

## The need to balance the Brazilian transport matrix

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### ABSTRACT

The transportation service is extremely important for economic growth, because through it it is possible to move goods and people. The five most widely used modes are: road, rail, water, pipeline and air. The unbalanced use of these modes can be detrimental to the country, i.e. if problems such as strikes occur, it can prevent production from leaving, supplying supermarkets, hospitals, gas stations, generating a lot of inconvenience for the population, in addition to generating losses at origin and destination and consequently leading to major losses (COLAVITE and KONISHI, 2015).

**Keywords:** Matrix imbalance, Transportation, Economic growth.

### INTRODUCTION

The transportation service is extremely important for economic growth, because through it it is possible to move goods and people. The five most used modes are: road, rail, waterway, pipeline and air. The unbalanced use of these modes can be harmful to the country, that is, if problems such as strikes occur, it can prevent the departure of production, supply of supermarkets, hospitals, gas stations, generating many inconveniences for the population, in addition to generating losses at origin and destination and consequently leading to great losses (COLAVITE and KONISHI, 2015).

Today, Brazil uses road transport to move more than 60% of its cargo. Therefore, it becomes very dependent on this modal, which has unsatisfactory conditions and has overloaded products with high freight and vehicle maintenance values, limiting its competitiveness (ELLER, SOUSA JUNIOR and CURI, 2011).

The Brazilian paved network is in poor quality conditions, in addition, the paved extension is still very little compared to the demand that is concentrated in this modal. According to the National Transport Confederation (CNT), only 12.4% is paved.

According to the CNT's 22nd survey of highways, the current condition of the pavement on Brazilian highways has generated a 26.7% increase in the operating cost of transporters. Road circumstances lead to an increase in fuel per kilometer driven, increased tire wear, additional maintenance expenses, and increased travel time, among others (CNT 2018).

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Rail and waterway transport can be advantageous options to balance the use of modes, they have peculiar and important characteristics, they are capable of transporting large quantities for long distances. However, the rail modal requires high investments and long-term execution, and because of these two factors, governments and companies have stopped investing and thus expanding the railway network in Brazil (FRANCE, 2014).

## **OBJECTIVE**

The objective of this work is to analyze the Brazilian transportation matrix through bibliographic research in the current literature, and qualitative and quantitative data collection of the agencies responsible for the monitoring and control of cargo transportation. Relate the benefits that can be obtained with the balancing of the use of modes, that is, the balance of the transport matrix.

To achieve the proposed objectives, the work is structured as follows: Introduction, Theoretical Framework, Methodological Procedures, Results and Conclusion.

## **METHODOLOGY**

For the elaboration of the present work, a bibliographic research was carried out in the existing literature, in which important data were related to the studied theme and qualitative and quantitative data extracted from the responsible agencies for the control and inspection of Brazilian cargo transport were presented.

The bibliographic research was carried out in articles, dissertations, performance reports, media articles such as websites of municipalities representing the transport and logistics sector and websites of institutions.

## **DEVELOPMENT**

In this section, the main modalities used in Brazil will be presented and discussed, and the main concepts will be addressed through the literature review.

### **ROAD TRANSPORT**

Road transport is through highways, roads or streets, whether paved or not. This transport model is responsible for more than 61% of cargo transport in Brazil according to the National Transport Confederation-CNT (2016), making it the most used mode for transporting various materials in general.

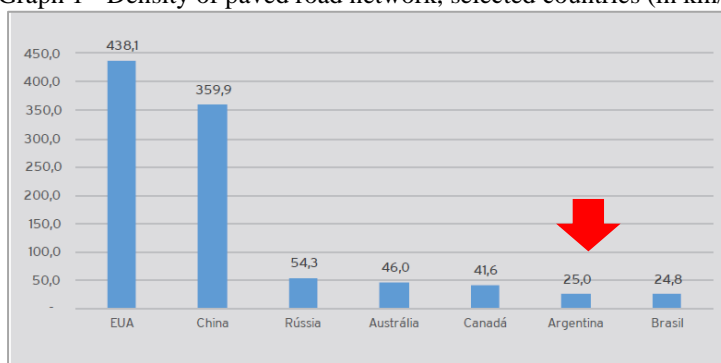
The freight costs of this modal are usually higher than those of rail and waterway, so it is recommended to use this modal for the transport of high value-added goods or perishable products (RIBEIRO and FERREIRA, 2002).

