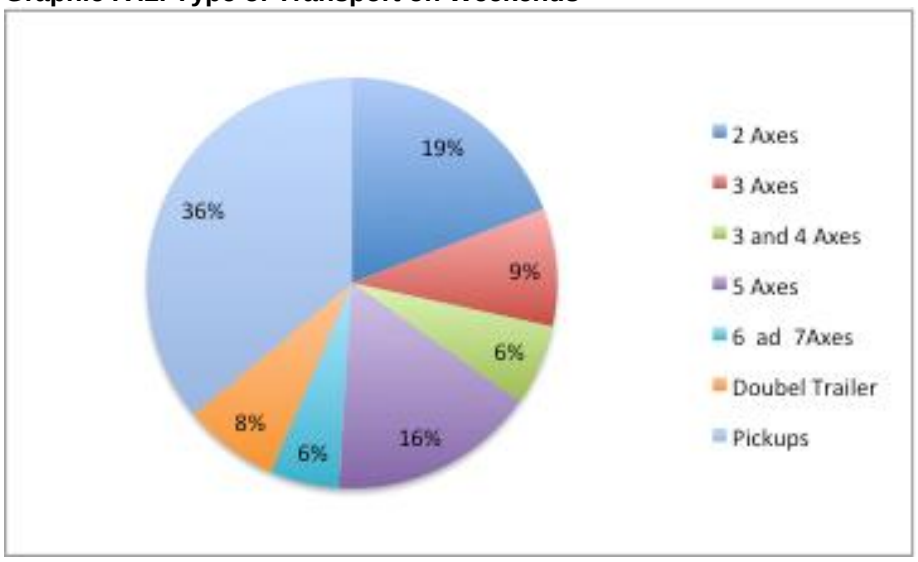
Source: Own elaboration with data of LOGIT, case of Tabasco

Table IV .4. Type of Transport on Weekends

Type of Transport	Quantit	%
2 Axes	531	19.14
3 Axes	257	9.26
3 and 4 Axes	177	6.38
5 Axes	451	16.26
6 ad 7Axes	151	5.44
Doubel Trailer	208	7.50
Pickups	999	36.01
	2774	100.00

Source: Own elaboration with data of LOGIT, case of Tabasco

Graphic IV.2. Type of Transport on Weekends



Source: Own elaboration with data of LOGIT, case of Tabasco

With the previous information we can find the most used type of transport for weekends and during the week are those for 2 Axes vehicles and pick-ups, medium distances and cargo, then the second most important kind is the vehicles with 5 Axes like heavy cargo, and in third place we find 3 Axes vehicles, although they are not so heavy cargo, this kind of vehicles are used for industrial cargo most of the time.

One of the most important variables are the distances, which we well analyse in the next tables:

Table IV.5. Important and must used destinations during the week

Locations	Origen	Destination
Campeche	21	15
Ciudad del Carmen	77	114
Jalapa Tabasco	39	27
Huimanguillo	56	47
Palenque	33	53
Teapa	69	62
Tuxtla Gutierrez	19	17
Toluca	19	11
Cancún Quintanaroo	261	46
Cardenas Tabasco	189	184
Centla Tabasco	195	208

Centro (Villahermosa)	484	960
Ciudad de México y A Metropolitana	61	63
Coatzacoalcos Veracruz.	32	56
Comalcalco Tabasco	91	117
Cunduacan Tabasco	231	211
Macuspana Tabasco	256	54
Merida Yucatan	118	116
Monterrey N. L.	9	12
Nuego Laredo Tamaulipas	3	3
Puebla Puebla	8	12
Veracruz Puerto	28	28

Source: Own elaboration with data of LOGIT, case of Tabasco

Table IV.6. Important and most used Destinations on weekends

Locations	Origen	Destination ~~y~~
Cancún Quintanaroo	56	78
Cardenas Tabasco	157	159
Centla Tabasco	177	109
Centro (Villahermosa)	749	882
Ciudad de México y A Metropolitana	252	187
Coatzacoalcos Veracruz.	32	53
Comalcalco Tabasco	105	95
Cunduacan Tabasco	172	196
Macuspana Tabasco	163	127
Merida Yucatan	136	149
Monterrey N. L.	18	8
Nuego Laredo Tamaulipas	3	3
Puebla Puebla	25	20
Reynosa Tamaulipas	10	7
Tijuana B.C.	2	1
Torreon Coahuila	3	0
Veracruz Puerto	28	28

Source: Own elaboration with data of LOGIT, case of Tabasco.

The data in the last two tables shows that for some important cities the freight transport is more frequent, either for sending or receiving. For “During the week” the city of Villahermosa receives more products than they send to other parts of the country and

México city sends more products than it receives. In the case of "the Weekends" we can find the same pattern for those two cities but in these cases the cities of Tijuana and Reynosa appear in the logistic of the freight transport, so we can conclude that during the weekend we can find larger routes.

Other important variables we have in our data are the model and age of the vehicle of freight transport. With this information we can find the weight of an empty truck and then calculate the average weight, as we specify at the "Diagram 4.1"

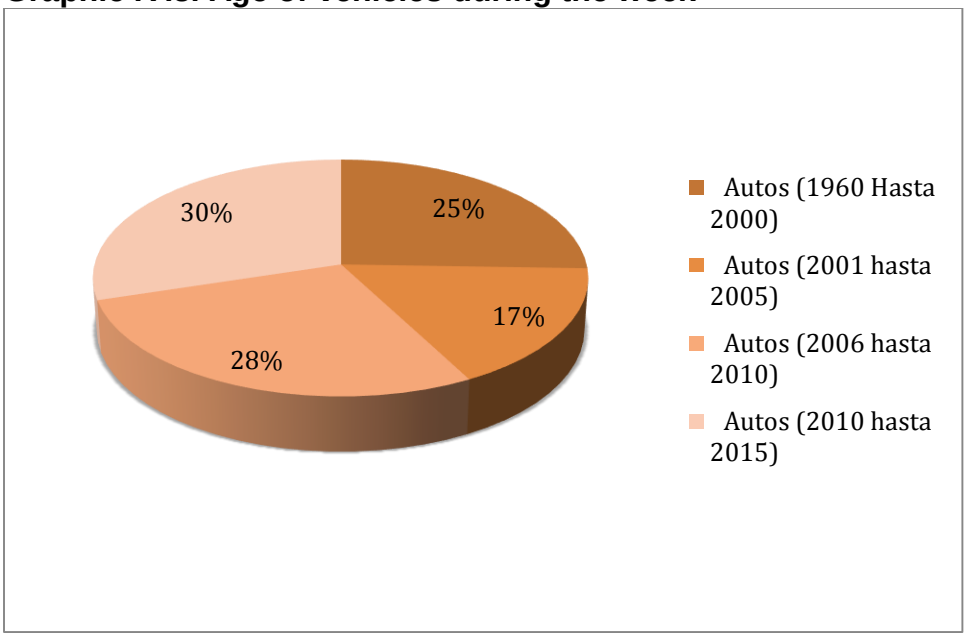
In the next tables and graphics, it will be described all variables involved to calculate the CO2 emissions.

Table IV.7. Age of the transport vehicle during the week in %

Año del transporte	Age of transport
Autos (1960 Hasta 2000)	22.9
Autos (2001 hasta 2005)	14.47
Autos (2006 hasta 2010)	28.28
Autos (2010 hasta 2015)	34.31

Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic IV.3. Age of vehicles during the week



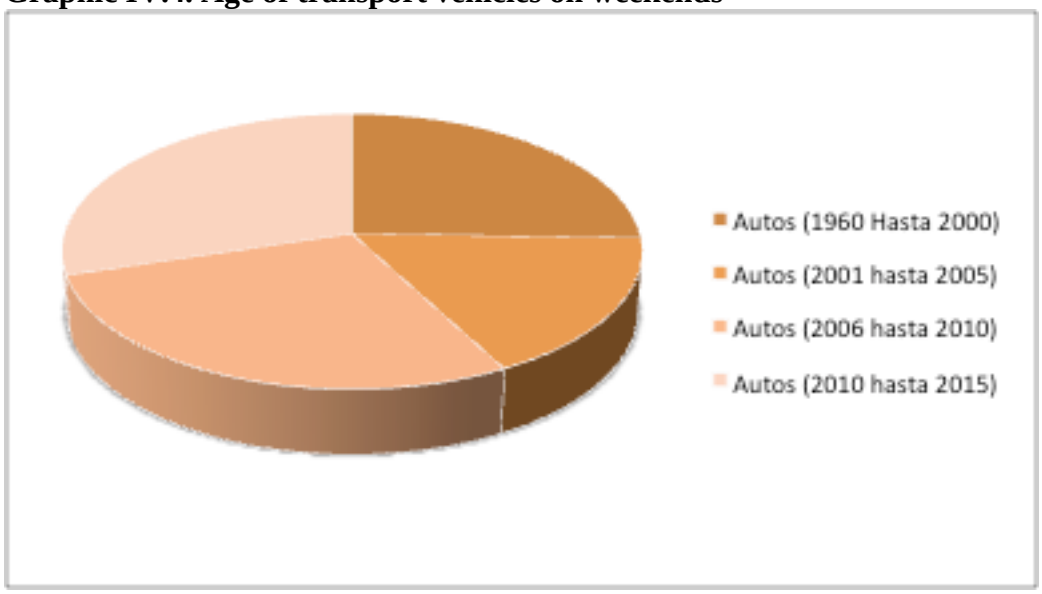
Source: Own elaboration with data of LOGIT, case of Tabasco.

Table 4.8. Age of the transport vehicle during weekends in %

Año del transporte	Age of transport
Autos (1960 Hasta 2000)	25.52
Autos (2001 hasta 2005)	16.73
Autos (2006 hasta 2010)	27.96
Autos (2010 hasta 2015)	29.79

Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic IV.4. Age of transport vehicles on weekends



Source: Own elaboration with data of LOGIT, case of Tabasco.

In this chapter we have analyzed the age of the transport vehicles. We need this information to calculate the empty weight of the vehicle.

By knowing the age of the transport/vehicle we also find out we need to observe in México we have a big problem with the technology of our freight transport right now, for one or other reasons in this country it is possible to assume we have really old vehicles, for example:

- During the week we find that 37.37 % of the vehicles are from 1960 to 2005 and on weekends 42.25 % for the same age, with probably bad mechanical maintenance and CO2 emissions.

- Also we have more old vehicles, not so old like the last ones but they have problems, with 28.28% during the week and 27.96% on weekend we find the vehicles with an age of 5 to 10 years.
- Better news is that we have 34.31% during the week and 29.79 % on weekends the age of the vehicles used is less than 5 years.

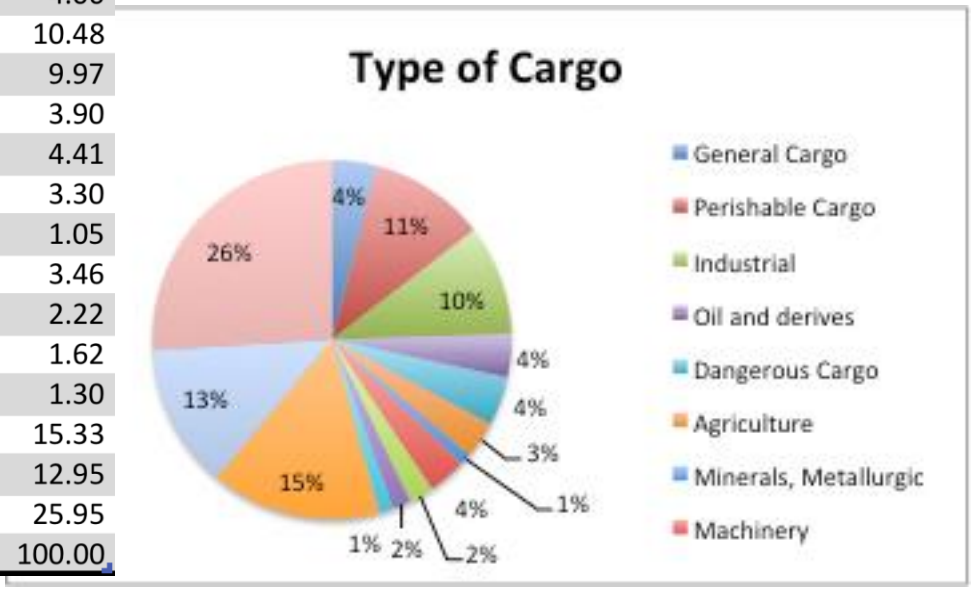
In conclusion the transportation fleet is quite old. This needs solutions, which we will approach in the next chapters.

Another variable to analyze is the weight of the cargo of the vehicles and what kind of cargo is t.

Table IV.9. Weight of the cargo during the week in %

Type of Cargo	%
General Cargo	4.06
Perishable Cargo	10.48
Industrial	9.97
Oil and derives	3.90
Dangerous Cargo	4.41
Agriculture	3.30
Minerals, Metallurgic	1.05
Machinery	3.46
Animals and derives	2.22
Refrigerated products	1.62
Automotive	1.30
No defined cargo	15.33
Construction Material	12.95
Others	25.95
Total	100.00

Graphic IV.5. Weight of the cargo during the week

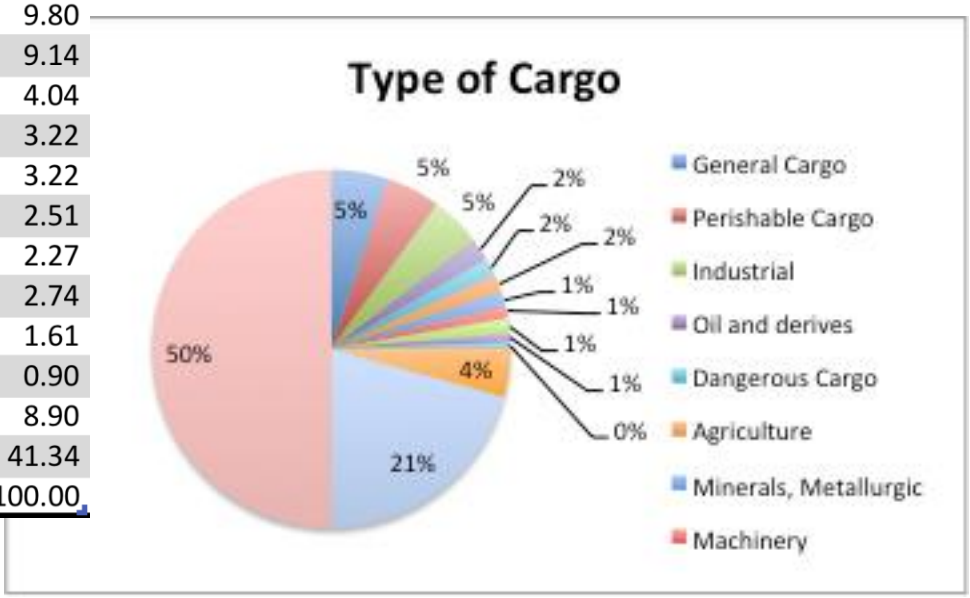


Source: Own elaboration with data of LOGIT, case of Tabasco.

Table IV.10. Weight of the cargo during

Type of Cargo	%
General Cargo	10.31
Perishable Cargo	9.80
Industrial	9.14
Oil and derives	4.04
Dangerous Cargo	3.22
Agriculture	3.22
Minerals, Metallurgic	2.51
Machinery	2.27
Animals and derives	2.74
Refrigerated products	1.61
Automotive	0.90
No defined cargo	8.90
Others	41.34
Total	100.00

Graphic IV.6. Weight of the cargo on weekends in %



Source: Own elaboration with data of LOGIT, case of Tabasco.

The last tables and graphs indicate that the most important products to transport during the week and on weekends are industrial, perishable cargo, oil and derives, dangerous and agriculture cargo, but we note that during the week, the construction material is really important.

Last but not less important we have to analyse the variable "Empty", with this one we can find if the transport was traveling empty o with cargo, this variable is going to help us to calculate the weight of the full road in our data.

Table IV.11. Empty percentages.

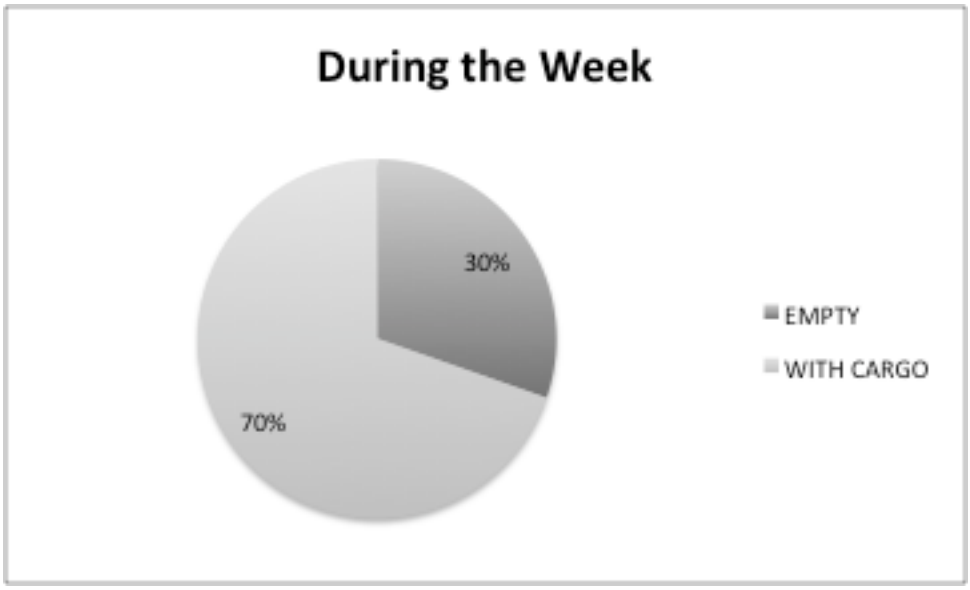
During the week	%
EMPTY	30.35
WITH CARGO	69.65

Weekends	%
EMPTY	#VALUE!
WITH CARGO	With cargo

TOTAL	%
Vacio	31.29
WITH CARGO	68.71

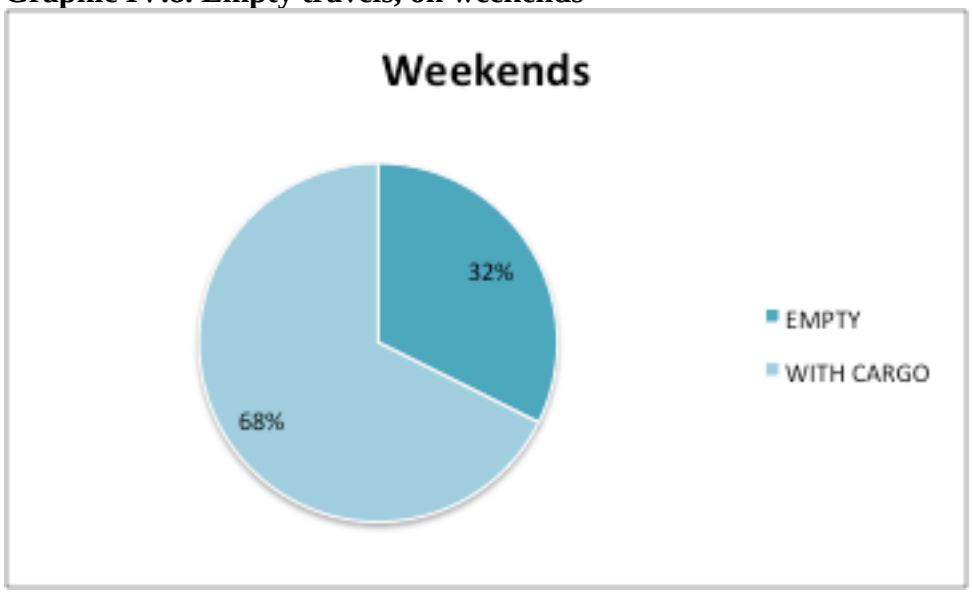
Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic IV.7. Empty travels, during the week



Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic IV.8. Empty travels, on weekends



Source: Own elaboration with data of LOGIT, case of Tabasco.

