INFLUENCE OF THE EVOLUTION OF LEGISLATION AND SUPERVISION IN THE IMPACT OF ACCIDENTS WITH ROAD TRANSPORTATION OF HAZARDOUS PRODUCTS

INFLUÊNCIA DA EVOLUÇÃO DA LEGISLAÇÃO E DA FISCALIZAÇÃO NA INCIDÊNCIA DE ACIDENTES COM TRANSPORTE RODOVIÁRIO DE PRODUTOS PERIGOSOS

Osmar Martins de Souza[1]
Sivanilza Teixeira Machado[2]

ABSTRACT

In view of the significant number of truck routes that travel in important avenues of the city of São Paulo, especially those that carry dangerous cargoes, it is of crucial importance the inspection of these vehicles in order to verify their conditions and adjustments to the current safety standards. This paper aims to investigate the inspections and accidents that took place in the period that covers the years 2012 to 2017, and the data collected in the CET database. After calculations based on Pearson's linear correlation and simple linear regression (calculations made from the variables of inspection and accident), it has been verified the correlation between the variables and the formula of the regression line was obtained. In the end, with the data collected and the results obtained, being restricted to those; it was considered that the number of inspections impacts on the amount of accidents, at a discrete level.

Keywords: Hazardous cargo. Road transport. Accident. Inspection.

RESUMO

Em vista do expressivo número de rotas de caminhões que trafegam em importantes avenidas da cidade de São Paulo, especialmente aqueles que transportam cargas perigosas, é de importância crucial a fiscalização desses veículos visando a verificação das suas condições e adequações às normas de segurança vigentes. Este artigo objetiva investigar as fiscalizações realizadas e os acidentes acontecidos no período entre os anos de 2012 até 2017, tendo como base as coletas feitas no banco de dados da CET. Após os cálculos elaborados a partir da correlação linear de Pearson e da regressão linear simples (cálculos executados tendo como referencias as variáveis fiscalização e acidente), constatou-se a correlação negativa entre as variáveis e se obteve a fórmula da reta de regressão. Considerou-se, tendo como suporte os dados coletados e os resultados alcançados, restringindo-se a esses, que, ao final, o número de fiscalizações impacta na quantidade de acidentes, em nível discreto.

Palavras chave: Carga perigosa. Transporte rodoviário. Acidente. Fiscalização.

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[1] Pós-graduando em Logística do Instituto Federal, campus Suzano. E-mail: osmoz800@hotmail.com.
[2] Doutora em Engenharia da Produção e professora do Instituto Federal, campus Suzano. E-mail: sivanilzamachado@ifsp.edu.br.

1 INTRODUCTION

Road Transport of Hazardous Goods (RTHG) is considered a matter of national, regional and local interest, encompassing public and private organizations and the community in general, not just manufacturers and transporters. This is due to the increase in the activities of production, storage and transportation of chemical substances throughout the planet, which has caused a significant increase in the number of individuals, in society in general and in materials exposed to their risks, evidencing the increase in frequency and severity of chemical accidents in these activities (FREITAS; AMORIM, 2001).

According to Lieggio Junior (2008), the United Nations (UN) does not apply a single definition for dangerous products in its regulation recommendations, in the analysis of this classification and in the classification in one of the Classes of Hazardous Products, thus making it possible to evaluate , for the purposes of transport, that dangerous products are considered to be those which, due to their chemical or physical characteristics, when exposed to the environment cause immediate damage to human life, property and ecosystems. They are basically chemicals, pure or in mixtures, including explosives, radioactive materials, etiological agents and hazardous waste that require special care in handling and transport.

Accidents in the transportation of these products have catastrophic consequences, especially if they occur in the vicinity of cities and populations bordering the main highways. In addition to social value, Ferreira (2003) explains, incalculable of human losses, the costs resulting from environmental contamination reach very high levels.

According to Nardocci and Leal (2006), the serious consequences of accidents involving the transport of dangerous goods by road depend on the properties of the substance involved, the type of the accident, the quality of the road network, the means of escape, the surrounding population density and movement of pedestrians on the road.

