

## **Controls at the starting point for preventing accidents in the road transport of dangerous products**

### **Controles no ponto de partida para prevenção de acidentes no transporte rodoviário de produtos perigosos**

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#### **ABSTRACT**

This article discusses activities related to the prevention of road accidents with dangerous products that precede trips by tank truck drivers. The Brazilian normative framework (laws, decrees, and norms), the Haddon Matrix as a systemic prevention model, and the premises of the Olho Vivo nas Estradas Program of the Brazilian Chemical Industry Association constitute the conceptual bases of the research. The empirical approach consists of semi-structured interviews with drivers of a fuel distributor who travel along the BR-116. The results indicate that the company has training practices and disclosure of recent accidents. The workgroup dominates the normative knowledge and preventive procedures, being the main concern of the interviewees with the carelessness practiced by drivers who travel the roads in all types of vehicles (trucks, automobiles, motorcycles).

**Keywords:** Road transport, dangerous products, pre-accident.

#### **RESUMO**

Este artigo discute as atividades relacionadas à prevenção de acidentes rodoviários com produtos perigosos que antecedem viagens de motoristas de caminhões tanque. O arcabouço normativo brasileiro (leis, decretos e normas), a Matriz de Haddon como modelo sistêmico de prevenção e as premissas do Programa Olho Vivo nas Estradas da Associação Brasileira da Indústria Química constituem as bases conceituais da pesquisa. A abordagem empírica consiste em entrevistas semiestruturadas com motoristas de uma distribuidora de combustíveis que percorrem a BR-116. Os resultados indicam que a empresa possui práticas de treinamentos e de divulgação de acidentes recentes. O coletivo

de trabalho domina o conhecimento normativo e os procedimentos preventivos, estando a principal preocupação dos entrevistados com as imprudências praticadas por condutores que transitam as estradas em todo tipo de veículo (caminhões, automóveis, motocicletas).

**Palavras-chave:** Transportes rodoviário, produtos perigosos, pré-acidente.

## 1 INTRODUCTION

In Brazil, road transport is responsible for handling more than 60% of goods (CNT, 2018). In 2014, road cargo transport was responsible for 36.2% of the GDP of the transport sector (IBGE, 2017) and, in 2015, establishments in the cargo segment employed, on average, nine workers per establishment, corresponding to 354, 6 thousand cargo drivers (CNT, 2017). In this scenario, the prevention of accidents involving the transport of dangerous products in road transport companies becomes important and it relevant to research the aspects of working with the transport of dangerous goods in the organizational dimension of companies.

During the transport of dangerous goods by road, truck drivers are subject to a combination of the probability of the occurrence of a dangerous phenomenon or exposure at work, with injuries or damage to health that can be caused by the event or exposure (HSE, 1993).

Many factors unfavorable to transport safety do not occur due to truck driver actions, given the precarious urban environments around the roads, the vehicle demands above the design capacities of the roads, the infrastructure conditions incompatible with the permitted load weights, adverse weather conditions, and inappropriate pedestrian behavior, among others.

According to Fragoso Jr. and Garcia (2018), among the causes identified in the literature as contributing to deaths with drivers who carry dangerous cargoes, excessive working hours, and inadequate rest should be considered primarily. Dawson et al (2000) and Silva (2011) add that studies carried out at the national and international levels highlight that the main factors that lead drivers to crash are fatigue, drowsiness, physical and mental tiredness, drug use [including alcohol use], and driver remuneration proportional to production.

On the other hand, there are factors associated with the behavior and skills of truck drivers to be considered when discussing preventive actions for road accidents. Driving the vehicle at the maximum permitted speed, maintaining the car in proper mechanical condition, and carrying out inspections of the truck at the starting point based on a wide range of safety items are crucial for safe travel.

## 2 METHODOLOGY

In order to explore how the prevention of road accidents involving dangerous products is considered the starting point by drivers and transportation companies, the objective of the article is to discuss the levels of knowledge of drivers and the commitment of companies that transport dangerous products in the prevention road accidents. The study is based on a bibliographic review of the Brazilian normative framework (laws, decrees, and norms), the Haddon Matrix as a systemic prevention model, and the premises of the Olho Vivo nas Estradas program of the Brazilian Chemical Industry Association. The research's empirical approach consists of semi-structured interviews with drivers of a fuel distributor that travel on the road BR-116 between the cities of Rio de Janeiro and São Paulo.