With this data we can observe that over 30 % of the freight transport is traveling empty, this is a big logistic problem for emissions.

ii. Methods used to calculate variables for calculation of carbon emission.

Now that we analysed in general our variables and know how to prepare them to calculate the CO2 emissions, we are going to use the methodology explained in the

chapter 1, and we are going to calculate with the help of this methodology some examples of CO2 emissions in the freight transport of the case of Tabasco, México.

In the next page we are going to show again the diagram or the simple algorithm to calculate the emissions of CO2 (Diagram 1, Chapter 1)

B.- Calculation and result of carbon emissions.

Now that we have the steps to calculate the emissions of CO2 we are going to calculate two examples.

Table IV.12. Data for Examples

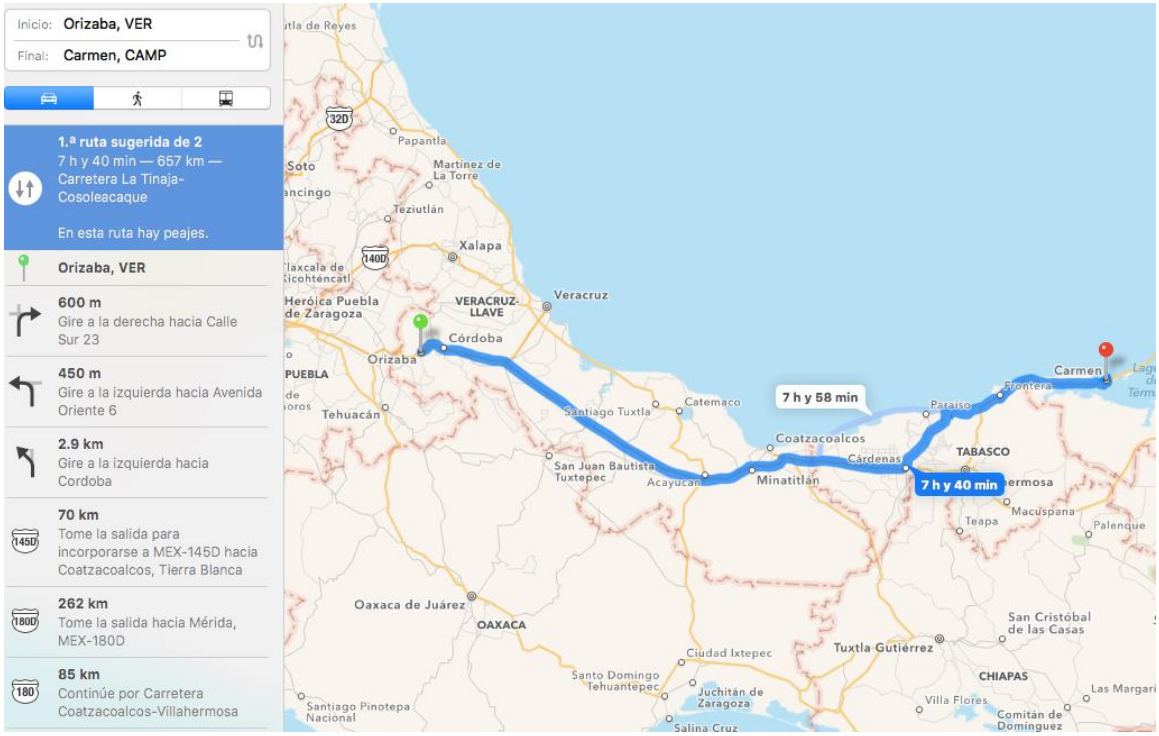
Type of V.	Origin	Destiny	Cargo	W. Of Cargo	Empty	T. Frecuency	Branch of V.	Model	Distance
4 EJES	COATZACOA	MERIDA	PETROLEO Y	0	SI	104	KENWORTH	1997	720
8 Y 9 EJES	ORIZABA	CD. DEL CAR	VIDRIO	1	NO	261	NISSAN	2002	657

Source: Own elaboration with data of LOGIT, case of Tabasco.

Step 1. Distance

In table IV.12., we already calculated the distance with some help of Google Maps.

Picture IV.1. Distances



Source: Google Maps.

Step 2. Calculating the average load

Average load= $0.7087e^{0.1882*\text{empty weight (truck with out cargo)}}$

a) Average load= $0.7087e^{0.1882*}$ $^{18.2}$ = 21.77836459
b) Average load= $0.7087e^{0.1882*}$ $^{4.8}$ = 1.748987461

****Empty Weight were chosen from the table 4.2**

Step 3. Calculation of liters of fuel consumed

Consume of Diesel litters per every kilometer (C) = 3.5 x (Total Weight in tones + 4) $^{0.65}$

a) (C) = 3.5 x (21.77836459 + ***4)*** $^{0.65}$ = 40.94 / 100 = .4094
b) *(C) = 3.5 x (*1001.748987 + ***4)*** $^{0.65}$ = 314.07 / 100 = 3.1407
**** Total Weight in tones = Weight of the data (If is empty = 0) + Average Weight**

Step 4.- Calculation of $C0_2$ kilograms per liter of consumed Diesel.

1 liter of Diesel produced X number of kilograms of CO2 = 3.67 x 0.72 = 2.64 kg

Step 5.- Calculation of the CO_2 emitted on the full road

$$\frac{\textit{Total distance X Liters of Diesel consumed X Kilograms of } C0_2 \textit{ per litter of Diesel}}{1000}$$

a) CO_2 Tones = 720 * .4094 * ***2.64 /1000 =*** 1.31
b) CO_2 Tones = 657* 3.1407 * ***2.64 /1000 =*** 9.15

Step 6.- And finally to obtain the total tones of CO_2 in a year.

CO_2 per year = CO_2 Tones * Total Frequency

a) CO_2 per year = 1.31 * 104 =136.30

b) CO_2 per year = 9.15 * 261 = 2385.65

Summary of the calculations:

Table IV.13. Summary of CO2 emissions (Tons)

Emissions of CO2 per year								
Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	3485	2194	3845	61834	41366	58824	4171	175719
Mediums 2000 to 3999 kgs	1854	2579	519	16502	6726	13251	2444	43876
Largess 4000 to 6999 Kgs	1776	3335	3506	32231	7905	38092	1003	87849
X-Larges 7000 a 16000 Kgs	3607	19775	14611	996896	954806	619063	13699	2622457
Vacias	3094	9574	3877	168375	82218	200125	14337	481600
Total	**13817**	**37457**	**26358**	**1275839**	**1093021**	**929355**	**35653**	3411501

Emissions of CO2 per year								
Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	2429	3628	4240	116192	149524	39543	6100	321656
Mediums 2000 to 3999 kgs	2016	909	10235	31712	103548	23681	902	173003
Largess 4000 to 6999 Kgs	1021	555	1776	432711	38789	52119	2250	529222
X-Larges 7000 a 16000 Kgs	10805	22434	26478	1381836	774096	2022523	40723	4278896
Vacias	1820	5758	6213	454325	138906	708413	9352	1324787
Total	**18091**	**33284**	**48942**	**2416777**	**1204863**	**2846280**	**59327**	6627564

Source: Own elaboration with data of LOGIT, case of Tabasco.

In this chapter we only have the summary of the CO2 emissions from all the procedures we described, for the moment we can only conclude that the empty travels are a big problem, not just because bad logistics costs a lot of money, they pollute a lot, especially when it is big cargo. In the next chapter we are going to analyze it in detail.

Chapter V. Interpretation of LOGIT statistics, case Tabasco.

E

Chapter V. Interpretation of LOGIT statistics, case Tabasco.

In the last chapter we described and analyzed the data we used for the calculation of CO2 emissions, now is the time to analyze the behaviour of the freight transportation in Mexico, we know that we divided the circulation of the freight transport in two: "During the week" and on "Weekends". We already know that the divisions are classified in the different type of vehicles, Axes, we know how many observations by classification we have so the next step is to study every classification of vehicle and observe their behaviour.

a) Variables to use to calculate carbon emissions.

To start analyse every classification of the freight transportation in the case of study, we have to understand the general behaviour of the two first classifications, "During the week" and "Weekends", but first why are these two classifications pertinent? Its simple, during the week we have the ordinary transportation of the industry, on weekends it is just the urgent transportation and the programmed travels on the roads.

Because we already know the type of the cargo we are going to step forward to know the Balance of Inter-Regional Transportation.

Balance of Inter-Regional Transport is just a positive, negative and neutral difference that shows us the behaviour in the logistic of Mexican transport.

- Positive percentage means that the city is sending more products to other cities than receiving.
- Negative percentage means that the city is receiving more products from other cities than sending.
- Neutral percentage means that is sending the same products as receiving them.

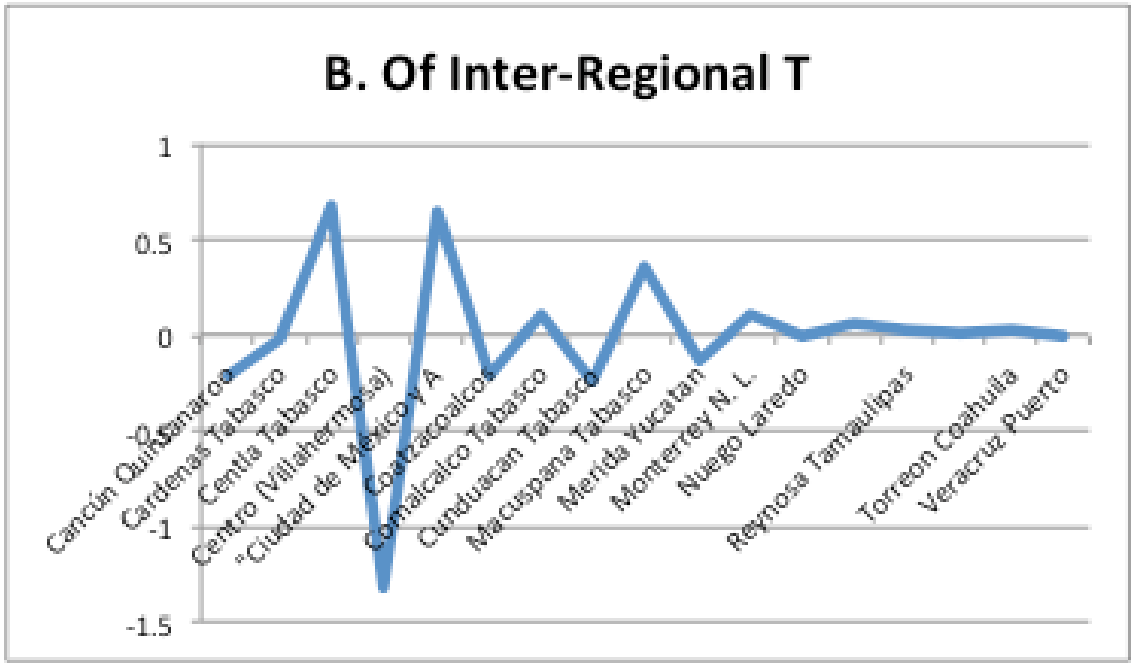
Table V.1 Balance of Inter-Regional Transportation During the Week, in percent of the difference between Origin and Destination.

Locations	Origin	Destination	B. of inter - regional transport (%)
Campeche, Campeche	21	15	0.06
Ciudad del Carmen, Campeche	77	114	-0.37
Jalapa, Tabasco	39	27	0.12
Huimanguillo, Tabasco	56	47	0.09
Palenque, Chiapas	33	53	-0.2
Teapa, Tabasco	69	62	0.07
Tuxtla Gutiérrez, Chiapas	19	17	0.02
Toluca	19	11	0.08
Cancún, Quintana-roo	261	46	2.15
Cárdenas, Tabasco	189	184	0.05
Centla, Tabasco	195	208	-0.13
Centro (Villahermosa)	484	960	-4.76
Ciudad de México	61	63	-0.02
Coatzacoalcos, Veracruz.	32	56	-0.24
Comalcalco, Tabasco	91	117	-0.26
Cunduacán, Tabasco	231	211	0.2
Macuspana, Tabasco	256	54	2.02
Mérida, Yucatán	118	116	0.02
Monterrey N. L.	9	12	-0.03
Nuevo Laredo, Tamaulipas	3	3	0
Puebla, Puebla	8	12	-0.04
Veracruz (Puerto), Veracruz	28	28	0

Source: Own elaboration with data of LOGIT, case of Tabasco.

In this general case of the table 5.1, we can observe that a lot of cities have problems with the logistics of transportation, the balance of inter-regional transport show us that cities like: Villahermosa, Campeche, Comalcalco has a big problem with the negative percentage, so we know that they import a lot of products but they don´t send enough to have a good logistic or no empty roads, the positive percentages for cities like: Cancun, Macuspana, means that the city is sending a lot of products but not buying or receiving the same amount, so they have a lot of empty trips and for the last the good scenery is when the percentage is 0, same amount goes and back, no empty roads.

Graphic V.1 Balance of Inter-Regional transportation during the week, in percent of the difference between Origin and destiny.



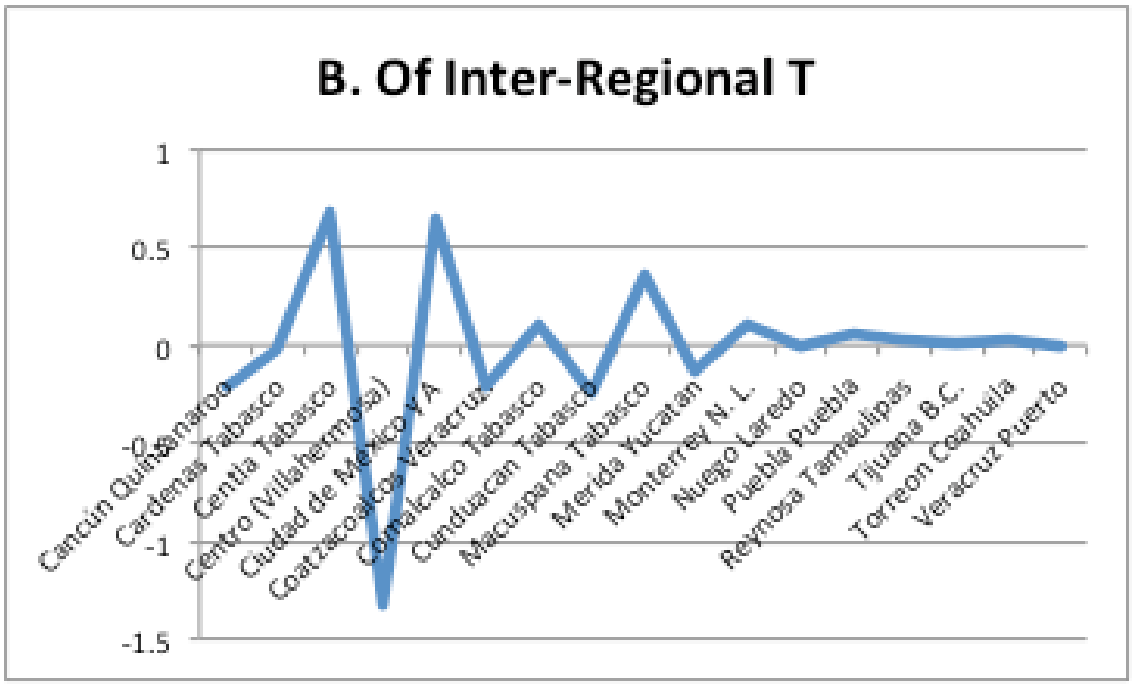
Source: Own elaboration with data of LOGIT, case of Tabasco.

Table V.2 Balance of Inter-Regional transportation on weekends, in percent of the difference between Origin and destiny.

Locations	Origin	Destination	B. Of Inter-Regional T
Cancún, Quintana-Ro	56	78	-0.22
Cárdenas, Tabasco	157	159	-0.02
Centla, Tabasco	177	109	0.68
Centro (Villahermosa), Tabasco	749	882	-1.33
Ciudad de México.	252	187	0.65
Coatzacoalcos, Veracruz.	32	53	-0.21
Comalcalco Tabasco	105	95	0.1
Cunduacán, Tabasco	172	196	-0.24
Macuspana, Tabasco	163	127	0.36
Mérida, Yucatán.	136	149	-0.13
Monterrey, N. L.	18	8	0.1
Nuevo Laredo, Tamaulipas	3	3	0
Puebla, Puebla	25	20	0.05
Reynosa, Tamaulipas	10	7	0.03
Tijuana, B.C.	2	1	0.01
Torreón, Coahuila	3	0	0.03
Veracruz (Puerto), Veracruz.	28	28	0

Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic V.2 Balance of Inter-Regional Transportation on Weekends, in percent of the difference between Origin and destiny.



Source: Own elaboration with data of LOGIT, case of Tabasco.

The interesting thing is that in two cities during the week and on weekends we can find a perfect logistic or a neutral percentage of Balance in an Inter-Regional Transport, those cities are Nuevo Laredo and Veracruz. Some cities in the two classifications seem to have important logistic problems, receiving a lot of products but not sending the same amount, those cities are Merida, Cancun, Villahermosa and others. The city with more sending of products and with a big problem to receive products the country is Mexico City, the problem is pay for empty travels and produce CO2 emissions without cargo.

The principal corridors observed in our case study are:

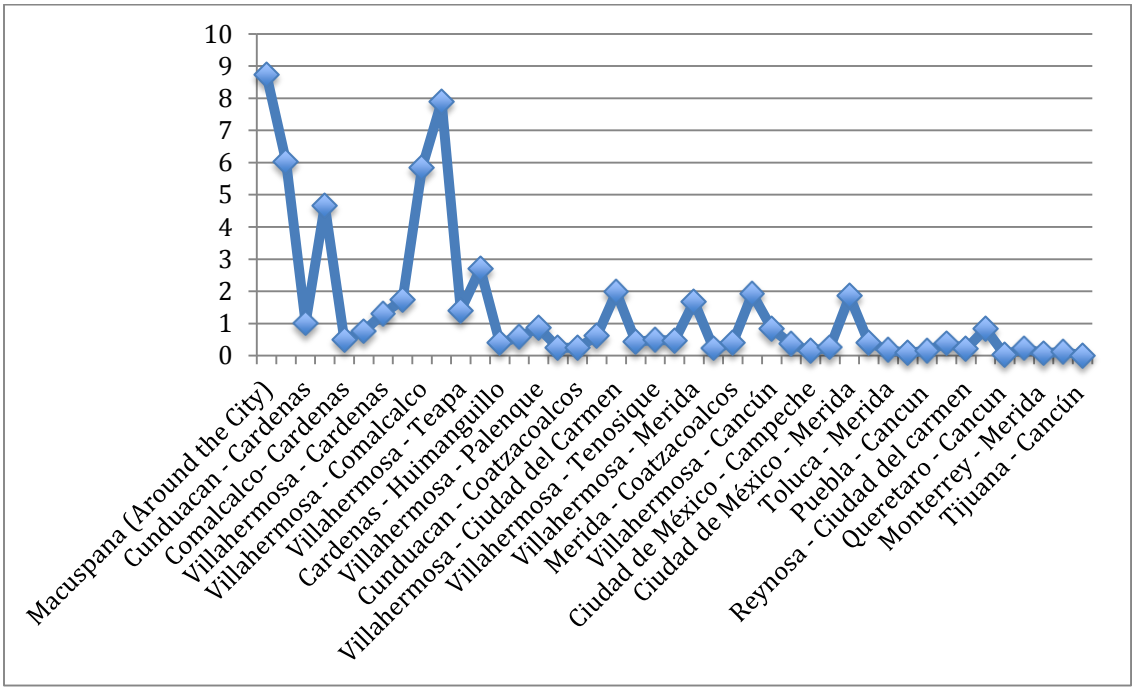
Table V.3 Principal corridors used during the week in %

Road Corridor	Distance kkms	%
Teapa - Paraiso	134	0.58
Villahermosa - Coatzacoalcos	170	0.61
Villahermosa- Jalapa (Tabasco)	43	0.76
Ciudad de México - Cancún	1625	0.83
Villahermosa - Cancún	923	0.84

Villahermosa - Palenque	136	0.87
Cunduacan - Cardenas	29	1.01
Villahermosa - Cardenas	50	1.3
Villahermosa - Teapa	60	1.41
Villahermosa - Merida	619	1.68
Villahermosa - Macuspana	52	1.73
Ciudad de México - Merida	1296	1.85
Ciudad de Mexico - Villahermosa	762	1.93
Villahermosa - Ciudad del Carmen	175	1.98
Villhaermosa - Paraiso	77	2.7
Villahermosa - Cunduacan	35	4.67
Villahermosa - Comalcalco	58	5.84
Villahermosa (Around the City)	22	6.03
Villhaermosa - Centla	59	7.89
Macuspana (Around the City)	5.7	8.72
Others		46.77
Total		100

Source: Own elaboration with data of LOGIT, case of Tabasco.