The issue of the transportation of hazardous cargoes has gained relevance in Brazil, this can be verified by the appearance of the System of Evaluation in Health, Safety, Environment and Quality (SASSMAQ), introduced in Brazil by the Brazilian Association of Chemical Industries (ABIQUIM) in 2001 The aim of SASSMAQ is to assist transport companies in advancing operational performance with a view to continuously and gradually reducing the risk of accidents in the transport and distribution of hazardous products, making them more competitive. It is important to mention, according to Abiquim (2017), that the implementation of this system has become an essential factor for the transport companies to be contracted by the chemical industries associated with ABIQUIM.

Considering the above, the objective of this investigation is to verify if there is influence of the amount of inspections carried out in the city of São Paulo on the amount of accidents in the transport of registered dangerous products, based on the statistical analysis of the data of the Traffic Engineering Company (CET) between the years 2012 and 2017.

It is also assumed that the inspection has an impact on the control and reduction of accidents.

2 THEORETICAL BACKGROUND

This section starts with Road Transport of Hazardous Products (RTHP).

2.1 Road Transport of Hazardous products (RTHP)

The transportation of dangerous goods by road has been boosted in Brazil by the policies and programs of economic development adopted in recent decades, accounting for about 70% of the transportation of these products, while 29% use the railroad mode and only 1% the river. Compared to other countries, such as the United States and Germany, for example, where only one third of all transported products use the road modal (NARDOCCI; LEAL, 2006).

According to Lieggio Júnior (2008), the transport of dangerous products (TDP) is regulated by interpretation of the principles established in international regulations, basically the UN Model Regulations or the European Agreement on the Transport of Hazardous Materials by Highways and Railways - ADR / RID, each of which presents application specificities and organizational structure. Each country edits its own regulations and technical standards for the transportation of this type of product upon national discussions on the subject.

The publication of the book entitled Recommendation on the Transport of Dangerous Goods - Model Regulations, known as the Orange Book, is the responsibility of the UN, summarizing the work of the Subcommittee of Specialists on the Transport of Dangerous Goods, linked to the Economic and Social Council - ECOSOC), a member of the UN, responsible for reviewing and updating the Orange Book every two years, in order to meet the requirements of modern transport systems and ensure the safety of people, property and the environment in view of the constant technological development (LIEGGIO JÚNIOR, 2008).

According to Barbosa, Freitas and Lima (2009), the transport of dangerous products is thus denominated in function of the potential of damage or negative impact that spills or accidental leaks can cause to the environment, the public and private patrimony.

2.2 Evolution of Legislation

According to Lieggio Júnior (2008), the activity of road transport of dangerous products in Brazil over the years has presented several changes as the following legislation:

a) Decree-Law No. 2068/83: Provides for fines to be imposed for infractions to the regulations for the execution of services of transport of dangerous goods or cargoes.
b) Decrees 96.044 / 88 and 1.797 / 96: Provide for the Regulation of Road Transport of Dangerous Goods (RTRPP) at the national level, determining requirements regarding the information contained in the tax document; mandatory document submission; signaling of transport and cargo units; security and emergency equipment; packaging certification; certification of inspection of vehicles and equipment intended for carriage in bulk; and specific course for drivers.
c) Law 9,503 / 97: Approves the National Traffic Code.
d) With the enactment of Law 10.233 / 01, which provides for the restructuring of water and land transport, the regulation and supervision of the movement of dangerous products on highways and railways became ANTT's sphere of activity (article 22, VII and Article 24, XIV).

e) Decree nº 4.097 / 02: Amends the wording of articles 7 and 19 of the regulations for the transport of dangerous goods by road and rail, approved by Decrees 96.044 / 88 and 98.973 / 90.

f) Ordinance MT No. 349/02: Governs the supervision instructions of the TRPP at the national level.

g) Resolutions ANTT nº 420/04, nº 701/04 and nº 1644/06: They are complementary instructions to the RTRPP.

h) Resolution ANTT no. 437/04: Establishes the National Registry of Freight Carriers - RNTRC.

i) Resolution Contran 168/04: Regulates the specific course for drivers of vehicles transporting dangerous products.

j) Law No. 11.442 / 07: Provides for the transportation of cargo by road on behalf of third parties and for remuneration

k) Inmetro Ordinances: Determine Quality Technical Regulations (RTQs) and Conformity Assessment (RACs) for packaging and vehicles and equipment for the transportation of dangerous products by road in bulk.

l) ABNT supplementary standards: Complement the RTPP.

m) Resolution 3,665 / 11: Updates the Regulations for Road Transport of Dangerous Goods.