Despite having greater representation in the transport of cargo and people, the low rate of paving of Brazilian highways proves the poor quality of our transport infrastructure (DE PAULA, 2016).

According to the CNT (2017), Brazil has 1,720,756 km, of which only 211,468 km are paved, which represents only 12.3% of the total length. This mileage value was obtained in a road infrastructure density of 24 km per 1000 km<sup>2</sup> of area, which is a small number when compared to the United States which has 438.1 km per 1,000 km<sup>2</sup> of area, in China, 359.9 km; and in Russia, 54.3 km.

Graph 1 shows the dimension of paved grid by country, through which it is possible to observe the behavior of Brazil in relation to other countries with similar territorial dimension.

Graph 1 - Density of paved road network, selected countries (in km/1,000 km)



Cast Iron: CNT (2017)

## INVESTMENT IN ROAD TRANSPORT

The conditions of highway infrastructure in Brazil result from several factors, among them the low volume of investment applied in this sector, which is influenced according to the country's economic activity. However, it cannot be stated exactly that the poor quality of highways is directly linked to the economic crisis that the country has been facing, considering that Brazil has a well-known history of low financial investments in road infrastructure (IPEA, 2011).

With the government facing difficulties in making direct investments in the expansion and maintenance of highways, it was decided to operate with the private sector in the provision of transport infrastructure through concessions. This investment model began to be adopted in the country in the 1990s (IPEA, 2011).

Graph 2 shows the evolution of investments made by the federal government, and the pace is far behind the needs of the sector. It can be seen in the graph that there is a downward trend in federal government disbursements. It is observed that in 2015 the performance was the same as in 2004 (0.10% of GDP invested in road infrastructure (CNT 2018)).

Public investments in transportation exceeded those of the private sector by R\$ 1.4 billion in 2002, but this situation was soon changed in the following years. From 2003 to 2005, the private sector invested

more than the public sector, and the figures reached an average of R\$ 1.7 billion higher than public investments. In 2006 there was a change in relation to the pattern observed in previous years, and public investments exceeded private ones (IPEA, 2011).

Graph 2 - Evolution of Federal public investment in road transport infrastructure/Brazilian GDP - Brazil 2001 to 2018 (%)