Graphic V.3 Principal corridors used during the week (Number of times used in the period)



Source: Own elaboration with data of LOGIT, case of Tabasco.

Table V.4. Main corridors used on weekends, in %

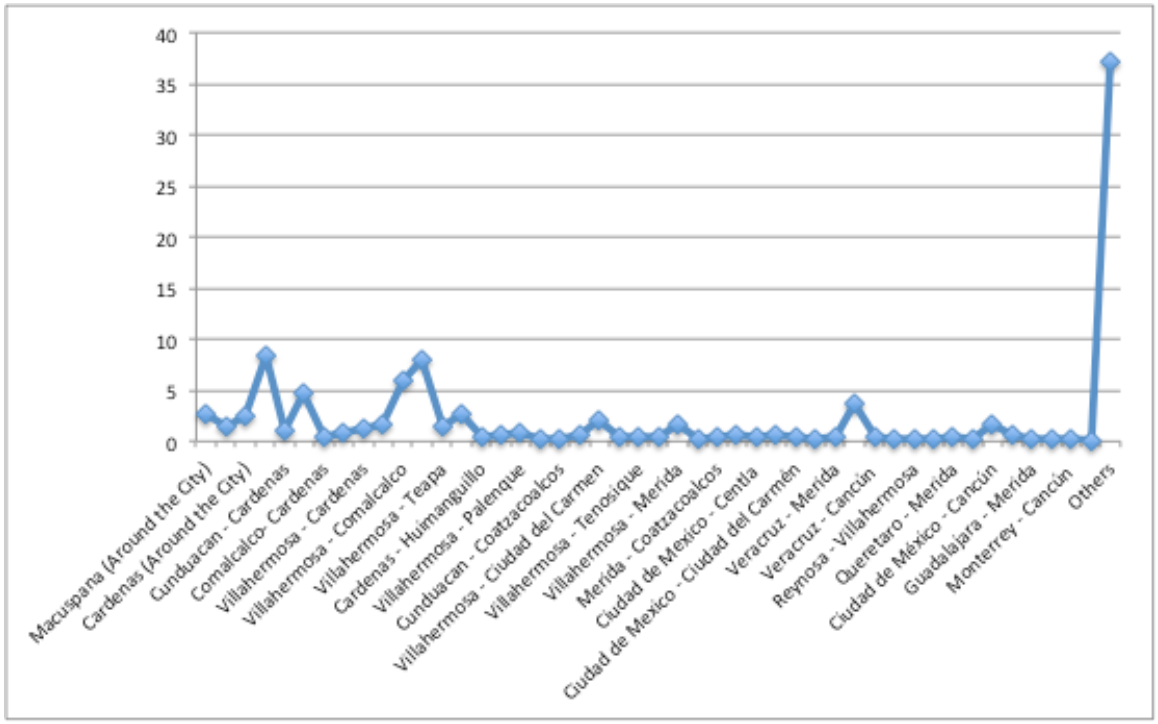
Road Corridor	Distance Kms	%
Villahermosa - Tenosique	234	0.5
Teapa - Paraiso	134	0.58
Villahermosa - Coatzacoalcos	170	0.61
Queretaro - Cancun	1816	0.62
Ciudad de Mexico - Villahermosa	762	0.65
Villahermosa - Cancún	923	0.69
Villahermosa- Jalapa (Tabasco)	43	0.76
Villahermosa - Palenque	136	0.87
Cunduacan - Cardenas	29	1.01
Villahermosa - Cardenas	50	1.3
Villahermosa - Teapa	60	1.41
Cunduacan (Around the City)	11.5	1.48
Villahermosa - Merida	619	1.68
Ciudad de México - Cancún	1625	1.71
Villahermosa - Macuspana	52	1.73
Villahermosa - Ciudad del Carmen	175	1.98
Cardenas (Around the City)	17	2.38
Macuspana (Around the City)	5.7	2.7
Villhaermosa - Paraiso	77	2.7
Ciudad de México - Merida	1296	3.75
Villahermosa - Cunduacan	35	4.67
Villahermosa - Comalcalco	58	5.84
Villhaermosa - Centla	59	7.89
Villahermosa (Around the City)	22	8.47
Others		44.02
Total		100

Source: Own elaboration with data of LOGIT, case of Tabasco.

It is interesting to see that the most used corridors are those around Villahermosa City; this is because all the surveys were made in Tabasco and we can observe how Villahermosa is the most important city in this area, bringing and sending different kind

of products. Mexico City, Cancún, Merida are cities with high frequency in the data, for origin or destination, they show some problems like a lot of empty travels as we found out earlier.

Graphic V.4. Main corridors used on weekends, (Number of times used in the period)



Source: Own elaboration with data of LOGIT, case of Tabasco.

In the last two graphics we can observe better how Villahermosa is the center of a lot of travels of the surveys and also we can find that Mérida, Cancun and México City are the most popular destinations of this case, but México City is also the origin of a lot of the transport.

e) Behaviour of the freight transportation, case Tabasco.

Lets start the analysis of the data of the cases of Tabasco; in this part we are going to describe the behaviour of:

- Type of cargo (% of the total in the axe classification)
- Balance of inter-regional transport (Difference of origin and destination)
- Most used corridors (% of the total in the axe classification)
- Empty or with cargo travels (% of the total in the axe classification)
- Age of vehicles

We will describe all the data using a classification of type of vehicles:

During the week:

Description of 2 Axes vehicles

Graphic V.5. Type of cargo, 2 axes, during the week.

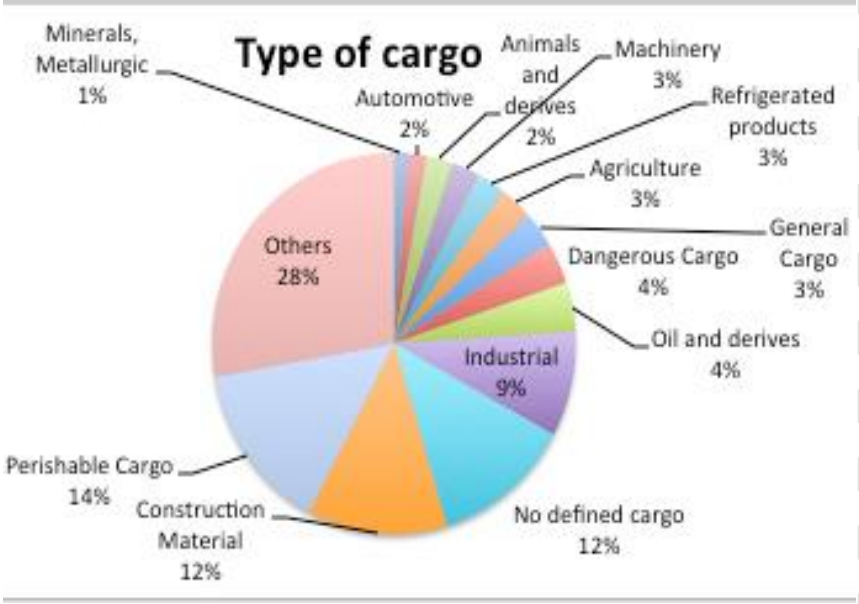


Table V.5. Balance of inter-regional transport of 2 axes, during the week.

Locations	B. Transporte Interegional
Centla Tabasco	-0.18
Cunduacan Tabasco	-0.15
Comalcalco Tabasco	-0.08
Coatzacoalcos Veracruz.	-0.06
Palenque	-0.04
Veracruz Puerto	-0.04
Merida Yucatan	-0.03
Ciudad del Carmen	-0.02
Tuxtla Gutierrez	-0.02
Teapa	-0.01
Cancún Quintanaroo	0
Jalapa Tabasco	0
Monterrey N. L.	0
Nuego Laredo Tamaulipas	0
Puebla Puebla	0
Huimanguillo	0.02
Toluca	0.02
Campeche	0.03
Cardenas Tabasco	0.04
Ciudad de México y A Metropolitana	0.06
Macuspana Tabasco	0.14
Centro (Villahermosa)	0.29

Table V.6. Most used corridors, 2 axes, during the week.

Road Corridor	%
Cardenas - Huimanguillo	1.03
Villhaermosa - Paraiso	1.34
Cunduacan - Coatzacoalcos	1.47
Villahermosa - Cardenas	1.61
Villahermosa - Teapa	1.62
Villahermosa - Emiliano Zapata	1.7
Ciudad de Mexico - Villahermosa	1.7
Villahermosa - Cunduacan	1.72
Villahermosa - Ciudad del Carmen	1.95
Cunduacan - Cardenas	2.07
Villhaermosa - Centla	4.59
Villahermosa - Comalcalco	4.93
Villahermosa (Around the City)	7.87
Macuspana (Around the City)	8.95

Table V.7. Empty travels, 2 axes, during the week.

2 AXES	%
EMPTY	23.97
WITH CARGO	76.03

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of Pick-ups vehicles

Graphic V.6. Type of cargo, Pick-ups, during the week.

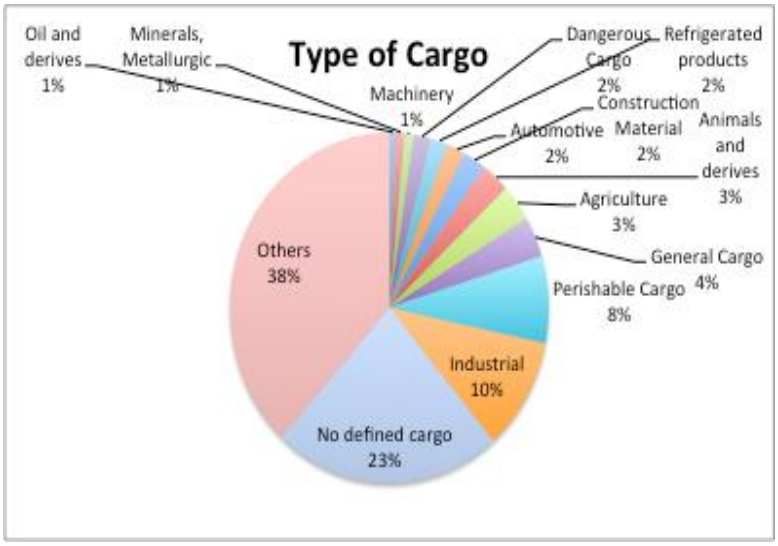


Table V.9. Most used corridors, D Pick-ups,, during the week.

Road Corridor	%
Comalcalco- Cardenas	1.09
Teapa - Paraiso	1.2
Villahermosa - Tenosique	1.2
Cardenas - Huimanguillo	1.31
Villahermosa - Palenque	1.42
Villahermosa - Comalcalco	1.86
Villahermosa - Cunduacan	1.96
Villahermosa - Macuspana	2.62
Villhaermosa - Centla	3.82
Villahermosa - Cardenas	4.15
Macuspana (Around the City)	9.61
Villahermosa - Teapa	14.96
Villahermosa (Around the City)	18.56

Table V.8. Balance of inter-regional transport of Pick-ups, during the week.

Locations	B. Of Inter-Regional Transport
Centro (Villahermosa)	-0.25
Palenque	-0.05
Teapa, Tabasco	-0.05
Cárdenas Tabasco	-0.04
Tuxtla Gutiérrez, Chiapas	-0.04
Campeche, Campeche	-0.01
Macuspana Tabasco	-0.01
Cancún Quintana roo	0
Ciudad del Carmen, Campeche	0
Coatzacoalcos Veracruz.	0
Huimanguillo	0
Mérida, Yucatán	0
Monterrey N. L.	0
Nuevo Laredo Tamaulipas	0
Toluca, E. México	0
Veracruz, Veracruz	0
Ciudad de México y A Metropolitana	0.01
Puebla, Puebla	0.02
Jalapa Tabasco	0.07
Centla, Tabasco	0.19
Comalcalco Tabasco	0.22
Cunduacán Tabasco	0.35

Table V.10. Empty travels, Pick-ups,, during the week.

PICK-UPS	%
EMPTY	52.84
WITH CARGO	47.16

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 3 Axes vehicles

Graphic V.7. Type of cargo, 3 axes, during the week.

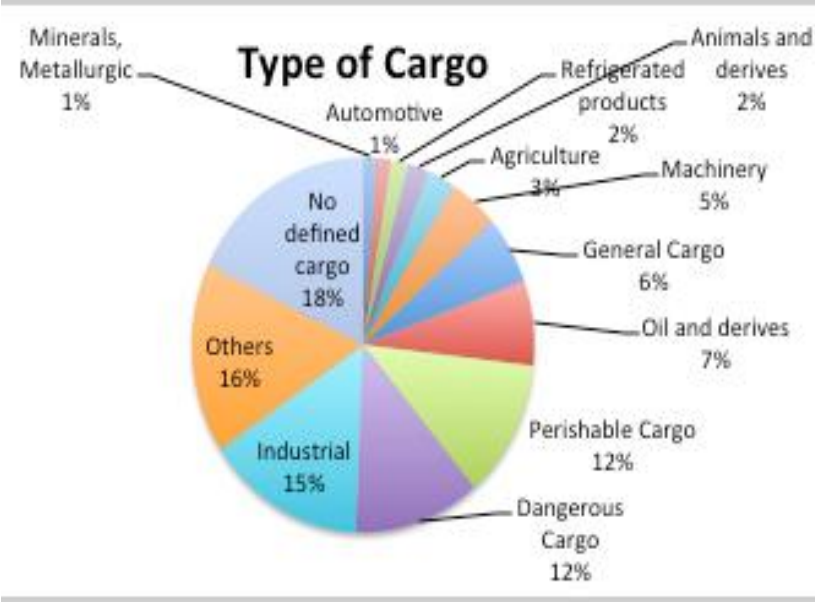


Table V.12. Must used corridors, 3 axes, during the week.

Road Corridor	%
Villahermosa - Coatzacoalcos	1.04
Ciudad de Mexico - Villahermosa	1.04
Villahermosa- Jalapa (Tabasco)	1.3
Villhaermosa - Centla	1.3
Villahermosa - Ciudad del Carmen	1.3
Villahermosa - Merida	1.3
Villahermosa - Comalcalco	2.07
Villhaermosa - Paraiso	2.07
Comalcalco- Cardenas	2.59
Villahermosa - Macuspana	2.85
Villahermosa - Cardenas	3.63
Villahermosa (Around the City)	7.25
Villahermosa - Cunduacan	7.29
Villahermosa - Teapa	10.1

Table V.11. Balance of inter-regional transport of 3 axes, during the week.

Locations	B. Of Inter-Regional Transport
Centla Tabasco	-0.18
Cunduacán Tabasco	-0.15
Comalcalco Tabasco	-0.1
Coatzacoalcos Veracruz.	-0.06
Palenque	-0.04
Veracruz Puerto	-0.04
Merida Yucatan	-0.03
Ciudad del Carmen	-0.02
Tuxtla Gutierrez	-0.02
Teapa	-0.01
Cancún Quintanaroo	0
Jalapa Tabasco	0
Monterrey N. L.	0
Nuego Laredo Tamaulipas	0
Puebla Puebla	0
Huimanguillo	0.02
Toluca	0.02
Campeche	0.03
Cardenas Tabasco	0.04
Ciudad de México y A Metropolitana	0.08
Macuspana Tabasco	0.14
Centro (Villahermosa)	0.39

Table V.13. Empty travels, 3 axes, during the week.

3 AXES	%
EMPTY	24.42
WITH CARGO	75.58

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 4 Axes vehicles

Graphic V.8. Type of cargo, 4 axes, during the week.

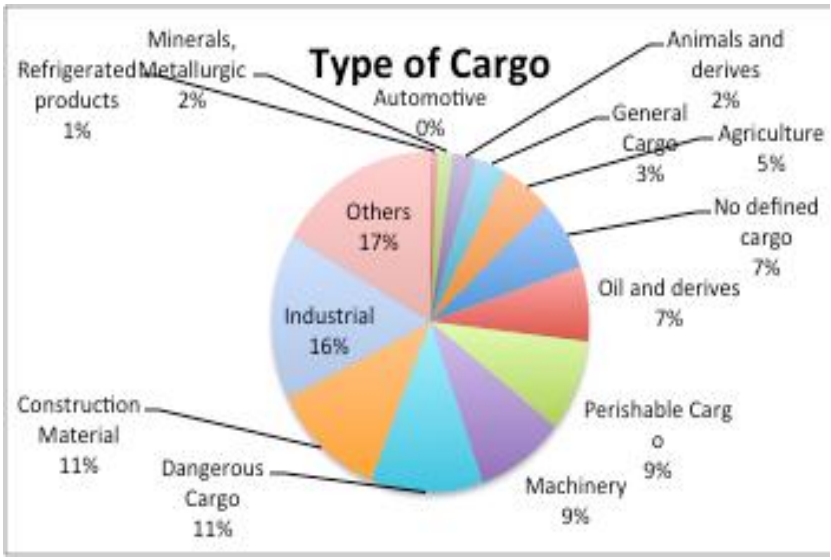


Table V.15. Must used corridors, 4 axes, during the week.

Road Corridor	%
Macuspana (Around the City)	1.19
Villahermosa (Around the City)	1.98
Villahermosa - Cunduacan	2.38
Cunduacan - Cardenas	2.78
Ciudad de México - Cancún	2.78
Comalcalco- Cardenas	3.17
Villhaermosa - Paraiso	3.17
Ciudad de México - Merida	3.97
Veracruz - Merida	4.37
Villahermosa - Teapa	5.16

Table V.14. Balance of inter-regional transport of 4 axes, during the week.