In 2018 ANTT Resolution 5232/16 was released, which determines the transition between resolutions, see Figure 1.
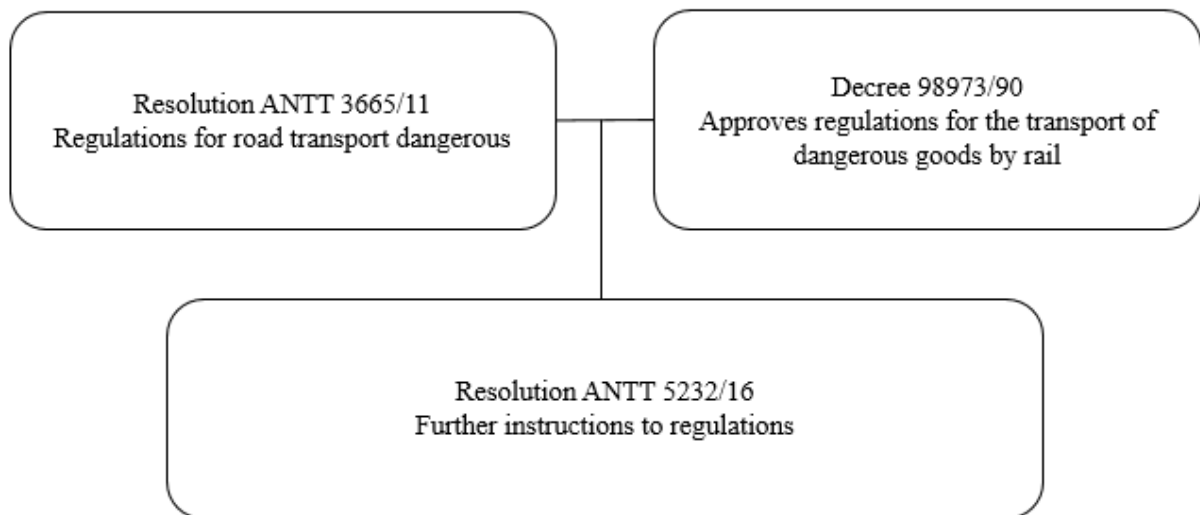

Figure 1 - Phases of the transition between resolutions
Source: Prepared by the authors

At the municipal level, the city of São Paulo has broad legislation. Costa e Ribeiro (2011) informs that Decree 36.957, dated July 10, 1997, which regulates Law No. 11.368, of May 17, 1993, provides for the transportation of dangerous products of any kind by cargo vehicles in the municipality.

According to the same authors, Municipal Decree No. 36.957 / 97 was updated by Municipal Decree No. 37,391 / 98 on April 8, 1998, which published the list of products of high intrinsic danger and the guidelines of the emergency plan with dangerous products as well as

Ordinance 77 of June 5, 1998, which approved all the documents used in the registration and municipal licensing of transporters of dangerous products, such as: a special transit license for hazardous products, a registry of dangerous goods carriers and a special license transit of dangerous products and Ordinance 15 of the DSV / GAB of 18 August 1998, with the publication of the listing of the products of high frequency of circulation and the conditions for the circulation of vehicles transporting dangerous products.

2.3 Incidence of Accidents

RTHP leads the statistics being responsible for 2,399 of the environmental accidents, corresponding to 38.1% of the total accidents occurred in the State of São Paulo between 1978 and 2005, according to data from the Environmental Sanitation Technology Company (CETESB, 2007 as cited in LIEGGIO JÚNIOR, 2008).

Ferreira (2003) points out that the statistics of the Highway Police highlight vehicle failures as another cause of accidents involving RTHP, inserting as a matter of concern the conditions of the fleet of vehicles transporting dangerous products, related to the average ages of the fleet and the degree of technological update.