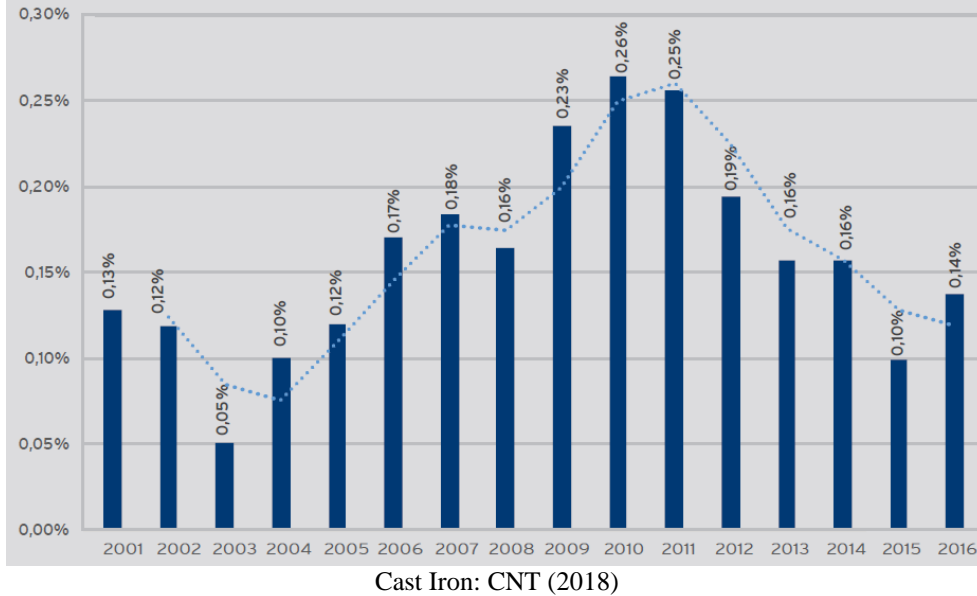


Figure 1 shows the investments of the public and private sectors in transportation, and analyzing only the road modal, it can be observed that private investments surpassed public investments only in 2003. The public network is much larger than the private one, which is one of the reasons why the federal government's investments are so much higher. In 2009 it reached its peak, surpassing private investments in highways by 4.7 billion (IPEA, 2011).

The strength of public road investments can be noted, which are clearly higher than those of private organisations. Public applications account for an average of 57.8% of total public investment in transport. For the same period of time, investments by the private sector correspond to 35.5% (IPEA, 2011).

Figure 1 - Public and private investments in transport from 2002 to 2009

Ano	2002	2003	2004	2005	2006	2007	2008	2009
Investimento público								
Investimento em transportes	5.355,47	1.917,71	3.357,82	5.125,47	9.957,96	10.333,97	9.017,99	12.619,82
Investimento em Rodovias	2.647,91	1.195,93	2.395,63	3.131,39	4.783,56	5.391,90	5.022,88	7.824,88
Participação Rodovias	49,44%	62,36%	71,34%	61,09%	48,04%	52,18%	55,70%	62,00%
Investimento Privado								
Investimento em transportes	3.938,31	4.308,31	5.057,02	6.196,73	5.194,75	5.611,21	7.745,31	6.605,76
Investimento em Rodovias	2.330,22	1.407,93	1.263,83	1.588,14	1.687,69	1.535,80	2.636,18	3.087,55
Participação Rodovias	59,17%	32,68%	24,99%	25,63%	32,49%	27,37%	34,04%	46,74%
Investimento Total								
Investimento em transportes	9.293,78	6.226,01	8.414,84	11.322,21	15.152,70	15.945,18	16.763,30	19.225,58
Investimento em Rodovias	4.978,13	2.603,85	3.659,46	4.719,53	6.471,25	6.927,71	7.659,06	10.912,43
Participação Rodovias	53,56%	41,82%	43,49%	41,68%	6.471,25	43,45%	45,69%	56,76%

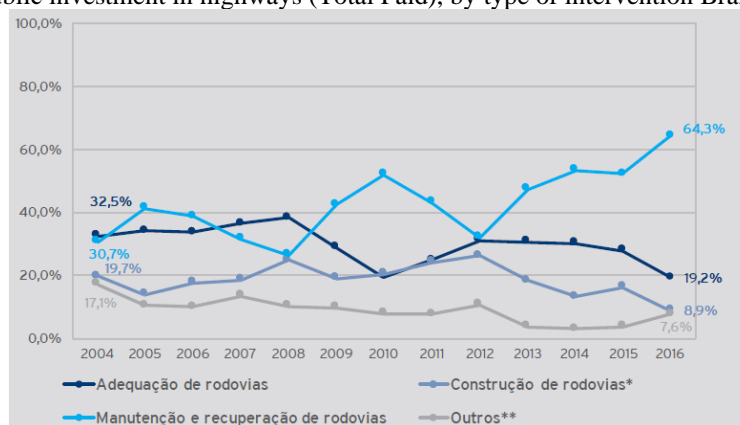
Source: IPEA (2011)

Figure 1 also portrays the investments in highways according to the total invested in transportation, and the importance of this modal can be perceived, which received an average of 46.15% of the total investments (IPEA, 2011).