Locations	B. Of Inter-Regional Transport
Centro (Villahermosa)	-0.21
Mérida, Yucatán	-0.09
Centla, Tabasco	-0.05
Ciudad del Carmen, Campeche	-0.04
Teapa, Tabasco	-0.04
Cunduacán Tabasco	-0.03
Campeche, Campeche	-0.02
Jalapa Tabasco	-0.02
Cancún Quintana roo	-0.01
Comalcalco Tabasco	-0.01
Toluca, E. México	-0.01
Monterrey N. L.	0
Nuevo Laredo Tamaulipas	0
Tuxtla Gutiérrez, Chiapas	0.01
Cárdenas Tabasco	0.02
Huimanguillo	0.02
Macuspana Tabasco	0.02
Veracruz, Veracruz	0.02
Puebla, Puebla	0.04
Coatzacoalcos Veracruz.	0.05
Palenque	0.05
Ciudad de México y A Metropolitana	0.2

Table V.16. Empty travels, 4 axes, during the week.

4 AXES	%
EMPTY	19.29
WITH CARGO	80.71

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

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Description of 5 Axes vehicles

Graphic V.9. Type of cargo, 5 axes, during the week.

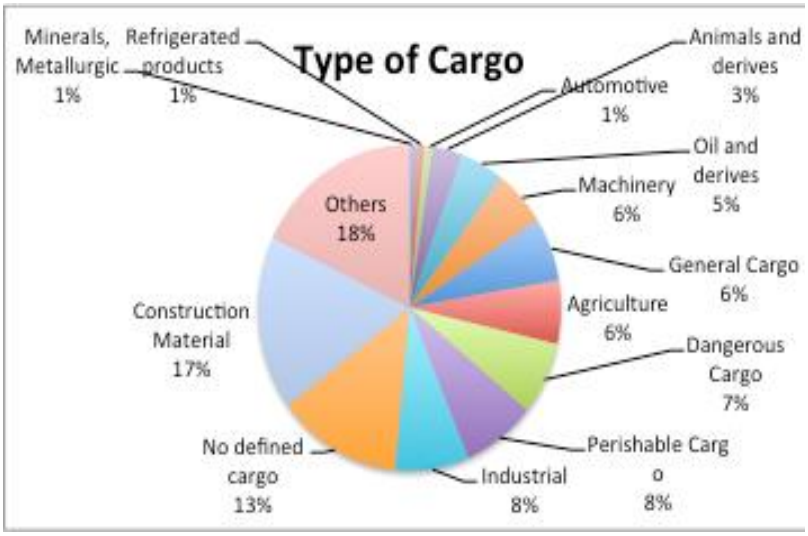


Table V.17. Balance of inter-regional transport of 5 axes, during the week.

Locations	B. Of Inter-Regional Transport
Centro (Villahermosa)	-0.54
Coatzacoalcos Veracruz.	-0.16
Centla, Tabasco	-0.11
Monterrey N. L.	-0.04
Comalcalco Tabasco	-0.02
Huimanguillo	-0.02
Ciudad de México y A Metropolitana	-0.01
Nuevo Laredo Tamaulipas	-0.01
Palenque	-0.01
Toluca, E. México	0
Ciudad del Carmen, Campeche	0.01
Jalapa Tabasco	0.01
Puebla, Puebla	0.01
Tuxtla Gutiérrez, Chiapas	0.01
Cárdenas Tabasco	0.02
Campeche, Campeche	0.03
Veracruz, Veracruz	0.04
Cunduacán Tabasco	0.08
Mérida, Yucatán	0.09
Teapa, Tabasco	0.1
Cancún Quintana roo	0.14
Macuspana Tabasco	0.18

Table V.18. Most used corridors, 5 axes, during the week

Road Corridor	%
Villahermosa - Cancún	1.68
Villahermosa - Cunduacan	2.1
Villahermosa - Ciudad del Carmen	2.1
Villahermosa - Macuspana	2.52
Villahermosa - Merida	2.52
Villahermosa (Around the City)	3.36
Ciudad de México - Cancún	4.2
Villahermosa - Cardenas	4.62
Villahermosa - Teapa	5.46
Ciudad de México - Merida	7.98

Table V.19. Empty travels, 5 axes, during the week.

5 AXES	%
EMPTY	22.69
WITH CARGO	77.31

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 6-9 Axes vehicles

Graphic V.10. Type of cargo, 6-9 axes, during the week.

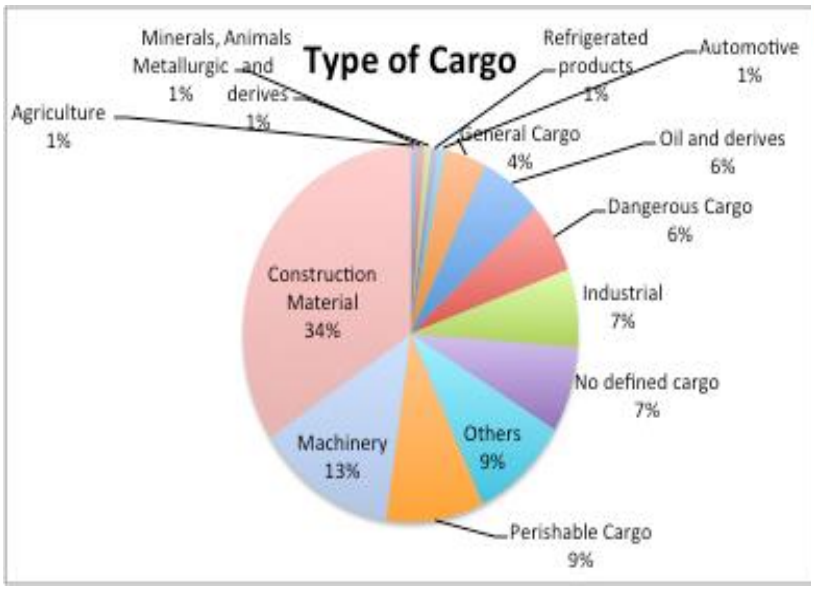


Table V.21. Most used corridors, 6-9 axes, during the week.

Road Corridor	%
Macuspana (Around the City)	1.36
Villahermosa - Palenque	1.36
Villahermosa - Merida	1.36
Cunduacan - Cardenas	2.03
Villahermosa - Cancún	2.03
Ciudad de México - Merida	2.03
Ciudad de México - Cancún	2.03
Villahermosa- Jalapa (Tabasco)	2.7
Villhaermosa - Centla	3.38
Villahermosa - Teapa	3.38
Comalcalco- Cardenas	4.05
Villahermosa - Cardenas	4.73
Villahermosa - Comalcalco	5.41
Villahermosa (Around the City)	7.43

Table V.20. Balance of inter-regional transport of 6-9 axes, during the week.

Locations	B. Of Inter-Regional Transport
Ciudad del Carmen, Campeche	-0.15
Centro (Villahermosa)	-0.08
Cancún Quintana roo	-0.07
Huimanguillo	-0.03
Mérida, Yucatán	-0.02
Coatzacoalcos Veracruz.	-0.01
Centla, Tabasco	0
Monterrey N. L.	0
Palenque	0
Tuxtla Gutiérrez, Chiapas	0
Nuevo Laredo Tamaulipas	0.01
Puebla, Puebla	0.01
Veracruz, Veracruz	0.01
Campeche, Campeche	0.02
Cárdenas Tabasco	0.02
Ciudad de México y A Metropolitana	0.02
Cunduacán Tabasco	0.03
Teapa, Tabasco	0.03
Toluca, E. México	0.03
Jalapa Tabasco	0.04
Comalcalco Tabasco	0.07
Macuspana Tabasco	0.1

Table V.22. Empty travels, 6-9 axes, during the week.

6 - 9 AXES	%
EMPTY	27.52
WITH CARGO	72.48

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of Double trailer vehicles

Graphic V.11. Type of cargo, Double trailer, during the

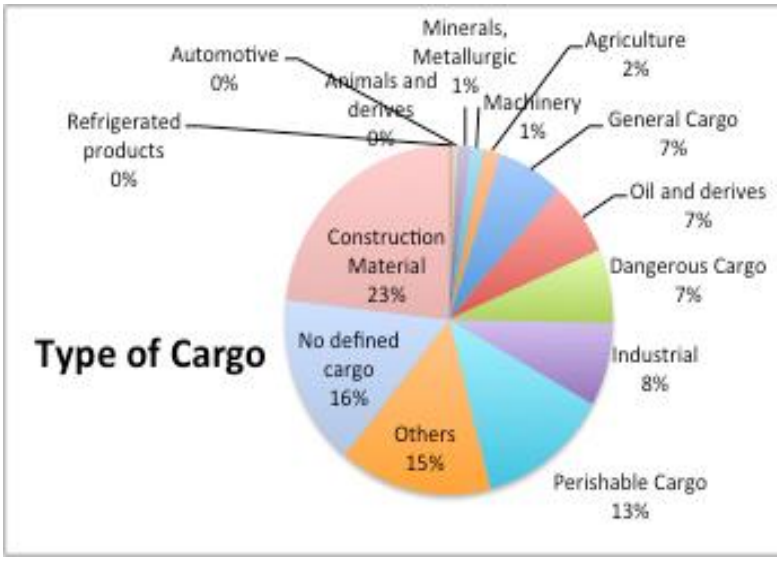


Table V.24. Most used corridors, Double trailer, during the wee

Road Corridor	%
Villahermosa - Palenque	1.31
Villahermosa - Tenosique	1.31
Merida - Coatzacoalcos	1.71
Ciudad de México - Cancún	1.75
Villahermosa - Teapa	2.18
Villahermosa - Cancún	2.28
Villahermosa - Cunduacan	2.62
Villahermosa - Coatzacoalcos	2.62
Villahermosa - Merida	3.95

Table V.23. Balance of inter-regional transport of Double trailer during the week.

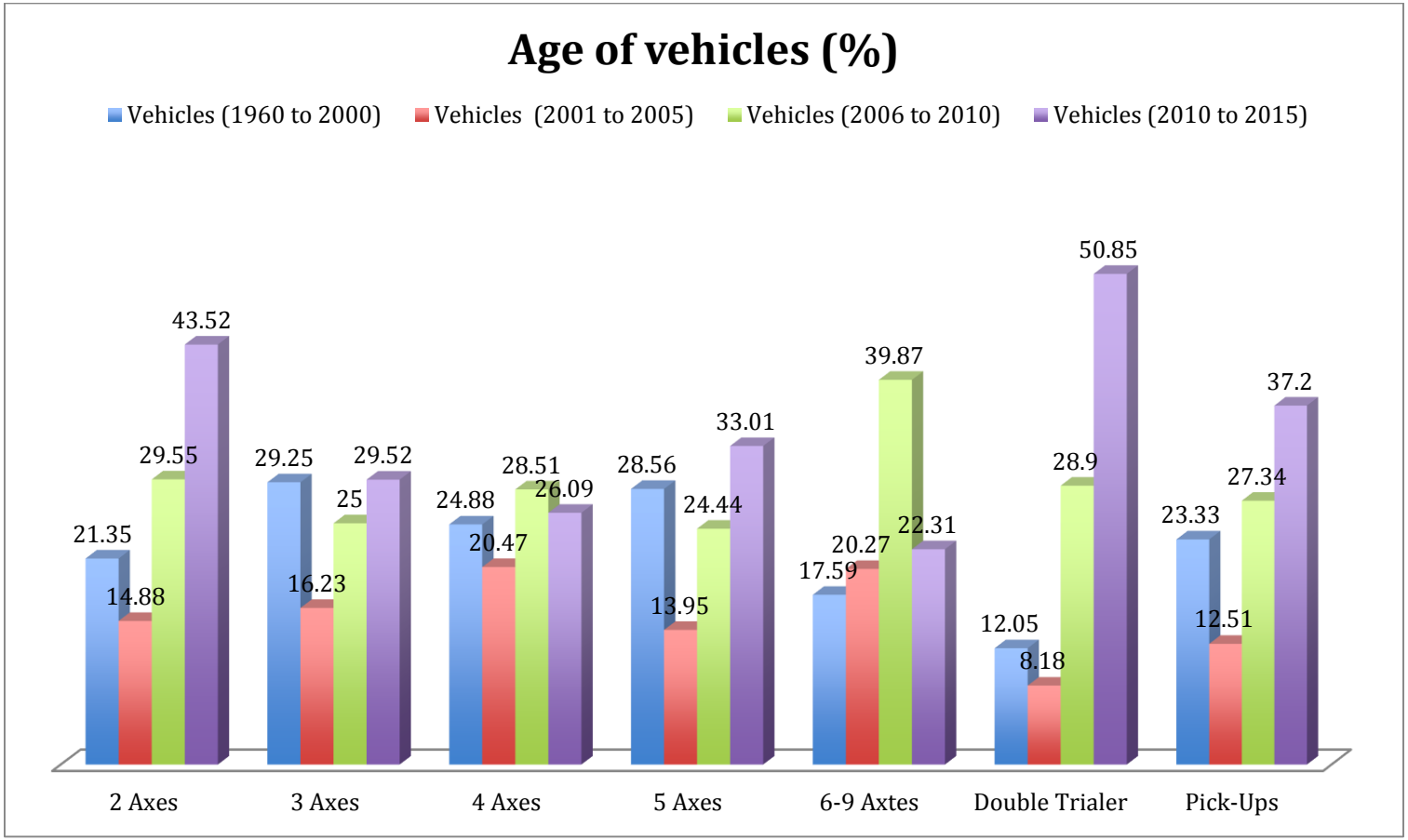
Locations	B. Of Inter-Regional Transport
Ciudad del Carmen, Campeche	-0.24
Veracruz, Veracruz	-0.09
Ciudad de México y A Metropolitana	-0.04
Comalcalco Tabasco	-0.03
Cunduacán Tabasco	0
Huimanguillo	0
Jalapa Tabasco	0
Nuevo Laredo Tamaulipas	0
Palenque	0
Puebla, Puebla	0
Toluca, E. México	0
Tuxtla Gutiérrez, Chiapas	0
Campeche, Campeche	0.01
Centla, Tabasco	0.01
Monterrey N. L.	0.01
Macuspana Tabasco	0.02
Coatzacoalcos Veracruz.	0.04
Teapa, Tabasco	0.04
Cancún Quintana roo	0.07
Cárdenas Tabasco	0.07
Centro (Villahermosa)	0.11
Mérida, Yucatán	0.15

Table V.25. Empty travels, Double trailer, during the wee

DOUBLE T.	%
EMPTY	35.78
WITH CARGO	64.22

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Graphic V.12. Age of vehicles during the week.



Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Table V.26. Summary of the important results, during the week:

	2 Axe	Pick-ups	3 Axes	4 Axes	5 Axes	6-9 Axes	Double trailer.
Most transported type of cargo	Perishable (14%), Construction Material (12%), Industrial (9%),	Industrial (10%), Perishable cargo (8%)	Industrial (15%), Dangerous cargo (12%), Perishable Cargo (12%).	Construction Materials (11%), Dangerous cargo (11%), Machinary (9%), Perishable cargo(9%).	Construction Materials (17%), Industrial	Construction Material (34%), Machinery (13%), Perishable cargo (9%)	Construction Material (23%), Perishable Cargo (13%), Industrial (8%)
Good logistic	Cancún, Jalapa Tab, Monterrey, Nuevo Laredo, Puebla	Cancun, Coatzacoalcos, Huimanguillo, Mérida, Monterrey, Nuevo Laredo, Toluca.	Cancun, Jalapa Tab, Monterrey, Nuevo Laredo, Puebla	Monterrey, Nuevo laredo	Toluca	Centla, Monterrey, Palenque, Tuxtla Guitierrez.	Cunduacán, huimanguillo, Jalapa Tab, Nuevo Laredo, Palenque, Puebla, Tuxtla Gutierrez.
Bad logistic	Centla Tab, Cunduacan Tab, Macuspana Tab, Villahermosa.	Villahermosa, Centla, Comalcalco.	Centla, Cunduacan, Villahermosa, Macuspana	Villahermosa, Mérida, Ciudad de México, Palenque.	Villahermosa, Coatzacoalcos, Macuspana, Cancun, Mérida.	Ciudad del Carmen, Villahermosa, Macuspana	Ciudad del Carmen, Veracruz, Ciudad de México, Merida, Villahermosa, Cancún.
% Of empty travels	23.97%	52.84%	24.42%	19.29%	22.69%	27.52%	35.78%
Most used corridors	Villahermosa to: Around the city, to México City, to Ciudad del Carmen	Villahermosa to: Around the city, Palenque, Cardenas.	Villahermosa to: Around the city, cardenas, Ciudad de México	Villahermosa to: Around the city, Veracruz-Mérida, Ciudad de Mexico-Mérida, Cancun.	Villahermosa to: Around the city, cardenas, Ciudad de México to Cancún and Mérida.	Villahermosa to: Around the city, cardenas, Ciudad de México to Cancún and Mérida.	Villahermosa to: Around the city, Ciudad de México, Mérida, Cancún.
Age of transport (Biggest %)	1 to 5 years old (43.52 %), 5 to 10 years old (29.55%)	1 to 5 years old (37.2 %), 5 to 10 years old (24.7%)	1 to 5 years old (29.5 %), more than 20 years old (29.25%)	1 to 5 years old (28.51 %), more than 20 years old (26.7%), 5 to 10 years old (24.88%)	1 to 5 years old (33.01 %), more than 20 years old (28.56%)	5 to 10 years old (39.87%), 1 to 5 years old (21.31) %), (29.25%)	1 to 5 years old (50.85 %), 5 to 10 years old (28.9)

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Weekends:

Description of 2 axes vehicles

Graphic V.13. Type of cargo, 2 axes, weekends.

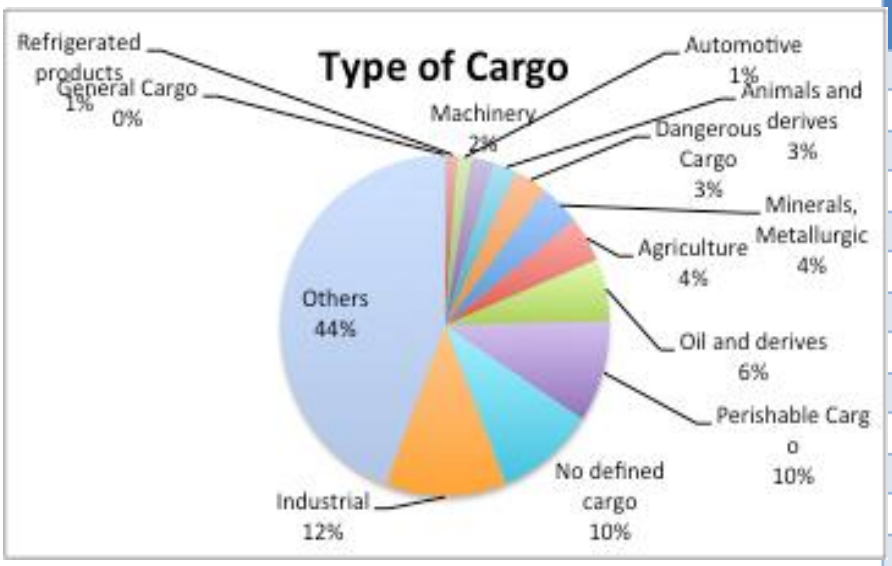


Table V.27. Balance of inter-regional transport of 2 axes, weekends.

Locations	B. Of Inter-Regional T
Centro (Villahermosa)	-0.41
Mérida, Yucatán	-0.08
Cárdenas, Tabasco	-0.06
Cancún, Quintana roo	-0.04
Monterrey N. L.	-0.01
Puebla, Puebla	-0.01
Reynosa, Tamaulipas	-0.01
Nuevo Laredo, Tamaulipas	0
Tijuana, B.C.	0
Torreón, Coahuila	0
Coatzacoalcos, Veracruz.	0.02
Ciudad de México	0.03
Veracruz, Veracruz	0.03
Macuspana, Tabasco	0.07
Comalcalco, Tabasco	0.09
Centla, Tabasco	0.19
Cunduacán, Tabasco	0.19

Table V.28. Most used corridors, 2 axes, weekends.