Thus, this text organizes the theoretical contents with the knowledge acquired about safety in the road transport of dangerous products from the perspective of the tank truck drivers interviewed in the context of the starting point of the journey between the cities of Rio de Janeiro and São Paulo. Such information is gathered with the help of impressions collected by drivers and managers of companies transporting dangerous products through interviews conducted to observe the training, knowledge, and understanding of safety rules and procedures of those responsible for handling and transporting products chemicals, ascertaining whether companies are aware of the causes of accidents and whether drivers' reports help to minimize them.

For semi-structured interviews with fifteen drivers and two managers, in road haulage companies located in the city of Rio de Janeiro, twenty-seven questions were prepared, distributed as follows: four in accordance with the Legislation applied to accidents, four in agreement on technical safety standards, six in accordance with prevent checking procedures, four on procedures on the way and four regarding post-accident procedures and five open questions about personal experiences at the company. In the questionnaire, a checklist based on the Haddon matrix (1980) containing twenty-eight questions, made it possible to assess the interviewees' domain regarding accident prevention routines in their work environment.

From the interviews that took place between July and August 2018, five categories of analysis were extracted: permissive environment, work system, travel planning, hazard identification, and preventive actions. These categories helped in the analysis of the actions of drivers and visited companies regarding accident prevention at the starting point.

### 3 TRANSPORTATION OF DANGEROUS LOADS

The United Nations - UN (2013) identified some physico-chemical properties that make it possible to classify dangerous products: temperature, pressure, toxicity, corrosivity, radioactivity, flammability, oxidation potential, explosiveness, spontaneous reaction, polymerization, decomposition, infectious, among others. This list has more than 3,000 products that are updated periodically (Araújo, 2001). Dangerous products are allocated to UN numbers and names appropriate for shipment according to their risk classification and composition (ANTT, 2004).

Brazil has 1,720,756 km of highways, of which only 211,468 km are paved, which represents 12.3% of the total length. This mileage results in a density of road infrastructure of 24.8 km per 1,000 km<sup>2</sup> of area, which represents a low value when compared to other countries of similar territorial dimension such as the United States where they are 438.1 km per 1,000 km<sup>2</sup> of area (CNT, 2017). According to the Federal Highway Police - PRF, the main causes of serious traffic accidents recorded in 2017 and 2018 involving any type of motor vehicle on Brazilian federal roads are related to driver failures. Of the 2,088 reported occurrences, there were 1,809 (86.7%) with causes attributed to the driver, with 18.9% of these disasters occurring on the BR-116 (PRF, 2018).

The BR-116 road is known as Via Dutra between Rio de Janeiro and São Paulo when it connects the two largest metropolitan regions of the country in 402 km in length and generates a relevant history of accidents in the Brazilian territory. Of all the roads that cross this region, it is the one with the highest rates of accidents with dangerous chemicals and is responsible for the highest number of traffic accidents with fatal victims. In the stretch between the cities of Rio de Janeiro and São Paulo, there were 1,143 truck accidents with 260 lives lost between 2017 and 2018 (CNT, 2019a). Problems of road infrastructure such as paving, signaling, and the geometry of the road, directly or indirectly, contribute to increasing the severity of traffic accidents (CNT, 2019b). What is observed are trucks traveling long sections of poor quality of the pavement causing mechanical wear on the vehicle and exposing the driver to exceptional fatigue that is not always compensated with adequate rest.

To comply with the mandatory eleven-hour daily rest, as determined by Federal Law No. 13,103 (Brazil, 2015), the truck driver must comply with ANTT Resolution No. 3,665 (Brazil, 2011) which establishes that “the driver of a vehicle transporting dangerous products can only park for rest or overnight in areas previously determined by the

competent authorities [...]”. The traffic authority with circumscription on the road must promote indicative signs along the roads, regarding the parking area for road vehicles for the transport of dangerous products. The areas for the installation of parking for road vehicles for transporting dangerous products must be at least 200 meters away from populated areas, water sources, and environmental protection, and these areas must have an Emergency Response Plan approved by Organs competent bodies (Prado Filho, 2017).