The performance of investment in highway infrastructure has behaved differently since 2012, when there was a reformulation of the category of public spending, with a greater accumulation of interventions in the types of maintenance and recovery. Thus, investments applied to the maintenance and recovery of highways have increased their share of federal government spending (CNT, 2018).

Graph 3 shows the federal public investment in highways by interventions. It can be observed that the percentage of maintenance and recovery in 2016 reached its highest number in relation to previous years.

Graph 3 - Federal public investment in highways (Total Paid), by type of intervention Brazil – 2004 to 2016 (%)



Cast Iron: CNT (2018)



## **WATERWAY TRANSPORT**

Waterway transport can be divided into three forms of navigation:

Cabotage: navigation carried out between ports or points in the Brazilian territory;

Inland Navigation: carried out on inland waterways on a national or international route.

Long-haul navigation: it is carried out between Brazilian and foreign ports.

Waterway transport is widely used to transport liquid bulk, chemicals, sand, cereals, and products with a high added value, in containers. When it comes to costs, this transport model has an average fixed cost (ships and equipment). Variable costs are low. One of the advantages of this modal is the ability to transport bulky and heavy products, and the cost of loss and damage is considered low, when compared to other modes. One of the main disadvantages of this mode is the delay, since waterway transport is on average slower than rail transport and there is a strong influence of metrological conditions (RIBEIRO and FERREIRA, 2002).

## **AIR TRANSPORT**

Aviation is a fundamental mode of transport to move people when it comes to long distances in a short time. This type of transport is controlled by the National Civil Aviation Agency (ANAC).

Air cargo transport has a group of characteristics such as speed, versatility, reliability and safety and points to great application competencies within the new business logistics strategies. It has been an important factor for industrial development, facilitating intermodality and stimulating internal and external growth (DE LIMA and BELDERRAIN, 2008).

Demand has doubled in the last ten years, the amount of cargo transported in 2017 reached 1.25 million tons, thus reaching an increase of 8.9% compared to 2016 (CNT 2018).

## **RAIL TRANSPORT**

In Brazil, rail transport is mostly used to move homogeneous products in large quantities, and with distances considered long. According to DNIT, since 1996 when the privatization of railroads began, this modal has been showing significant growth in the amount of cargo movement in Brazil, with an increase of 26%.

## **RAIL TRANSPORT IN THE WORLD**

Brazil portrays a low dimension of railway network (km) when compared to other countries that have the same territorial characteristics.

As can be seen in Table 1, the United States has the largest rail network in the world, with almost 293 thousand kilometers, and the country also leads in cargo handling (ANTF, 2018).

However, Russia is the country where railways have the greatest expression in the transport matrix, approximately 80% (ANTF, 2018).

According to Vilaça (2013), in countries such as Canada, the United States, Russia and China, railroads have a share of 40 to 60% in the transportation matrix. In Brazil, on the other hand, rail transport is still 25%.

On the other hand, road transport has been growing and moves about 60% of cargo in the national territory, and this worrying distortion has generated economic, environmental and social costs (VILAÇA, 2013).

Table 1- Density of railway networks

Densidade das Malhas Ferroviárias			
	Área Milhões Km <sup>2</sup>	Ferrovias Mil Km	Ferrovias/Áreas (Km/ 1.000 Km <sup>2</sup> )
 EUA	9,83	292,56	29,8
 Índia	3,29	68,53	20,8
 África do Sul	1,22	20,99	17,2
 Argentina	2,78	36,92	13,3
 China	9,6	124	13,2
 México	1,96	15,39	7,8
 Canadá	9,98	77,33	7,8
 Rússia	17,1	87,16	5,1
 Austrália	7,74	36,97	4,8
 Brasil	8,52	29,18	3,4

Source: Adapted from Cia World Factbook and ANTF (2018)