Road Corridor	%
Villahermosa - Macuspana	1.13
Teapa - Paraiso	1.13
Puebla - Villahermosa	1.13
Tijuana - Cancún	1.13
Cardenas (Around the City)	1.69
Villahermosa - Cardenas	1.69
Villahermosa - Ciudad del Carmen	1.69
Villahermosa - Merida	1.69
Ciudad de México - Cancún	1.69
Villahermosa - Cunduacan	2.26
Ciudad de Mexico - Villahermosa	2.26
Villahermosa (Around the City)	3.95
Villhaermosa - Centla	3.95
Villhaermosa - Paraiso	3.95
Ciudad de México - Merida	5.08
Villahermosa - Comalcalco	9.6

Table V.29. Empty travels, 2 axes, weekends.

2 AXES	
EMPTY	42.18
WITH CARGO	57.82

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of pick-ups

Graphic V.14. Type of cargo, pick-ups, weekends.

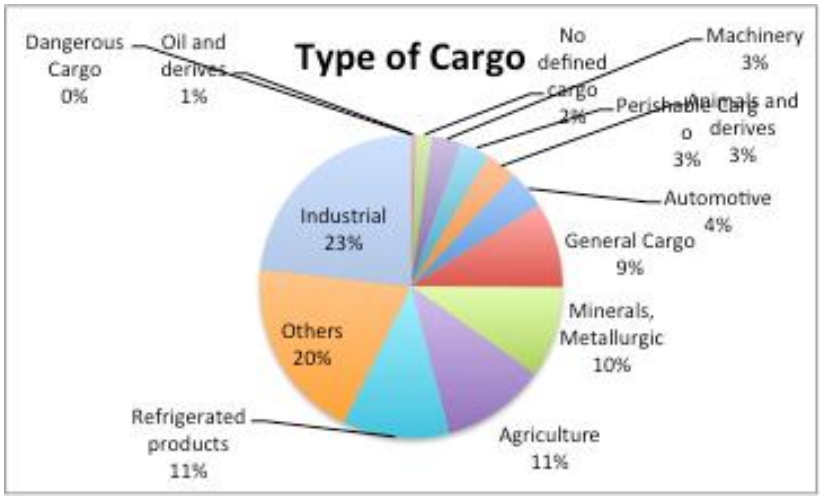


Table V.31. Most used corridors, pick-ups, weekends.

Road Corridor	%
Cunduacan - Cardenas	1
Villahermosa - Cardenas	1.1
Villahermosa - Palenque	1.1
Villahermosa- Jalapa (Tabasco)	1.2
Villahermosa - Teapa	1.2
Villahermosa - Macuspana	1.4
Villahermosa - Ciudad del Carmen	1.8
Cunduacan (Around the City)	2.1
Villhaermosa - Paraiso	2.4
Cardenas (Around the City)	4
Macuspana (Around the City)	4.1
Villahermosa - Cunduacan	4.3
Villahermosa - Comalcalco	5.91
Villahermosa (Around the City)	15.82
Villhaermosa - Centla	15.82

Table V.30. Balance of inter-regional transport of pick-ups, weekends.

Locations	B. Of Inter-Regional T
Centla, Tabasco	-0.58
Macuspana, Tabasco	-0.11
Cancún, Quintana roo	-0.04
Cárdenas, Tabasco	-0.04
Monterrey N. L.	0
Nuevo Laredo, Tamaulipas	0
Tijuana, B.C.	0
Torreón, Coahuila	0
Ciudad de México	0.01
Puebla, Puebla	0.01
Reynosa, Tamaulipas	0.01
Veracruz, Veracruz	0.01
Coatzacoalcos, Veracruz.	0.04
Mérida, Yucatán	0.04
Comalcalco, Tabasco	0.17
Cunduacán, Tabasco	0.31
Centro (Villahermosa)	0.6

Table V.32. Empty travels, pick-ups, weekends.

PICK-UPS	%
EMPTY	43.44
WITH CARGO	56.56

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 3 axes vehicles

Graphic V.15. Type of cargo, 3 axes, weekends.

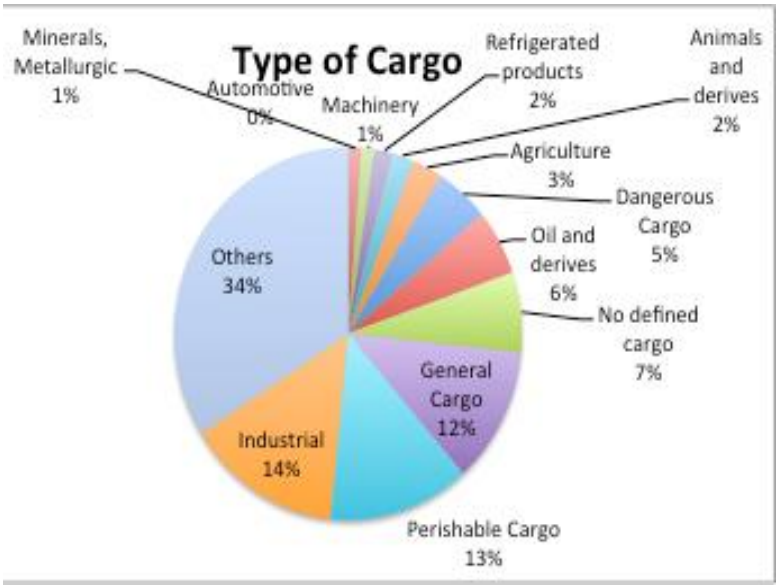


Table V.34. Most used corridors, 3 axes, weekends.

Road Corridor	%
Cunduacan - Cardenas	1.17
Villhaermosa - Centla	1.17
Villahermosa - Tenosique	1.17
Ciudad de México - Cancún	1.17
Macuspana (Around the City)	1.56
Cunduacan (Around the City)	1.56
Villahermosa - Cardenas	1.56
Villahermosa - Teapa	1.56
Villahermosa - Palenque	1.56
Ciudad de Mexico - Villahermosa	1.95
Ciudad de Mexico - Ciudad del Carmén	1.95
Cardenas (Around the City)	2.33
Villahermosa - Macuspana	2.71
Villahermosa (Around the City)	2.72
Villahermosa - Cunduacan	2.72
Villahermosa - Merida	4.25
Ciudad de México - Merida	4.67
Villhaermosa - Paraiso	5.06
Villahermosa - Comalcalco	10.12

Table V.33. Balance of inter-regional transport of 3 axes, weekends.

Locations	B. Of Inter-Regional T
Mérida, Yucatán	-0.16
Centro (Villahermosa)	-0.09
Cunduacán, Tabasco	-0.04
Centla, Tabasco	-0.03
Veracruz, Veracruz	-0.03
Cancún, Quintana roo	-0.02
Coatzacoalcos, Veracruz.	-0.01
Monterrey N. L.	0
Reynosa, Tamaulipas	0
Tijuana, B.C.	0
Nuevo Laredo, Tamaulipas	0.01
Torreón, Coahuila	0.01
Comalcalco, Tabasco	0.02
Cárdenas, Tabasco	0.04
Puebla, Puebla	0.08
Macuspana, Tabasco	0.11
Ciudad de México	0.12

Table V.35. Empty travels, 3 axes, weekends.

2 AXES	
EMPTY	42.18
WITH CARGO	57.82

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 4 axes vehicles

Graphic V.16. Type of cargo, 4 axes, weekends.

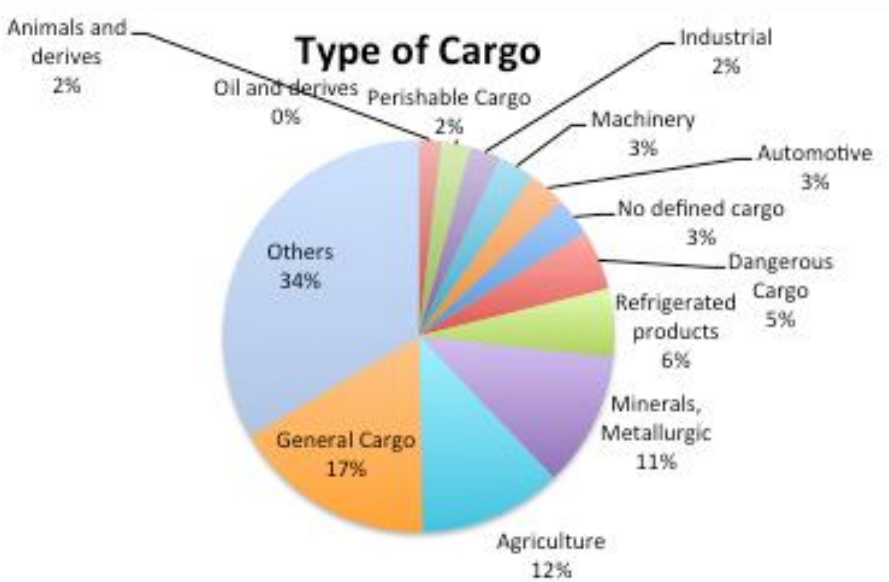


Table V.37. Most used corridors, 4 axes, weekends.

Road Corridor	%
Villahermosa - Macuspana	1.13
Teapa - Paraiso	1.13
Puebla - Villahermosa	1.13
Tijuana - Cancún	1.13
Cardenas (Around the City)	1.69
Villahermosa - Cardenas	1.69
Villahermosa - Ciudad del Carmen	1.69
Villahermosa - Merida	1.69
Ciudad de México - Cancún	1.69
Villahermosa - Cunduacan	2.26
Ciudad de Mexico - Villahermosa	2.26
Villahermosa (Around the City)	3.95
Villhaermosa - Centla	3.95
Villhaermosa - Paraiso	3.95
Ciudad de México - Merida	5.08
Villahermosa - Comalcalco	9.6

Table V.36. Balance of inter-regional transport of 4 axes, weekends.

Locations	B. Of Inter-Regional T
Centla, Tabasco	-0.07
Mérida, Yucatán	-0.06
Cancún, Quintana roo	-0.04
Coatzacoalcos, Veracruz.	-0.04
Cunduacán, Tabasco	-0.04
Cárdenas, Tabasco	-0.01
Macuspana, Tabasco	-0.01
Nuevo Laredo, Tamaulipas	-0.01
Puebla, Puebla	-0.01
Tijuana, B.C.	0.01
Torreón, Coahuila	0.01
Monterrey N. L.	0.02
Reynosa, Tamaulipas	0.03
Veracruz, Veracruz	0.03
Comalcalco, Tabasco	0.05
Centro (Villahermosa)	0.09
Ciudad de México	0.12

Table V.38. Empty travels, 4 axes, weekends.

4 AXES	%
EMPTY	33.9
WITH CARGO	66.1

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 5 axes vehicles

Graphic V.17. Type of cargo, 5 axes, weekends.

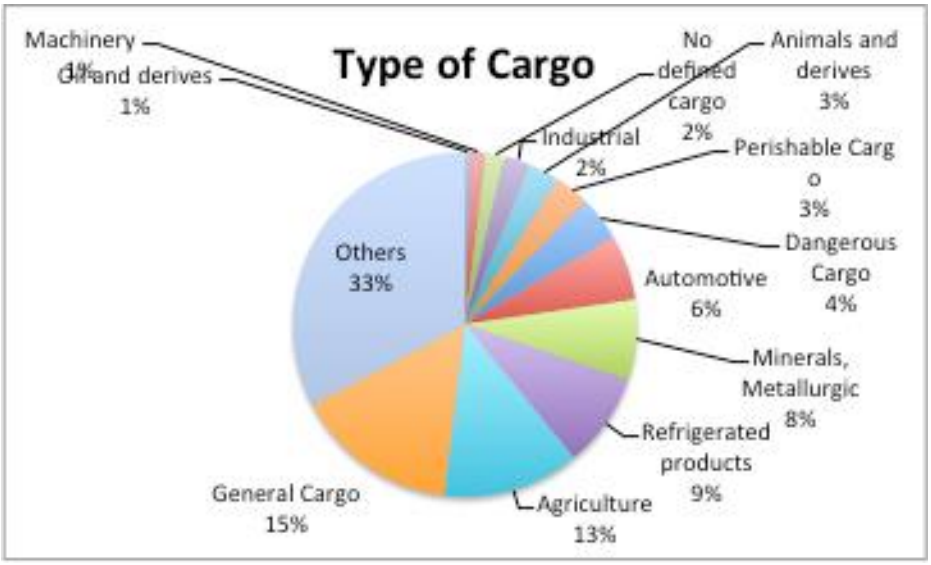


Table V.39. Balance of inter-regional transport of 5 axes, weekends.

Locations	B. Of Inter-Regional T
Mérida, Yucatán	-0.23
Centro (Villahermosa)	-0.16
Cárdenas, Tabasco	-0.12
Coatzacoalcos, Veracruz.	-0.07
Cunduacán, Tabasco	-0.04
Cancún, Quintana roo	-0.03
Veracruz, Veracruz	-0.03
Ciudad de México	-0.02
Macuspana, Tabasco	-0.01
Nuevo Laredo, Tamaulipas	-0.01
Tijuana, B.C.	0
Puebla, Puebla	0.01
Torreón, Coahuila	0.01
Centla, Tabasco	0.02
Reynosa, Tamaulipas	0.03
Monterrey N. L.	0.05
Comalcalco, Tabasco	0.13

Table V.40. Most used corridors, 5 axes, weekends.

Road Corridor	%
Veracruz - Cancún	1.1
Villahermosa - Macuspana	1.11
Villahermosa - Cardenas	1.33
Villahermosa - Teapa	1.33
Villahermosa - Cancún	1.54
Cardenas (Around the City)	1.55
Villhaermosa - Centla	1.77
Teapa - Paraiso	2.21
Villahermosa - Ciudad del Carmen	2.21
Villahermosa - Comalcalco	3.54
Villahermosa - Merida	3.54
Ciudad de México - Merida	4.2

Table V.41. Empty travels, 5 axes, weekends.

5 AXES	%
EMPTY	39.25
WITH CARGO	60.75

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Description of 6-9 axes vehicles

Graphic V.18. Type of cargo, 6-9 axes, weekends.

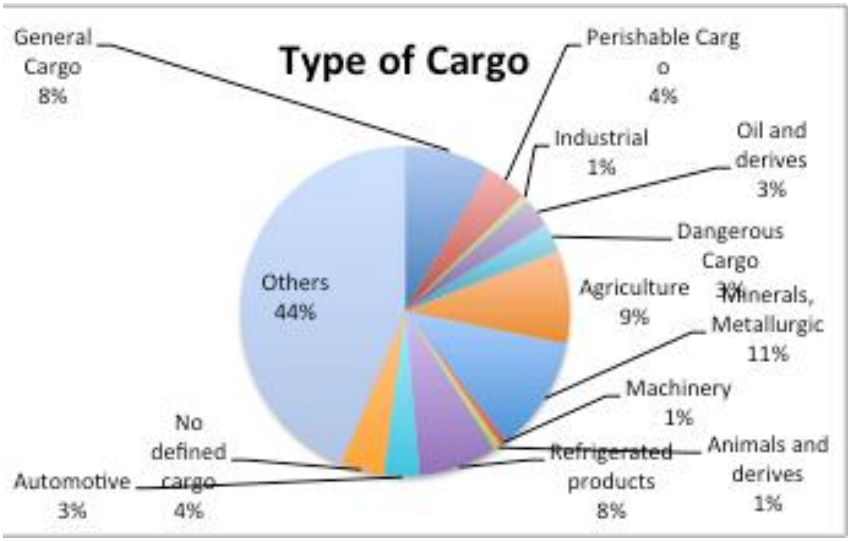


Table V.42. Balance of inter-regional transport of 6-9 axes, weekends.

Locations	B. Of -Regional T
Centro (Villahermosa)	-0.12
Mérida, Yucatán	-0.07
Cancún, Quintana roo	-0.04
Comalcalco, Tabasco	-0.04
Cunduacán, Tabasco	-0.04
Centla, Tabasco	-0.02
Coatzacoalcos, Veracruz.	-0.01
Puebla, Puebla	-0.01
Monterrey N. L.	0
Reynosa, Tamaulipas	0
Tijuana, B.C.	0
Torreón, Coahuila	0
Nuevo Laredo, Tamaulipas	0.01
Veracruz, Veracruz	0.01
Cárdenas, Tabasco	0.04
Macuspana, Tabasco	0.06
Ciudad de México	0.07

Table V.43. Most used corridors, 6-9 axes, weekends.

Road Corridor	%
Tijuana - Cancún	1.13
Cunduacan - Coatzacoalcos	1.32
Villahermosa - Coatzacoalcos	1.32
Villahermosa - Merida	1.32
Puebla - Villahermosa	1.32
Macuspana (Around the City)	1.99
Villhaermosa - Centla	1.99
Villhaermosa - Paraiso	1.99
Villahermosa - Ciudad del Carmen	1.99
Ciudad de Mexico - Villahermosa	1.99
Merida - Coatzacoalcos	2.65
Ciudad de México - Merida	2.65
Villahermosa - Cardenas	3.31
Villahermosa - Macuspana	3.97
Villahermosa - Comalcalco	7.95

Table V.44. Empty travels, 6-9 axes, weekends.

6 - 9 AXES	%
EMPTY	38.41
WITH CARGO	61.59

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

o

Description of double trailer vehicles

Graphic V.19. Type of cargo, double trailer, weekends.

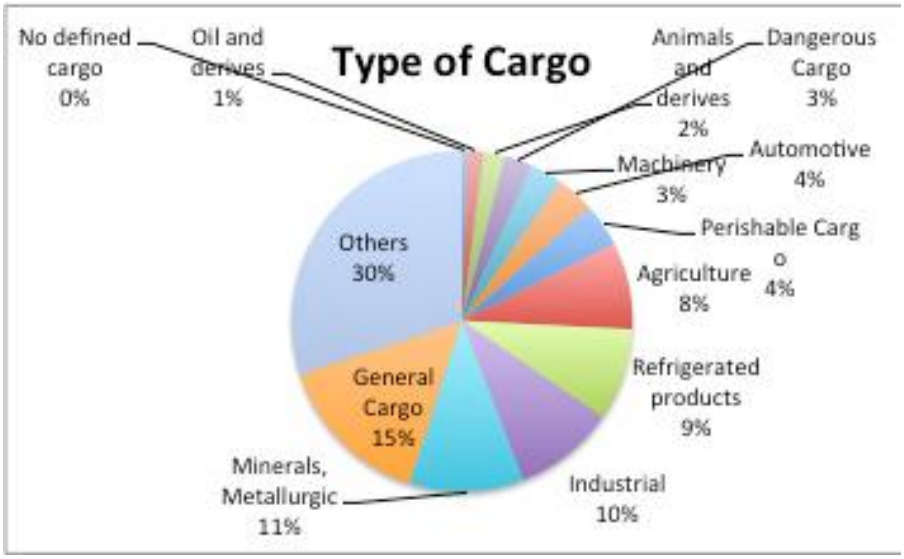


Table V.45. Balance of inter-regional transport of double trailer, weekends.

Locations	B. Of Inter-Regional T
Coatzacoalcos, Veracruz.	-0.07
Mérida, Yucatán	-0.05
Cancún, Quintana roo	-0.01
Puebla, Puebla	-0.01
Reynosa, Tamaulipas	-0.01
Veracruz, Veracruz	-0.01
Centro (Villahermosa)	0
Nuevo Laredo, Tamaulipas	0
Tijuana, B.C.	0
Torreón, Coahuila	0
Centla, Tabasco	0.01
Ciudad de México	0.02
Comalcalco, Tabasco	0.02
Macuspana, Tabasco	0.03
Cunduacán, Tabasco	0.04
Monterrey N. L.	0.04
Cárdenas, Tabasco	0.05

Table V.46. Most used corridors, double trailer, weekends.