The Federal Highway Police (PRF) emphasizes speeding, disobedience to signaling and lack of attention as other key factors involved. Besides these, the PRF points to several other causes: vehicles without personal protective equipment, without emergency equipment and without fire extinguisher, absence of specific equipment (tachographs and odometers), vehicle failures due to the high average age of the fleet, inadequate training , excessive hours worked, lack of information and non-compliance with legislation, and lack of supervision.

According to the State Highway Police, the main causes of accidents involving hazardous chemicals are fixed by driver errors (44.3% of total accidents), vehicle failures (21.83%), road conditions (3 , 71%) and others (30.16%).

As for the classification of hazardous products transported during acidentes, Barbosa, Freitas and Lima(2009) state that flammable liquids represented 57.01%, corrosive substances 11.71% and flammable gases 8.3.

In the state of São Paulo, the high concentration of industrial poles in the Metropolitan Region of the capital causes the intense movement of chemical products. Only 11,000 trucks carrying dangerous products were circulated daily, according to research carried out in 2004 by the Traffic Engineering Company of São Paulo (CET), in the city of São Paulo (Marginal Pinheiros, Marginal Tietê, Salim Farah Maluf Avenue and Bandeirantes avenue) . Therefore, the accident data in the TRPP in São Paulo highways indicate the existence of a relation between the density and the location of industrial facilities, and their occurrence (LIEGGIO JÚNIOR, 2008).

Araújo (2007) reports that several relevant aspects are directly or indirectly related to the occurrence of accidents:

a) Saturation of the road network;

b) Precarious maintenance of highways;

c) Precarious signposting of highways;

d) Mechanical failure of vehicles;

e) Human factor;

f) Impaired driving ability;

g) Inadequacy of traffic legislation; and,

h) Inefficient supervision.

The same author states that many institutions are dedicated to study and analyze the subject with proposals of awareness, to minimize the occurrence of the accidents. Campaigns and severe penalties foreseen in the Brazilian Traffic Code contribute to the reduction of accidents.

According to statistics from the Volvo-Senai program, items such as "inspection", "company" and "vehicles and equipment" presented their share of the contribution to the reduction of accidents and represent the form of government performance and professionalism of companies. The existence of laws and technical norms does not produce a satisfactory effect if the supervision is inefficient or precarious, since the active presence of the State as a regulatory and supervisory body contributes to the efficiency of the process (ARAÚJO, 2007).

3 METHOD

The method used in the study is that of documentary research, which according to Gil (2002), uses the analysis of documents that did not receive an analytical treatment.

For the investigation, the data on the inspection and the accidents occurred involving the transport of dangerous cargoes stored in the database of the Traffic Engineering Company of the city of São Paulo (CET) were collected.

After the data collection of six years between 2012 and 2017, statistical treatment was given to the method (s) of tabulations using statistics on parametric bases.

A bibliographical research was also carried out to identify sources on the characteristics of transport of dangerous cargoes and the need for inspection as a form of accident control, in order to verify if the other studies supported the existence of the relation between the inspection and the accident rate.

The latent limitations observed in the results and discussions indicate restrictions regarding the number of years collected, but not making statistical calculations and analyzes unfeasible.

4. RESULTS AND DISCUSSION

Between the years of 2012 and 2017, 3,749 records of inspections were carried out and 94 records of accidents occurred, distributed in terms of quantities according to Table 1. The averages calculated, for inspection, 624.8; and, for accidents, 15.7.

Year	Inspections	Accidents
2012	299	26
2013	812	21
2014	763	19
2015	608	5
2016	687	13
2017	580	10

Table 1 - Inspections and accidents
Source: authors

The correlation, according to Larson and Farber (2016), is a relationship between two variables, containing the variable x (independent) and the variable y (dependent). The calculated value varies from +1 to -1, passing through 0; the closer to +1, the stronger the positive correlation, the closer to -1, the stronger the negative correlation; and, the closer to 0, there is no correlation. In terms of analysis if the correlation is positive, when a variable moves in one direction, the other follows it; when negative, the meanings of the two variables are inverse.