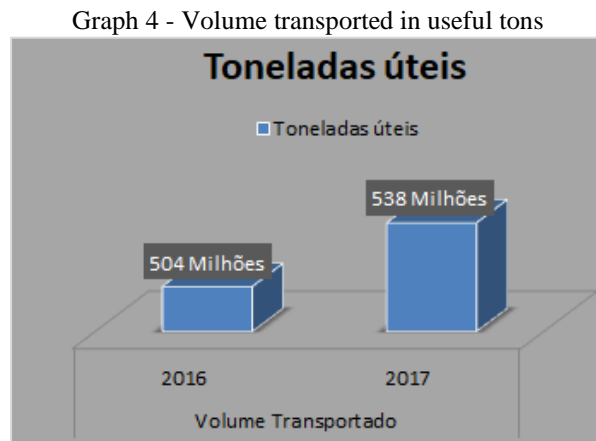
## RAIL TRANSPORT IN BRAZIL

The railway evolution in Brazil has undergone major transformations over the years. Its implementation began in 1854, with the construction of the iron work in Mauá in Rio de Janeiro. In the 1950s it reached approximately 37,000 km. Before being liquidated in 1999, the Federal Railway Network operated for more than 40 years. Concessions were made and the operation of the annihilated Rede Ferroviária Sociedade Anônima (RFFSA) network began to be carried out by private companies, and the state-owned company's assets were transferred to the National Department of Transport Infrastructure (DNIT, 2018).

After the administration of the railways was carried out by private initiatives, rail freight transport has undergone a huge transformation. Freight railways have considerably expanded the volume

transported, and in 2017 achieved an advantageous growth compared to 2016 and previous years (ANTF, 2018).

Graph 4 shows the values transported in useful tons in relation to the years 2016 and 2017.



Fonte: Adapted from ANTF (2018)

In 2017, 34 million tons more were transported than in 2016, an increase of 6.2%.