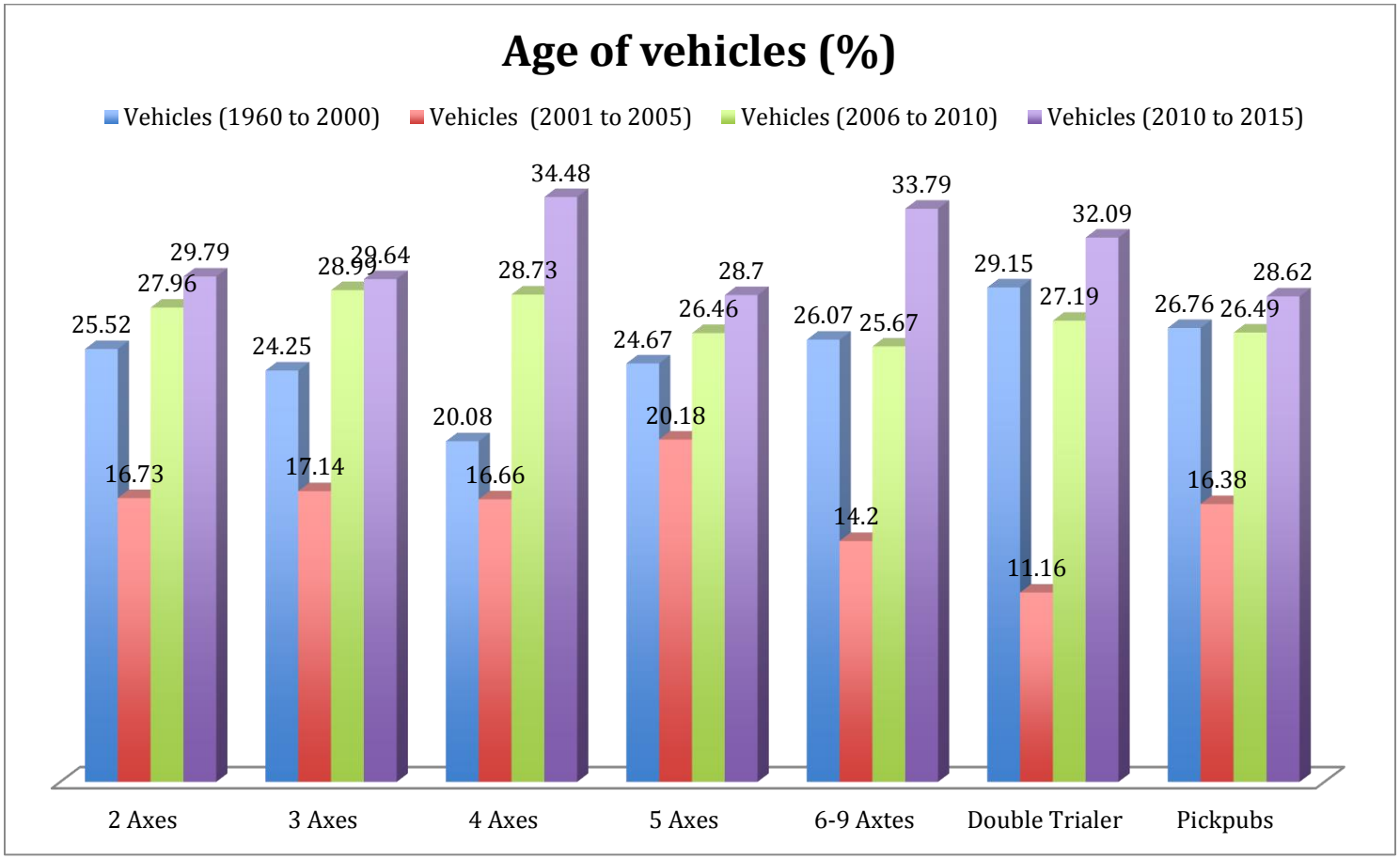
Road Corridor	%
Macuspana (Around the City)	1.44
Villahermosa - Cardenas	1.44
Villahermosa - Tuxtla Gutierrez	1.44
Merida - Coatzacoalcos	1.44
Villahermosa - Comalcalco	1.92
Villahermosa - Cancún	1.92
Monterrey - Cancún	1.92
Villahermosa - Ciudad del Carmen	2.4
Ciudad de México - Merida	2.88

Table V.47. Empty travels, double trailer, weekends.

DOUBLE T.	%
EMPTY	38.46
WITH CARGO	61.54

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Graphic V.20. Age of vehicles during the week.



Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Table V.48. Summary of the important results, weekends:

	2 Axe	Pick-ups	3 Axes	4 Axes	5 Axes	6-9 Axes	Double trailer.
Most transported type of cargo	Industrial (12%), Perishable (10%).	Industrial (23%), Agriculture (11%), Mineral, Metallurgic (10%)	Industrial (14%), Perishable Cargo (13%).	Agriculture (12%) Minerals Metallurgic (11%).	Agriculture (13%), Refrigerated products (9%), Minerals Metallurgic (8%).	Minerals, metallurgic (11%), Agriculture (9%), Refrigerated products (8%).	Minerals, Metallurgic (11%), Industrial (10%), Refrigerated products (9%)
Good logistic	Nuevo Laredo, Tijuana, Torreón	Monterrey, Nuevo Laredo, Tijuana, Torreon.	Monterrey, Reynosa, Tijuana.		Tijuana.	Monterrey, Reynosa, Tijuana, Torreón.	Villahermosa, Nuevo Laredo, Tijuana, Torreón.
Bad logistic	Villahermosa, Merida, Cunduacán, Centla.	Centla, Macuspana, Villahermosa, Merida, Cancun.	Mérida, Villahermosa, Ciudad de México, Puebla, Macuspana.	Centla, Mérida, Ciudade de México, Villahermosa.	Merida, Villahermosa, Comalcalco.	Villahermosa, Mérida, Cancún, Ciudade de México.	Coatzacoalcos, Mérida, Cancún, Cardenas, Monterrey.
% Of empty travels	42.18%	43.44%	42.18%	33.9%	39.25%	38.41%	38.46%
Most used corridors	Ciudad de México-Merida, Villahermosa-Around the city	Villahermosa to: Around the city.	Villahermosa to: Around the city, Merida, Ciudad de México	Villahermosa to: Around the city, Ciudad de México to Merida.	Ciudad de México-Merida, Villahermosa-Mérida.	Villahermosa to: Around the city, cardenas, Ciudad de México to Mérida	Ciudad de México-Merida, Villahermosa-Ciudad del Carmen, Monterrey-Cancún.
Age of transport (Biggest %)	1 to 5 years old (43.52 %), 5 to 10 years old (29.55%)	1 to 5 years old (28.62.2 %), more than 20 years old (26.76%), 5 to 10 years old (26.49%)	1 to 5 years old (29.64 %), 5 to 10 years (28.99%), more than 20 years old (24.25.25%)	1 to 5 years old (34.5%), 5 to 10 years old (28.73%)	1 to 5 years old (28.7 %), 5 to 10 years old (26.43%) more than 20 years old (24.67%)	5 to 10 years old (32.09%), More than 20 years old (29.15) %)	1 to 5 years old (28.62%), 5 to 10 years old (28.9)

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

Now that we have the results in the last tables and graphics of the Tabasco's case and analysed them in the summary of the table 5.26, during the week, and 5.49 for weekends, we can conclude that the freight transport has different kinds of cargo but specifically: Perishables, Construction Material, Industrial are the must claimed for transport during the week in every kind of vehicle, and for weekends are; industrial and perishable for small vehicles, minerals metallurgical an refrigerated products for vehicles of 4 or more axes.

We discovered that a few cities have great logistics, they send an receive the same amount of products, those cities are;

Cancún, Jalapa Tab for small vehicles (2 to 3 axes), and for every vehicle is Monterrey and Nuevo Laredo, also Toluca and Puebla for big vehicles during the week,

For weekends we have: Monterrey, Nuevo Laredo and Tijuana for every kind of vehicle.

Bad logistic presents in cities like:

Villahermosa and all cities around of Villahermosa for vehicles of 2 to 3 axes, Mérida, Ciudad de México and Ciudad del Carmen for vehicles of 4 and more axes, during the week, for weekends; Villahermosa, Cancun, Mérida for every axe, Ciudad de México for 3 and 4 axes.

Empty travels is a big problem for weekends, at least we have 34% and a maximum of 42.18% of them are more than 20 years old, during the week is a big problem with pickups with 52.84% and for double trailer is 35.78%, the other axes has a problem but no so dramatic like the others two we mentioned.

The most used road corridors are; obviously all those around Villahermosa and in the interior of this city (normal since the surveys were made there), other corridors are those used to go to México city, Mérida, Cancun, Veracruz, Puebla, Nuevo Laredo, Tijuana, Torreon and Monterrey. Something worth to mention is that on weekends, the long distances are more frequent than during the week.

And for the last variable but not less important, the age of vehicles, during the week the vehicles of 3, 5 to 9 axes and double trailer are really old, with an average of 29% of vehicles of more than 20 years old. For weekend we found the same average of 29% of more than 20 years old problem but just with 6 to 9 axes and double trailer, so we can observe that with big and heavy cargo we have a lot of old vehicles.

C.- Behaviour of the carbon emissions in the case of Tabasco.

Table V.49. Carbon emissions per year (Tons), during the week.

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	8982	7706	13506	852257	335479	479653	10748	1708330
Mediums 2000 to 3999 kgs	4779	9060	1822	227453	54548	108046	6299	412006
Largess 4000 to 6999 Kgs	4578	11716	12316	444243	64112	310603	2584	850152
X-Larges 7000 a 16000 Kgs	9295	69463	51324	13740218	7743476	5047842	35301	26696920
Vacias	7973	33629	13619	2320715	666789	1631820	36946	4711490
Total	**35608**	**131574**	**92587**	**17584886**	**8864404**	**7577963**	**91877**	**34378899**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

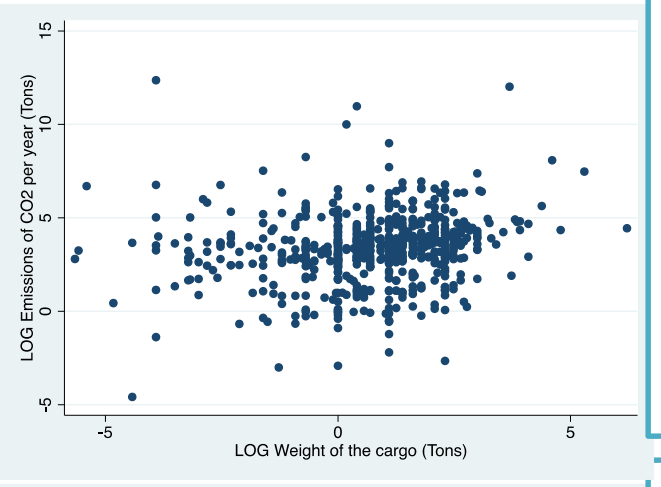
Table 5.50. Carbon emissions per year (Tons), weekends.

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	2366	6040	8206	1055402	983115	183767	6184	2245080
Mediums 2000 to 3999 kgs	2953	2064	23568	284772	577752	119375	1811	1012295
Largess 4000 to 6999 Kgs	1393	678	4355	4165593	267029	268524	2712	4710284
X-Larges 7000 a 16000 Kgs	13202	45135	49886	10680307	4409236	9746991	56452	25001209
Vacias	1413	9840	9404	3550634	688900	3433939	9456	7703587
Total	**21327**	**63757**	**95419**	**19736708**	**6926032**	**13752595**	**76615**	**40672454**

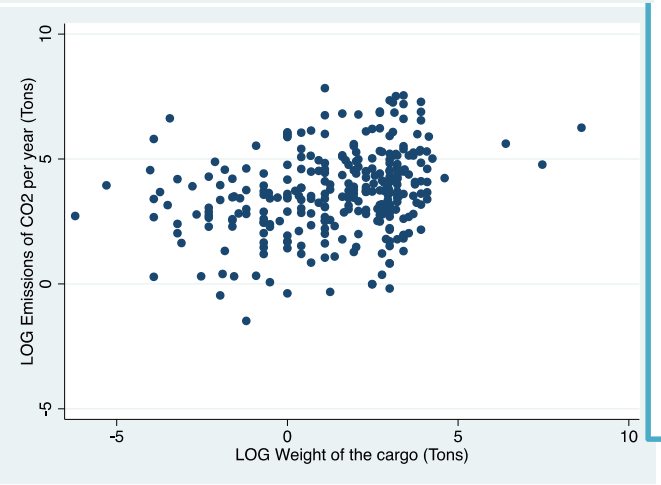
Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014.

In the tables 5.50 and 5.51 we can observe the CO2 emissions per year for our two classification, during the week and weekends, in a simple analysis we can conclude that with small vehicles the emissions are less than with the biggest vehicles, with the heaviest cargos we observe that the CO2 emissions are higher than in the lighter cargo. To have detailed conclusions we will analyse every behaviour of the axes:

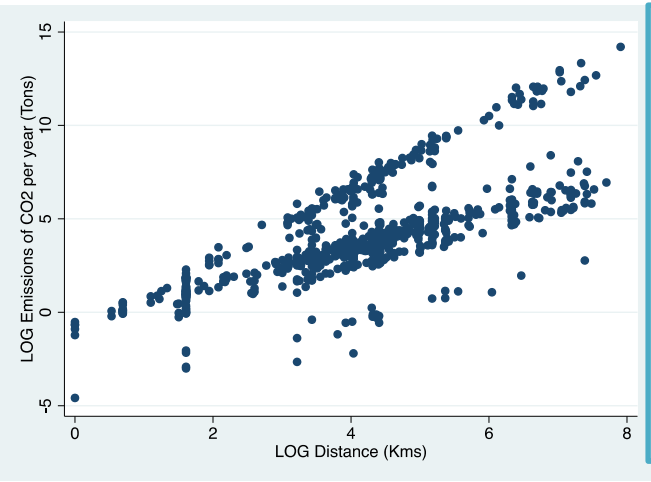
Graphic V.21. Resume of behavior, 2 axes: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



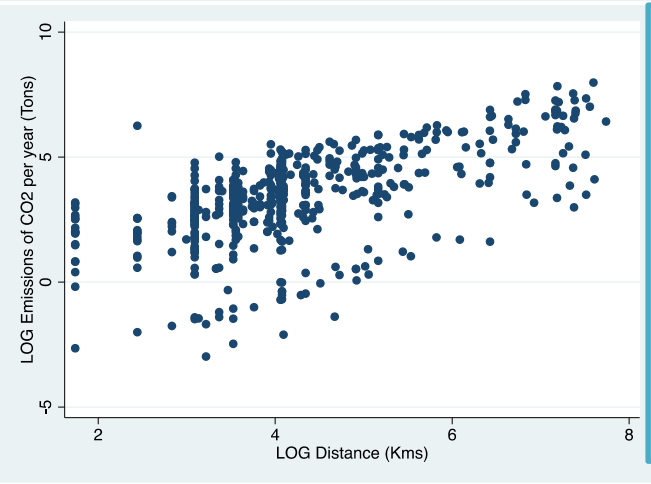
With more cargo, we have more emissions of CO2, but it will be proportional to the weight of the cargo. More emissions are caused by the frequency during the year with medium weights than with low frequency and big cargo.



On weekends, big cargos will produce more emissions of CO2, but it will be proportional to the weight of the cargo. More emissions are caused by the frequency during the year, in this case not just with small cargos, with mediums also.



With large distances, we have more emissions of CO2. Frequency is affecting the emissions caused by some large distances

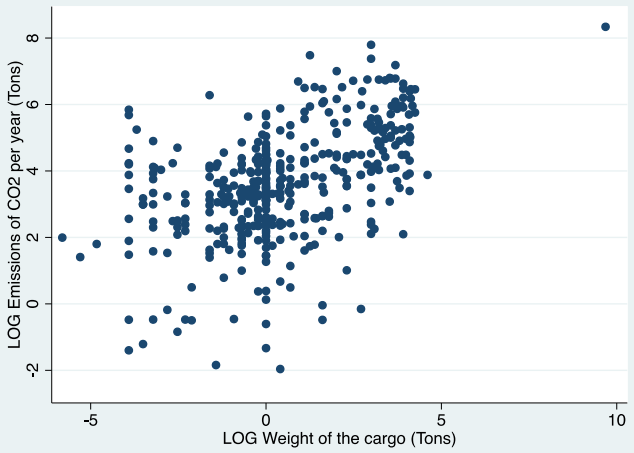


With large distances, we have more emissions of CO2. Frequency is not affecting the emissions caused by large distances.

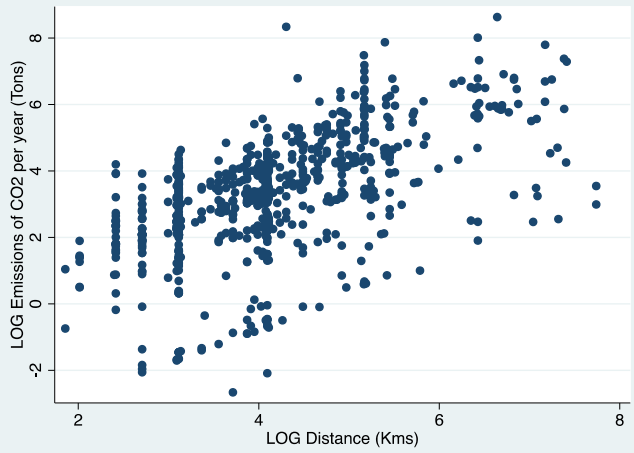
*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

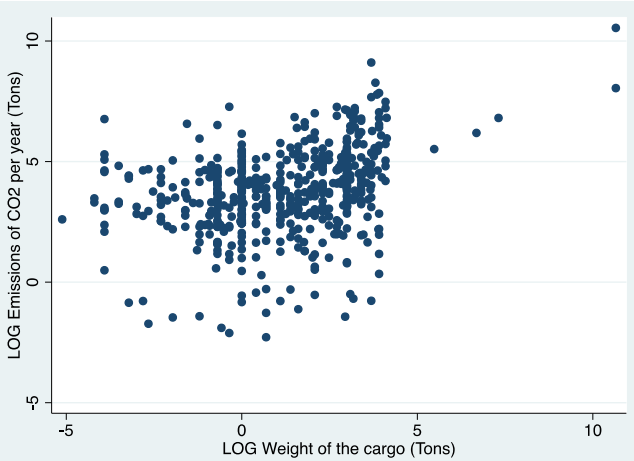
Graphic V.22. Resume of behavior, pickups: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



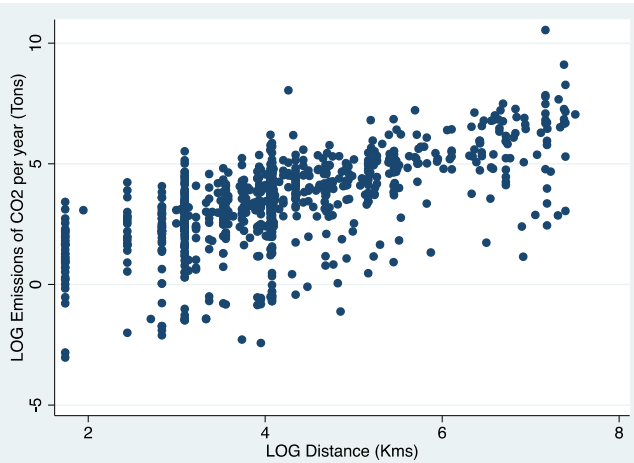
With more cargo more emissions of CO2, but it will be proportional to the weight of the cargo. We will have more emissions caused by the frequency during the year, in this case frequency affects all kind of weights of cargo.