#### **4 SYSTEMIC ACCIDENT PREVENTION MODELS**

For Queiroz et al. (2017), the knowledge of the factors that trigger accidents with vehicles that transport loads of products is fundamental for the effectiveness of preventive and corrective actions involving this type of product. Concepts related to dangerous products, accidents, and prevention permeates the context of road transport workers due to the nature of their work practices.

The models of systemic approach recognize that the individual interacts within a permissive environment, subject to a network of factors that act at different levels of determination, including the factors directly involved in the occurrence of accidents and the macro-structural determinants that contribute to fatal accidents or flaws that influence the severity of the injury (Muhlrad and Lassarre, 2005; WHO, 2012).

Obtaining sufficient knowledge about the factors that generate risks on the road and in the transport system implies the analysis of the chain of events that lead to collisions and injuries. As these factors are related to human behavior and the physical and technical components of the road and the transport system, detailed investigation of road collisions may require a multidisciplinary approach such as the one proposed by Haddon (1968) which, according to the World Health Organization Health - WHO (2012), is the most used paradigm in the field of injury prevention. For land transport accidents, a matrix of three columns (human or host; vehicle and equipment; environment) and three phases (pre-event, event, post-event), helps to identify risk factors before, during, and after the accident, in relation to the person, vehicle and equipment and environment.

By combining public health concepts with other areas of knowledge, the Haddon Matrix was widely adopted as a tool to identify risk factors related to an injury or death and to develop effective strategies to reduce the likelihood of disasters and minimize the risks consequences (Blau, 2011). Once the multiple factors associated with the accident are identified, measures can be developed and prioritized for short- and long-term

execution. In the pre-accident phase, it is necessary to select all measures to prevent the accident from occurring, while the accident phase is associated with measures aimed at preventing the occurrence of injuries or reducing their severity and the post-accident phase involves all activities that reduce the adverse effects resulting from the WHO accident (2012).

Pre-accidents are those that constitute in themselves those actions that must be planned or planned ahead of time so that, in the same way, they also give results before the accident. It is the block of purely preventive actions, that is, those that are programmed to prevent the production of accidents and, therefore, its effectiveness is shown in reducing the frequency of accidents. They can be called on the property of 'accident prevention' actions.

Accidents are those that constitute in themselves those actions that must be planned or planned in order to give results during the succession of accidents. That is, that, assuming that accidents can happen, these measures are applied to ensure that the consequences of the accident are as light as possible and, therefore, their effectiveness will be demonstrated in reducing the severity or severity of such consequences. These are the 'prevention of the effects of the accident' measures and, taken as a whole, are the protection measures applied to the vehicle-vehicle-person or the machine-worker-environment.

Post-accidents are those that constitute in themselves those actions that must be planned or planned before they can give results after the accident. That is, that, assuming that accidents can happen and that their consequences can become serious, these measures are applied to mitigate the possibility that the negative effects of the accident will multiply even more and to be able to give a possible answer, as effective as possible, to repair the greatest damage and injuries produced. These are the measures of 'prevention to prevent further damage and the convenient cure of injuries to the wounded', and, as a whole, are the assistance measures applied to the road-vehicle-person or the machine-worker-environment (Pedragosa, 2015, translation free).

This model becomes especially useful to contemplate the risk aspects that can be faced in a work environment or on the highways because it faces the two lines of study that are the specialization in investigation and reconstruction of traffic accidents and the ordering in space or in the physical environment of what is involved that should be investigated or prevented.

Applied to a road accident prevention plan, the Haddon Matrix allows, in relation to the pre-accident phase, some elements in aid to the knowledge management of the drivers of a transport company (Tab. 1).

Table 1: Haddon matrix - pre-accident phase in the prevention of road

Human (driver)	Vehicle (tank truck)	Environment (roads)
- Information: trip planning	- Emergency File - NBR 7503: 2020	- Highways layout - Decree Law 512: 1969
- Attitude: Adequate rest before and during the journey (LF n° 13.103 / 2015); Protective equipment - individual and collective - NR 6	- Emergency equipment - NBR 9735: 2016	- Speed limits - Law 13281: 2016
- Commitment: Training	- Vehicle check - NR 12	- Facilities for pedestrians - Law 12,587 / 12
	- Local Emergency Plan - NBR 15480: 2007	

Source: Own authorship based on Haddon (1968).