Calculating the Pearson correlation coefficient between the variables (independent) and accidents (dependent), the value r was -0.232, indicating a weak negative correlation.

Thus, according to the result of the negative correlation exposed, it is observed that the more inspections, the less accidents, even though the correlation intensity is weak.

The minimum squares line serves to estimate or predict the relationships between variables (named Y hat), reports Freund (2007), presented at the end of the calculation, the values of a and b. The value of a is a constant and the value of b is established as the multiplier of values of the independent variable that will be used for the calculation of Y.

For this calculation, here called simple linear regression analysis, the values of x are collected, the relevant calculation is applied and the calculated values of a and b are obtained at the end. In another approach, determine the equation of the line that best models the data,

$Y = bx + a$.

Larson and Farber (2016) define the regression line, also known as the best fit line, as the straight line for which the sum of the squares of the residuals is a minimum.

In order to determine the formula that would define the associations established between the variables surveyed, inspections and accidents, simple linear regression was calculated (Graph 1), resulting in Formula 1.

$$Y = -0,01x + 21,824 \qquad (1)$$

Inspections/Accidents

$$y = -0{,}0099x + 21{,}824$$
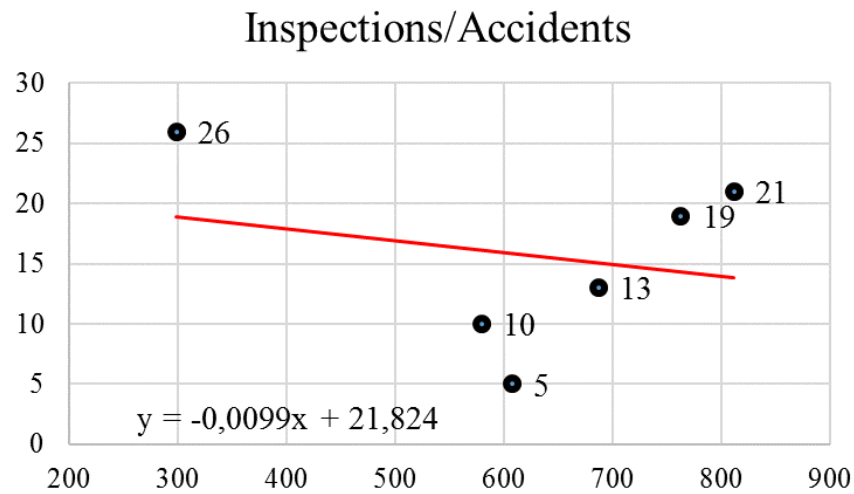
Graph 1 - Simple linear regression - Inspections and accidents
Source: authors

The line shown in Graph 1 expresses the regression line constructed from the calculated formula. The values shown in the graph show a and b of the formula.

Therefore, as viewed, every 100 inspections decreases an accident. It should be emphasized that variations in the values of x and y should be restricted to the intervals within the calculated data (interpolation). Values outside the ranges, extrapolation, should be analyzed more carefully.

However, the calculated coefficient of determination was set at 0.054 and, therefore, had a weak explanation level. The calculated F-value (p-value) of 0.657 also indicates the acceptance of the values of a and b with reservations.

5. FINAL CONSIDERATIONS

The traffic of trucks transporting dangerous cargoes through the main avenues of the city of São Paulo is a matter of paramount importance for the safety of society and individuals, among other factors of relevant concern.

The research carried out showed a moderate influence among the studied variables, calculated statistically by the correlation, in the sense of representing less accidents in functions of greater inspections, having as numerical result the reduction of one accident in every 100 inspections done.

However, the resulting discrete values are corroborated in a complete sense by the reductive consideration. And still, the limitations imposed by interpolation.

The hypothesis on the impact on the control and reduction of accidents through the amounts of inspections should be accepted, even mitigated by the modest valid values.

As a suggestion for future studies, it is recommended the elaboration of a research associating the occurrence of accidents with dangerous loads and the qualification of the transporters, using as a parameter of qualification the certification of the companies by norms like ISO 9001, ISO 14001 and SASSMAQ.

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