With large distances, will be more emissions of CO2. Frequency is affecting the emissions caused by small and medium distances, but for large distances it doesn´t affect to much.



On weekends, all sizes of cargo will produce proportional emissions of CO2, more emissions caused by the frequency during the year on medium and smalls sizes.

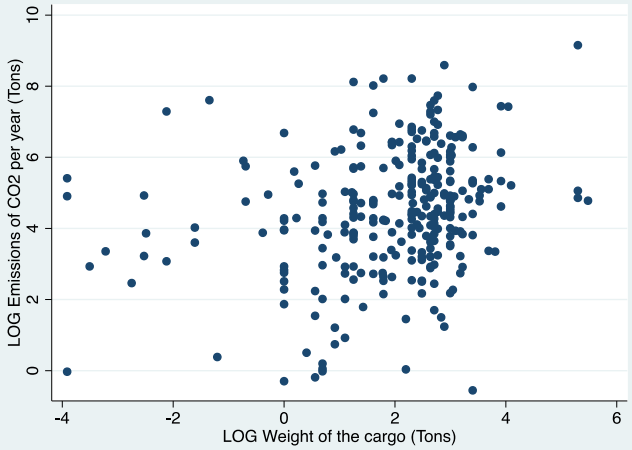


With large distances, more emissions of CO2, frequency is not affecting the emissions caused by small and medium distances, just with large ones.

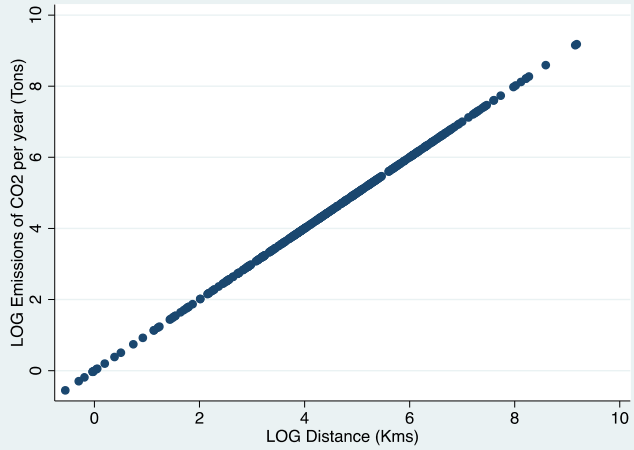
*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

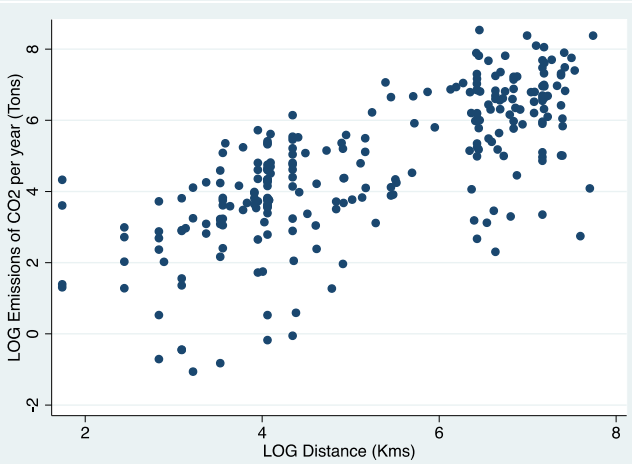
Graphic V.23. Resume of behavior, 3 axes: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



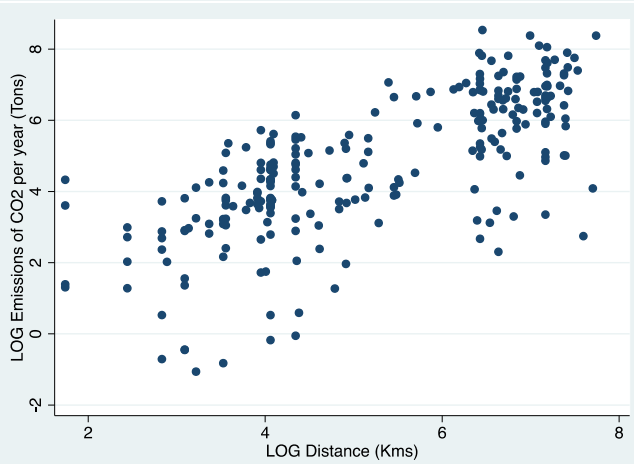
The emission of CO2 will be proportional to the weight of the cargo. Also will be more emissions caused by the frequency during the year, in this case frequency affects mediums sizes of cargo.



On weekends, all sizes of cargo will have a linear behavior of CO2 emissions. More emissions caused by more distance, frequency is not affecting the variables.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We will have more emissions caused by the frequency during the year, of all sizes of cargo.

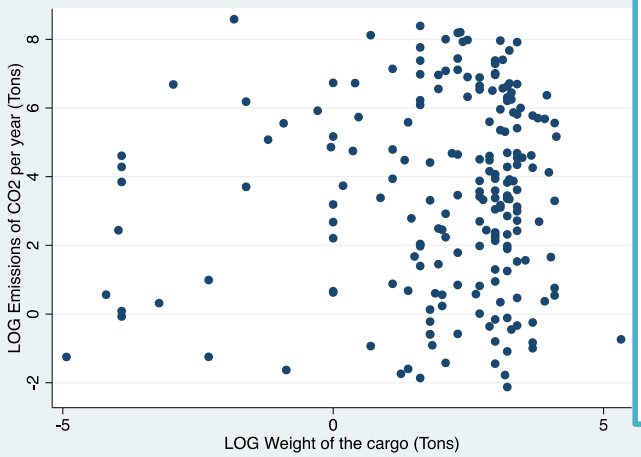


On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance.

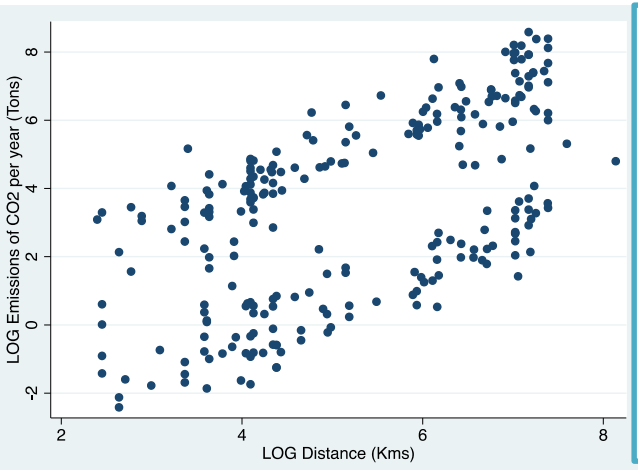
*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

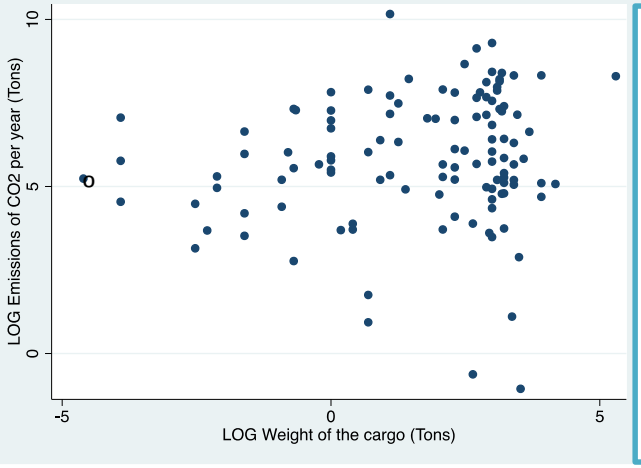
Graphic V.24. Resume of behavior, 4 axes: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



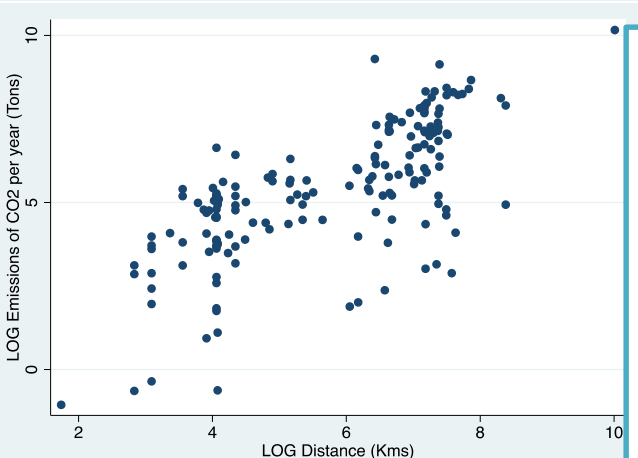
The emission of CO2 will be proportional to the weight of the cargo. More emissions caused by the frequency during the year, in this case frequency affects just medium weights of cargo.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with large and medium distances.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year, especially with medium cargos



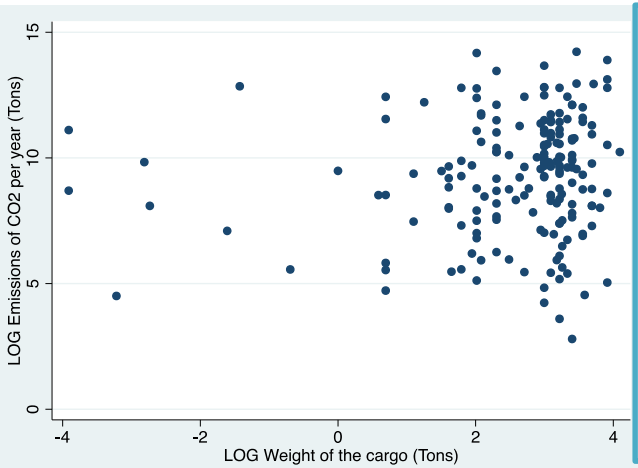
All sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance. On weekend, large distances are more than during the week.

*** First two graphics for during the week.**
****Second two graphics for weekends.**

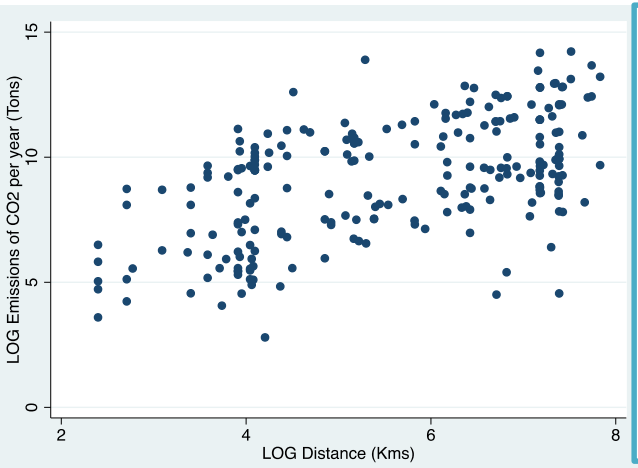
Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

Graphic V.25. Resume of behavior, 5 axes: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)

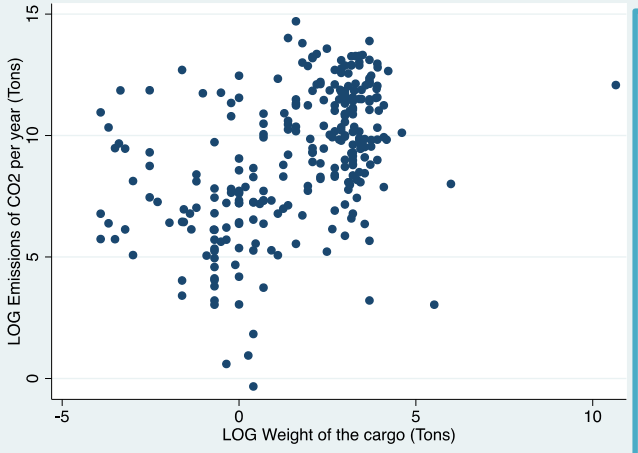
e



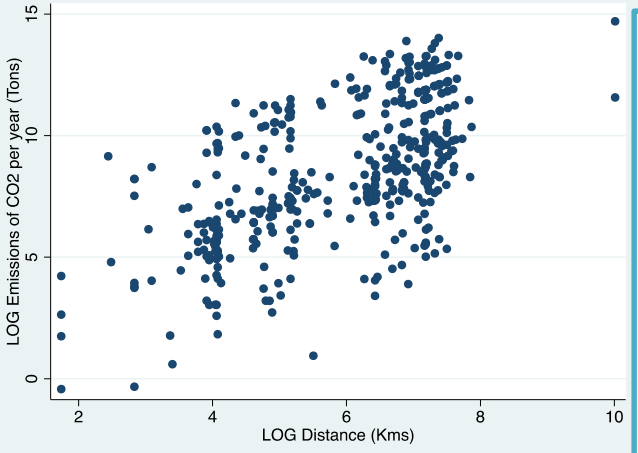
The emission of CO2 will be proportional to the weight of the cargo. More emissions caused by the frequency during the year, in this case frequency affects all weight sizes of cargo.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. More emissions caused by the frequency during the year, especially with small and medium cargos

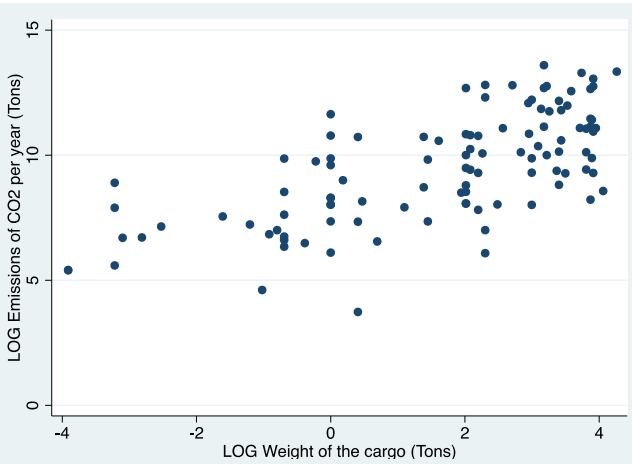


All sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance. On weekend, large distances are more frequents than during the week.

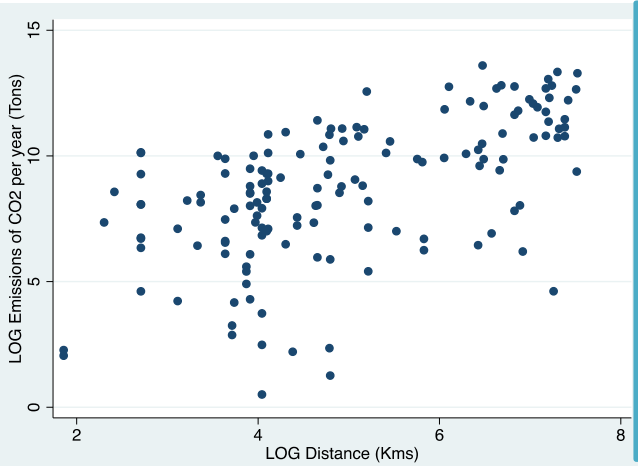
*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

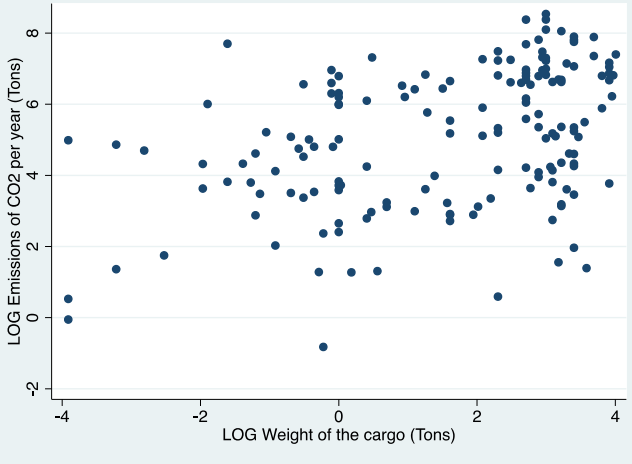
Graphic V.26. Resume of behavior, 6-9 axes: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



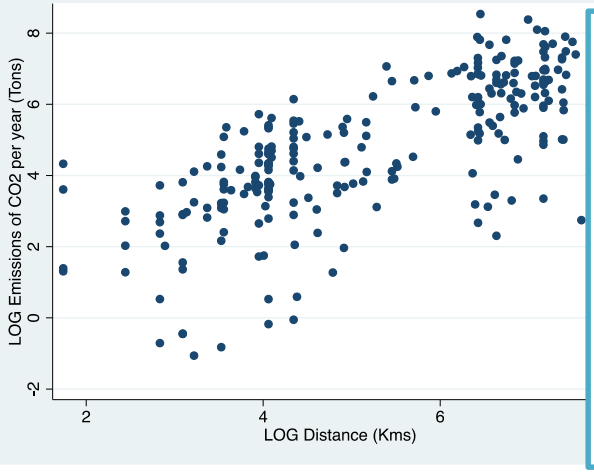
The emission of CO2 will be proportional to the weight of the cargo. Emissions caused by the frequency during the year, in this case frequency affects all weight sizes of cargo.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year, with any sizes of cargo

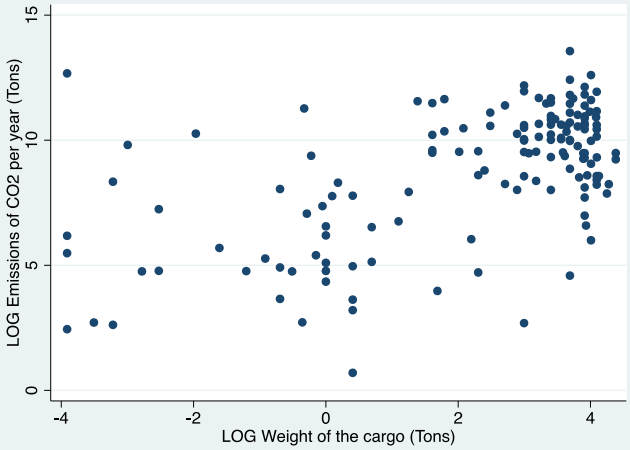


All sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with any distance. On weekend, large distances are more frequents than during the week.