Awareness campaigns on the highways carried out with the distribution of information leaflets, installation of banners with safety tips and messages on the Variable Message Panels - PMVs are complementary actions to corporate initiatives and with public reach. They serve to raise awareness, sensitize, and guide truck drivers and the population. These campaigns lead drivers to a better awareness of the dangers and risks that can occur during their journey and is one of the ways to try to prevent accidents and have a safer trip (Vieira, 2019).

The Brazilian Chemical Industry Association (Abiquim, 2003), in partnership with the Brazilian Association of the Alkali, Chlorine and Derivatives Industry - ABICLOR created an Eye Live on the Roads Program. The program was launched in May 2001, where it covers all modes, and aims to prevent unsafe attitudes in the transport of dangerous products, focusing on driver awareness and is part of a risk management system, which considers man and his attitude, showing a driver awareness methodology, carried out through courses.

The Olho Vivo nas Estrada Program is part of the work carried out by the chemical industry, with the concept of a model of a process of continuous improvement in all stages of the production chain, in health, safety, environment, and corporate sustainability in the area of road transport focused on human behavior and aims to reduce to zero the number of accidents with unsafe attitudes in the distribution of chemicals (Falcão, 2012). The program allows for the investigation of accidents that occurred due to an incorrect



assessment at the starting point, specific driver error, or when the cargo was displaced (Cabral, 2019).

## 5 INTERVIEWS WITH DRIVERS

The field research was conducted through face-to-face interviews, between July and August 2018, with workers from medium-sized fuel transportation companies, located in the city of Rio de Janeiro. The objective of the interview was to identify, from the point of view of tank truck drivers, if the accidents that occur during the Rio-São Paulo route through the BR-116 with fuel loads may have caused a failure at the starting point (pre-phase) Haddon Matrix accident). It was possible to obtain information with seven drivers and a company manager.

The semi-structured interviews were based on the Brazilian normative framework (laws, decrees, and norms), on the Haddon Matrix as a systemic prevention model, and on the premises of the Olho Vivo nas Estradas Program of the Brazilian Chemical Industry Association. The script was organized with questions in five categories: normative knowledge, interviewee's preventive procedures, the company's preventive culture, the interviewee's critical sense, the company's reactive policy in the face of an accident. Among the knowledge reviewed in the research, the norms and laws that organize the road transport of dangerous products in Brazil stand out. The skills of drivers on such topics were declared in interviews, especially regarding legislation applied to accidents, technical safety standards, pre-event checking procedures, on-route procedures, post-accident procedures.

Asked about their active participation in safety training, the interviewees informed that they participate actively and agree with the way that the content is transmitted. They said that their participation occurs spontaneously for the purpose of improvement, to obtain more security through the knowledge acquired, and as a form of professional commitment when putting into practice the theories received. The training received, the rules and procedures of the company, allow drivers to put into practice the knowledge acquired when they are involved in the event of an accident. It is noticed that the interviewees have knowledge of NBR 14064 (ABNT, 2015) which addresses the guidelines for emergency care when it establishes the minimum operational procedures to be considered in the actions of preparation and rapid response to accidents involving the road transport of products dangerous.



Inspection, evaluation, and checking are carried out 100% in a very thorough way on vehicles daily. Based on laws, rules, and procedures, drivers of dangerous products carry out a general checklist of the truck before each trip to prevent undesirable events from occurring. The vehicle is checked by means of a departure checklist and completed by the driver before the dangerous product leaves (departure point) at its destination. The trips are planned by the responsible operators with the transport companies and distributors. The script is carried out with a view to the effective delivery of the product and the safe return of the driver. To ensure safety on the route, routes are pre-defined by checking the points that present greater or lesser risks in such a way that drivers can follow those considered safer, respecting mainly the speed limit required on highways.

The results of the interviews were categorized based on the revised theory on the transport of dangerous products: permissive environment, work system, planning, hazard identification, and preventive actions, as shown in Tab. 2.

Table 2: Result of the interviews

Category	Result
Permissive environment	<ul style="list-style-type: none"> <li>- Permissive environment - When hired by companies, drivers are required to carry out various types of safety training, both standard and non-standard.</li> <li>- Daily responsibilities of drivers to carry out general vehicle checks at the starting point.</li> </ul>
Work system	<ul style="list-style-type: none"> <li>- Drivers check the routes before starting their trips. They use cell phones to communicate with other drivers who will take the same route.</li> <li>- Rest break time was reported by drivers that it is not always respected for having to meet the work target. Which leads drivers to fatigue and, consequently, may cause an accident.</li> <li>- In a period of six years ago there were places owned by the company to park and rest, in the present times these places were extinct.</li> </ul>
Travel planning	<ul style="list-style-type: none"> <li>- The trips are planned with the operators responsible for the transport companies and the distributors and if the product leaves the plants directly, the itinerary is prepared by the plant itself.</li> <li>- There is a qualified and qualified professional who only performs the travel plans and itineraries.</li> <li>- Before starting the trip, the drivers deliver the checklist form carried out at the departure point to a responsible technician, where this professional checks the documentation required by law.</li> <li>- If the road is not able to travel and drivers need to change their route, drivers call the company (base) and the distributor communicating their new route.</li> </ul>
Hazard identification	<ul style="list-style-type: none"> <li>- Respondents said that accidents on the road or even in urban areas do not occur due to inspection failures at the starting point, but caused by drivers of alcoholic private vehicles, recklessness or high speed, road bikes, and motorcyclists who do not respect traffic laws, recklessness, and absence of signs,</li> </ul>
Preventive actions	<ul style="list-style-type: none"> <li>- In addition to the daily checks, the companies carry out a general check every three months, with qualified and qualified professionals, of the trucks.</li> <li>- Some distributors carry out audits of trucks, documentation, and whether drivers have completed all the training required by law.</li> <li>- Drivers reported that they never take to the roads without carrying out the checks at the starting point because it is extremely risky, some failure may occur and cause accidents and their lives are at risk.</li> </ul>

Source: Own authorship.

Regarding the permissive environment and based on Haddon's perceptions, the models of systemic approach recognize that the individual interacts within a permissive environment, subject to a network of factors that act at different levels of determination, including the factors directly required in the occurrence of accidents and the macro-structural determinants that contribute to fatal accidents or failures that influence the severity of the injury (Ferreira, 2014).

The work system developed for drivers transporting dangerous products has been positive, like the workforce, their skills, knowledge, and competences motivate them to put all learning into practice. It is through planning that objectives are set, as goals and choices are made as to the method or path to be followed for the best functioning, as measures to prevent the effects of the accident, and as a whole, and the protective measures applied road-vehicle-person or worker-machine-environment. Based on the system, drivers reported that they perform vehicle checks daily before trips.

Regarding planning, how work actions should be planned or planned before they take effect. Assuming that accidents can happen, how measures are applied to ensure that the consequences of the accident are as light as possible, and their effectiveness will be demonstrated in reducing the severity and severity of such consequences. The trips are planned with the responsible persons in charge of the transport companies and as distributors and if the product leaves the plants directly, the itinerary is prepared by the plant itself. The script is carried out for product delivery and driver's return and follows as follows: first, drivers deliver the delivery script that comes with the product invoice and the Chemical Safety Information Sheet - MSDS and the drivers another return route to the base. There is a qualified and qualified professional who only performs the travel plans and itineraries.

Identifying hazards is an important strategy, as it allows you to have a real view of all the critical points of the activities that may negatively impact the processes. Regarding preventive actions, monitoring and information are necessary for better control in operations and to detect possible failures that may occur during the process. The usefulness of the monitored information will be all the greater the knowledge acquired by the drivers during the training received. Based on the identification of hazards, all respondents reported that accidents that occur on roads, and even in urban areas, with trucks transporting dangerous products, are not related to a failure of inspection at the point of departure, but caused by drivers of alcoholic private vehicles, recklessness or

high speed, bicycles on the roads and motorcyclists who do not respect traffic laws, recklessness, and absence of signs.

Normative knowledge is the domain of all employees, where the rules pre-established by companies are applied and monitored by managers. Employees believe that the standardization and standardization of the language transmitted to them are important for unification, for the correct application of techniques, in addition to their security.