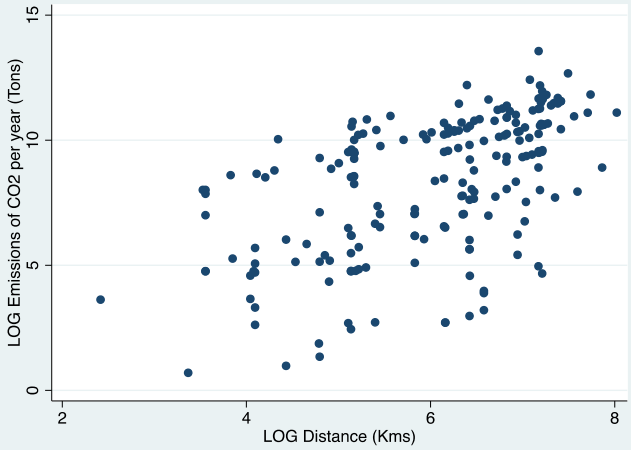
*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

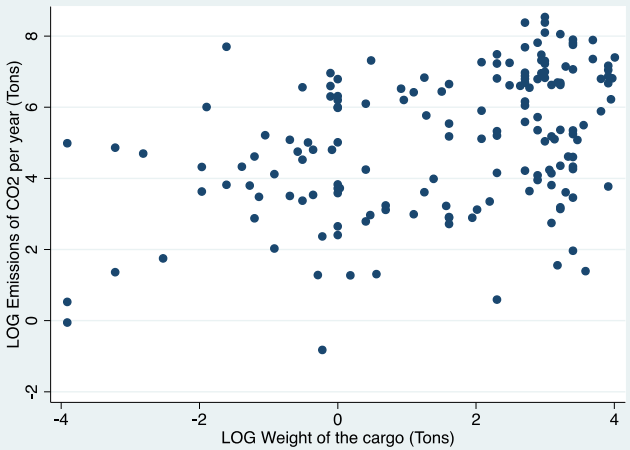
Graphic V.27. Resume of behavior, double trailer: LOG CO2 emissions VS LOG weight of cargo and distance (Case of Tabasco, 2014)



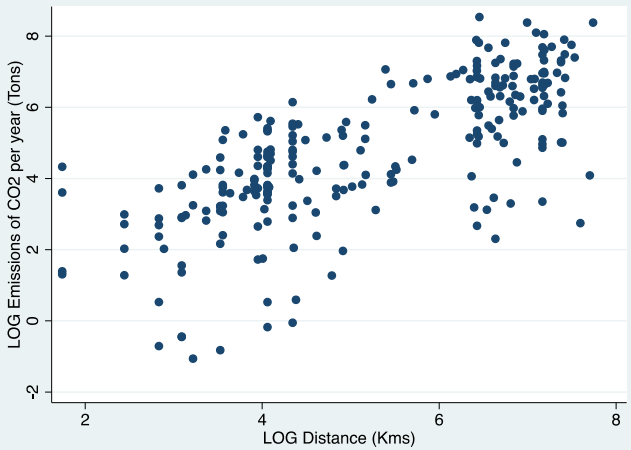
The emission of CO2 will be proportional to the weight of the cargo. More emissions caused by the frequency during the year, in this case frequency affects all weight sizes of cargo.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2; other point is that it will be more emissions caused by the frequency during the year with medium distances.



On weekends, all sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year, with any sizes of cargo



All sizes of cargo will produce a proportional amount of emissions of CO2. We have more emissions caused by the frequency during the year with small and medium distances. On weekend, large distances are more frequents than during the week.

*** First two graphics for during the week.**
****Second two graphics for weekends.**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

Now that we have all the data analysed in the last graphics. The next resume presents the results in a more synthetic and simplified form.

Table V.51. Resume of analysis of CO2 emissions, distances and weight of the cargo, case of Tabasco 2014.

	During the week	**Weekends**
CO2 emissions VS weight of the cargo (tons)	• Frequency affects more small cargos in small vehicles (2 axes and pickups) • Big cargos with small distances are frequent (medium vehicles, 3 and 4 axes). • In big vehicles (5 to 9 axes and double trailers) frequency affects the emissions of all sizes of cargo.	• Frequency affects small sizes of cargo in vehicles of 2 to 3 axes and pickups • On weekends frequency increase the emissions with all sizes of cargo, big vehicles.
CO2 emissions VS distances (kilometers)	• Small distances are frequent during all year. • Large distances are not so frequent in small vehicles. • 3 axes has a linear behaviour, if distances and frequency grows, emissions grows.	• There are more travels with large distances on weekends with all kind of vehicles. • Large distances with big cargos are frequent and they produce a lot of emissions

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

d) Behaviour of the application of the low price of carbon emission.

In Mexico we don´t have a price per ton of CO2 and we can´t observe the behavior if we apply the price we are suggesting, this is because we don´t have an official system to measure all the CO2 emissions of the freight transport in the country, without this data is really hard to try to calculate the elasticity of carbon emissions. Just to have an idea we applied two different prices to calculate the potential cost of a carbon tax necessary to reduce CO2 emissions and which could have an important impact competitiveness and try to reduce the emissions of CO2.

Table 5.52. Application of 20 Dls prices emissions, during the week

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	179638	154122	270120	17045141	6709576	9593050	214960	34166608
Mediums 2000 to 3999 kgs	95580	181210	36434	4549053	1090954	2160926	125973	8240130
Largess 4000 to 6999 Kgs	91559	234319	246327	8884863	1282241	6212058	51679	17003046
X-Larges 7000 a 16000 Kgs	185909	1389261	1026486	274804369	154869521	100956830	706021	533938397
Vacias	159467	672576	272374	46414295	13335781	32636400	738911	94229803
Total in Dollars	**$712,153**	**$2,631,488**	**$1,851,741**	**$351,697,721**	**$177,288,074**	**$151,559,264**	**$1,837,544**	**$687,577,984**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

Table 5.53. Application of 20 Dls prices to CO2 emissions, weekend.

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	77333	168885.143	229434	29738525	22427752	5814640	202072	58658641
Mediums 2000 to 3999 kgs	96504	57710.5252	658955	8024151	13180216	3777204	59170	25853909
Largess 4000 to 6999 Kgs	45512	18956.3745	121775	117375792	6091706	8496486	88621	132238849
X-Larges 7000 a 16000 Kgs	431481	1261959.84	1394797	300943832	100587632	308408859	1844657	714873217
Vacias	46180	275127.494	262944	100047816	15715840	108654781	309006	225311694
Total in Dollars	**$697,010**	**$1,782,639**	**$2,667,904**	**$556,130,116**	**$158,003,145**	**$435,151,969**	**$2,503,527**	**$1,156,936,311**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

e) Behaviour of the application of the high price of carbon emission.

Table 5.54. Application of 40 Dls prices to CO2 emissions, during the week.

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	359277	308244	540240	34090283	13419153	19186100	429920	68333216
Mediums 2000 to 3999 kgs	191160	362420	72867	9098106	2181909	4321852	251945	16480259
Largess 4000 to 6999 Kgs	183117	468639	492654	17769725	2564482	12424116	103358	34006091
X-Larges 7000 a 16000 Kgs	371819	2778521	2052972	549608737	309739042	201913661	1412042	1067876794
Vacias	318933	1345152	544748	92828590	26671562	65272800	1477822	188459607
Total in Dollars	**$1,424,306**	**$5,262,976**	**$3,703,482**	**$703,395,441**	**$354,576,147**	**$303,118,529**	**$3,675,087**	**$1,375,155,968**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

Table 5.55. Application of 40 Dls prices to CO2 emissions, weekends.

Type of Cargo	2 Axes	3 Axes	4 Axes	5 Axes	6-9 Axes	D. Trailer	Pick-ups	Total
Smalls 0 to 1999 kgs	94648	241612	328235	42216062	39324615	7350663	247360	89803195
Mediums 2000 to 3999 kgs	118111	82562	942719	11390883	23110070	4775008	72431	40491784
Largess 4000 to 6999 Kgs	55702	27120	174214	166623721	10681141	10740959	108483	188411340
X-Larges 7000 a 16000 Kgs	528091	1805395	1995435	427212292	176369436	389879631	2258072	1000048352
Vacias	56520	393605	376174	142025362	27556010	137357552	378258	308143483
Total in Dollars	**$712,153**	**$2,550,293**	**$3,816,777**	**$789,468,320**	**$277,041,273**	**$550,103,814**	**$3,064,603**	**$1,626,898,154**

Source: Own elaboration with data of LOGIT, case of Tabasco México, 2014

In conclusion we can only observe the amount of the money that CO2 can produce if we apply a price to the tons of CO2, but analyzing all the data we find out that on weekends a carbon tax would generate more money, mainly because on weekends the freight transport uses large distances and big sizes of cargo.

For this chapter we can conclude that Mexico has many logistics problems, old vehicles and high emissions of C02, those problems are more or less severe in specific kind types of vehicles, periods of time and cities, for example we can find higher emissions on weekends for the medium and big vehicles than during the week (the oldest vehicles are small and medium type of vehicles) Finally as we said before we can observe more emissions on weekends because of the large distances. We will come tack to this in our conclusions chapter.

Chapter VI. Synthesis and final considerations.

Road Freight Transport, Logistics and CO2 Emissions:

Case study of Tabasco, Mexico

Chapter 6. Synthesis and final considerations

Mexico has serious problems with the road freight transport, like absence of organization between men truck and transport companies, old technology of the vehicles, bad logistics of the road travels and the road freight transport in this country is polluting a lot.

Based on the statistic analysis of the case study of Tabasco, we have seen that there are some cities, with bad logistics of freight transport, a lot of pollution and old vehicle technology.

As we mentioned earlier, logistical problems or empty trips cause large amounts of CO2 emissions, in populations with a positive or negative differential in the balance of Inter-Regional Transport, we also have problems with old technology of freight transport vehicles. Policies that have been implemented in Mexico for a renewal of freight transport vehicles have been inadequate or wrong so freight transport with old vehicles keep polluting a lot. Studying the most problematic populations, Mexico City is one of them and it is common that in the national news is mentioned, this city has a lot of pollution problems because of its vehicular transport, as at the federal level or entity, we can see that policies to reduce CO2 emissions are inefficient or they do not exist, as in the case of Tabasco, Yucatan and Quintana ro.

Some countries are trying to reduce the CO2 emissions giving a price to the ton of CO2 and implementing a tax. But what is carbon pricing? A carbon price gives an economic signal and polluters decide what to do with their polluting activity, reduce emissions, or continue polluting and pay for it. Hopefully the environmental goal is achieved in the most flexible and least-cost way to society. In the medium and long term the carbon price will help to stimulate clean technology and market innovation.

There are two main types of carbon pricing:

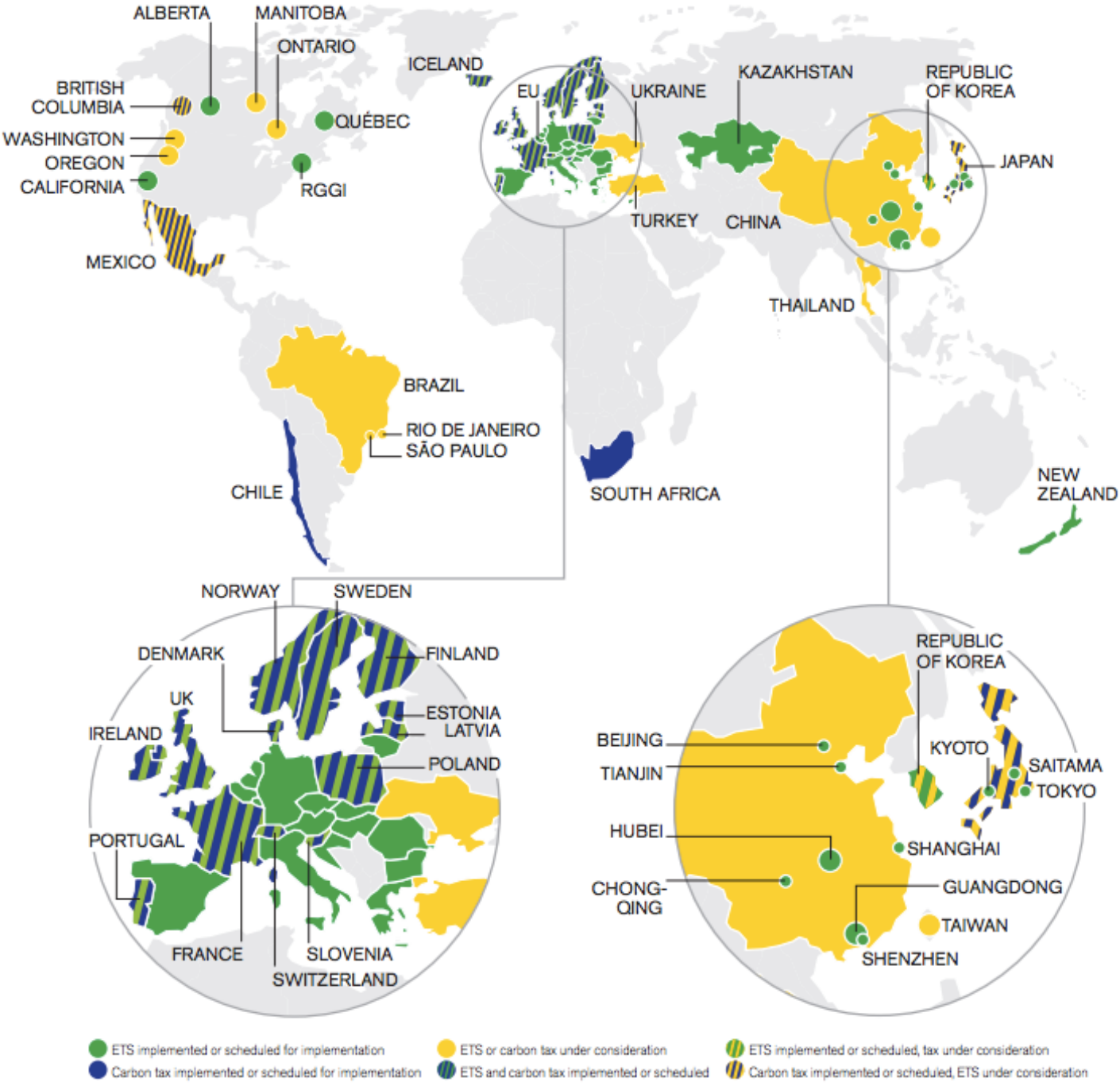
An **ETS (Refers to emissions trading schemes)**: sometimes referred to as a cap-and-trade system – caps the total level of greenhouse gas emissions and allows those industries with

low emissions to sell their extra allowances to larger emitters. By creating supply and demand for emissions allowances, an ETS establishes a market price for greenhouse gas emissions. The cap helps ensure that the required emission reductions will take place to keep the emitters (in aggregate) within their pre-allocated carbon budget (World Bank, 2015).

A **carbon tax** directly sets a price on carbon by defining a tax rate on greenhouse gas emissions or – more commonly – on the carbon content of fossil fuels. It is different from an ETS in that the emission reduction outcome of a carbon tax is not pre-defined but the carbon price is (World Bank, 2015).

In the following countries we can find some examples of pricing carbon emissions:

Figure 6.1. Overview of existing, emerging, and potential regional, national, and subnational carbon pricing instruments (ETS and tax)



Source: World Bank ("State and Trends of Carbon Pricing, 2015"). Note, ETS refers to emissions trading schemes

Ireland:

Ireland promulgates a carbon tax in 2010 under a coalition government of its Green Party, Fianna Fáil (one of Ireland's two mainstay center-right parties) and the Progressive Democrats. This tax was originally to provide a double dividend to income taxes, the revenue was re-allocated to satisfy the Troika orders and suggestion — the triumvirate of the European Commission (EC), International Monetary Fund (IMF) and European Central Bank (ECB) that administered the austerity policies on EU member nations of 2008 debt crisis.

Ireland's carbon tax covers nearly all of the fossil fuels used by homes, offices, vehicles and farms, based on each fuel's CO2 emissions. It began in 2010 at €15/ton and grew to €20/ton in 2012, where it remains today. Solid fuels (carbon) were added in 2013 at €10/ton after concerns from agricultural interests were resolved, and that price has since risen to match the €20 price on other fuels. The tax generates about €400 million annually.

Environmentally and economically, the new taxes have delivered results. Long one of Europe's highest a per-capita producer of greenhouse gases, with levels similar to United States, Ireland has reduces its emissions more than 15 percent since 2008.

Australia

Australia instituted a carbon tax on July 1, 2012 and repealed it two years later, on July 17, 2014. Australian carbon tax was the first *explicit* national tax on carbon emissions. The repeal was also precedent setting, and predictably it has more global attention than did the tax itself.

The tax is $23 per ton (metric ton), corresponding to $19.60 per U.S. ton of CO2, in July 2014.

Chile

In October 2014, Chile promulgated the first climate pollution tax in South America. It is a modest tax, $5 per metric ton of CO2, which applies to only 55% of emissions. It doesn't take effect until 2018. Still, it's a positive first step.

Sweden

In this country, they promulgated a carbon tax emission in 1991. Currently, the tax is $150 per ton of CO2, but no tax is applied to fuels used for electricity generation, and industries are required to pay only 50% of the tax. However, non-industrial consumers pay a separate tax on electricity. Fuels from renewable sources such as ethanol, methane, biofuels, peat, and waste are exempted. As a result the tax led the expansion of the use of biomass for heating and industry.

France

France has no carbon price outside of the price from its participation in the European Union's Emission Trading System. In April 2016, Ségolène Royal, Minister of Environment, Energy and the Sea, issued a declaration calling for the nations of Europe to adopt "a carbon component in the energy tax" of €22 per ton of CO2 emission in 2016, with a price trajectory of €56 per ton in 2020 and €100 ton in 2030.

Canada

British Columbia promulgated its carbon tax on July 1, 2008 at $10 (Canadian) per metric ton of CO2. The tax incremented by $5 per ton annually, reaching its current level of $30 per ton of CO2 in July 2012, or $20.40 (U.S.) per ton of CO2.

Earlier we mentioned the problems of freight transport and the problematic cities we located because of its production of CO2 emissions (or CO2 equivalent). In Mexico, the principal producer of CO2 is the production of electrical energy and in second place is transportation where the road freight is important. We calculated the amounts of the CO2 emission in the freight transport in the eastern corridor of Mexico with help of LOGIT case of Tabasco, which gives us an idea of the economic cost of CO2 emissions, which may be quite high, depending on the price of the ton of CO2. Some countries have already succeeded in imposing carbon taxes. In a near future this type of tax may be inevitable to insure a realistic fight against global warming.

Mexico does not seem to have yet the institutional and political structures to implement such a tax but some measures to diminish emissions could be introduced such as some improvements like:

- Reduce empty travels improving the logistics and get better freight transport in Mexico.
    - Create an organization to:
        - Link all drivers and transport companies to the industry or the market who has the cargo to transport to different points.
        - Create a multi-driver system; with old technology of vehicles, drivers cannot drive long distances, so it could be easier to use different old trucks in different regions on a long road to complete the delivery.
        - Locate different cargos in different regions for drivers who go back home empty.
        - Help with GPS technology for the safety of all drivers and the cargo.
    - Create a platform or internet site for freight transport in México
        - To show cargo an its location.
            - For drivers who need cargo.
        - To show empty drivers.
            - For companies who need transportation to different places.
        - Show prices per kilometer and size of cargo, for transportation.
            - It could help the driver and the company to have a better idea of the transportation market.

Reducing empty travels can reduce CO2 emissions. Other options to reduce the CO2 emissions is to use bio-fuel; they are environmental friendly. Use some new options like in the new company named EMISION MX, this is a company who transform plastics like polyethylene terephthalate to biodiesel, they already produce three kinds of diesel: diesel additive, diesel premium and diesel standard. The innovation here is that this company from Puebla is using recycled material. Only in this city the polyethylene terephthalate is about 13 percent of total garbage or trash generated per month, an amount that could be reused for the production of fuels, and reduce CO2 emissions in the atmosphere, the machine used to transform the materials has capacity to produce 400 liters of biodiesel

per hour and for a period of eight hours. As an example of its potential, it would get enough fuel to supply 40 units of public transport. In addition, the production system is scalable, if is required to increased production " (Centro de Innovación y Competitividad Empresarial (CICE), 2016).

Many options are available to reduce CO2 emissions, but this will take political will and time and probably international political pressures to meet the Paris COP 21 objectives. In a further research it would interesting to measure the potential impact of different levels of a carbon tax on the competitiveness of the road freight sector of Mexico. This would probably be possible calculating the cost of typical freight trips y product with the cost of a carbon tax linked to emissions and eventually make scenarios of with a better truck fleet and better logistics. This could be possible using complementary data collected by LOGIT in 2014 on the origin and destination of goods of the Wholesale Market (*Central de Abasto*) of Villahermosa. However, this exceeded the scope of the present thesis.

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