Preventive procedures serve to ensure the safety of all employees involved. The importance of checking each item correctly helps to eliminate or minimize the possibility of errors. Checks are carried out by drivers daily, both when taking the dangerous product to its destination and when returning to the base. Drivers are aware of the extreme importance that all checks are carried out, as this way the risks of accidents can be minimized or eliminated.

The preventive culture is a key element for optimum performance in carrying out tasks in terms of safety. Drivers have this culture, rooted in the vision, in the mind, in the conduct and action of each professional, since looking at the risks that may occur means that each preventive action applied will result in a reduction of risks.

The critical sense is reflected in the way of thinking and acting and is directly linked to knowledge and experiences. Although each driver has a look at each action they take, they usually think, analyze, reflect in a rational way, bringing their thinking to awareness and reality for their work environment. The empirical knowledge acquired by drivers in the course of their activities is passed on as a way to propagate this knowledge and seek, through the acquired methods, and their natural experiences to propagate actions that contribute to preventing negative impacts and results in the transport of dangerous products.

For every accident that occurs on the highways with drivers who transport dangerous products, the company discloses, through meetings and courses applied to its employees. The company's reactive policy is well-publicized by managers so that there is a better awareness of failures. Mistakes made during the operation or journey is another way of demonstrating the company's concern to minimize failures and break the vision of employees who can believe that what would be unreal to become real, is that nothing can be done in the face of negative circumstances.

## 6 CONCLUSIONS

From the understanding of the interaction between the drivers of a road transport company of dangerous products with the prevention practices prescribed in the legislation and in safety rules, it becomes possible to discuss minimally the work activities related to the prevention of road accidents with dangerous products that precede the trips of tanker drivers.

Through interviews with the drivers, it was found that the vehicle checking procedures are performed at the starting point, consisting of checks on the equipment and the documentation related to the trip in order to anticipate possible problems and risks that may occur during the phase operational transport. Based on this system, vehicles are checked daily before trips. The trips are planned with the responsible operators with the transport companies and the distributors.

From the information collected in the drivers' reports, it is possible to infer that many accidents did not occur due to the lack of knowledge transmitted in the training offered by the companies or due to inspection failures at the starting point, but due to complications caused by third parties along the route (load-unload) or on the way back to the starting point. The central idea of the interviewees is that a major problem for safety on the roads lies in the recklessness of other drivers who do not respect traffic laws, use alcohol, travel at high speed, use bicycles on the side of the road without proper use signs and safety equipment, they ride motorcycles recklessly, etc.

On the other hand, the reports revealed that each driver has a type of attitude and behavior in traffic and whenever he encounters obstacles such as traffic jams he looks for the best solution to escape from this situation, always looking for a better alternative. The search for better routes is a practice that exists even among regular truck drivers. Despite the availability of technologies that seek better routes, drivers reported that they use the cell phone while they are driving on of the moving truck, and especially when they communicate with colleagues from the company, who will take the same route, to exchange information about road and traffic conditions.

In cycles of continuous improvement for accident prevention, companies enrich their checking and training procedures at the starting point, based on learning from each accident occurrence. The safety policy is to disclose not only to new and old drivers in training or in progress but also to managers of industries, distributors, companies, and to all professionals who work in the carrier and supplier regardless of whether they are connected or not directly to chemical transportation activities. Such disclosure is carried

out to indicate the failures, to prevent recurrences, and to minimize the risks of accidents on the highways.

In relation to rest time, this action is one of the normative and mandatory requirements, which the companies that transport dangerous products, according to the interviewees, strictly adopted. The visited company monitors (with the aid of - and GPS instruments) the necessary rest time for the trips and, if not followed, the driver is removed to carry out new recycling training.

Since both the transportation company and its collective work indicate a concern with normative knowledge and preventive procedures, including safety training based on legislation applied to accidents, technical safety standards, pre-event checking procedures, commuting procedures, and procedures post-accident, we deduce that the preventive actions related to the pre-accident phase of the Haddon Matrix are well delineated at the starting point (within the company).

The diagnosis presented highlights the need for greater investments in awareness campaigns for drivers on highways such as the Olho Vivo nas Estradas Program. At the same time, the importance of actions that strengthen support areas on the roads for rest, generally associated with food and petrol station, is perceived. Finally, it seems clear the need for greater policing on Brazilian roads so that there is more security in cargo transportation.

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