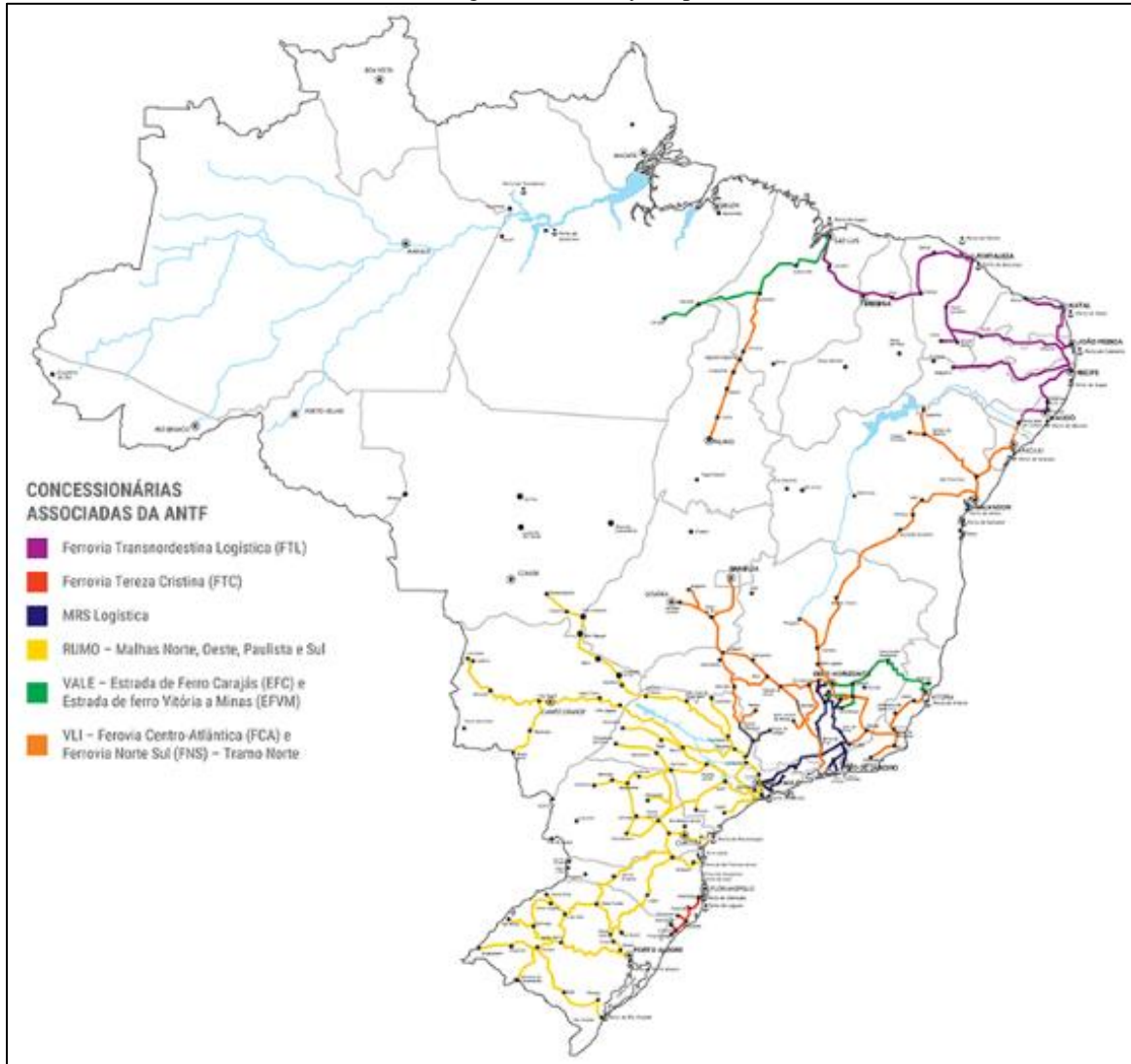
## RAIL MAP

The railway map has 27,782 km, and the companies related to the National Association of Railway Carriers - ANTF connect the Iron Quadrangle, in the South of Minas Gerais and other mining and steel centers, in addition to the major agricultural centers of the country.

Figure 2 shows the map where it is possible where the concessionaires linked to the ANTF are located.



Figure 2 - Railway Map



Font: ANTF (2016)

## INVESTMENTS

The lack of investment in the railway sector may be one of the major factors for the railway network not having a significant percentage of cargo transport in Brazil.

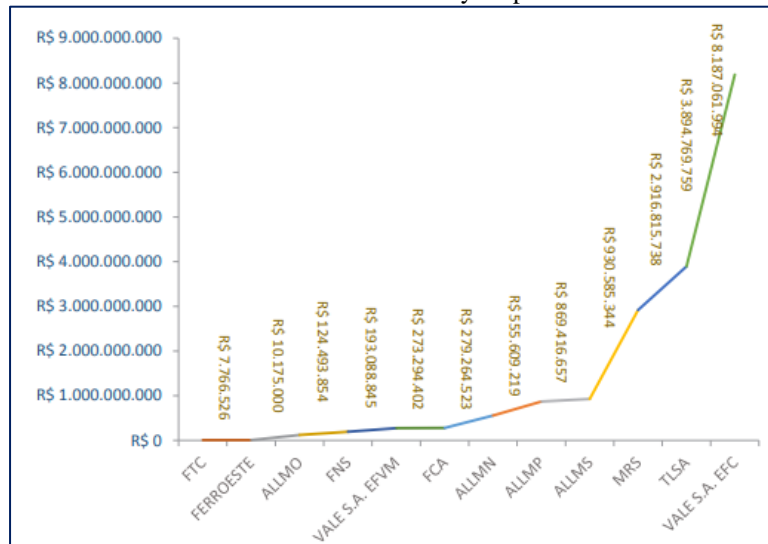
The government does not see potential in the expansion of the railway network, and has saved investments in this modal. In addition, it has faced difficulties in attracting investment from private companies. One of the reasons may be the fact that a kilometer of railroad costs approximately seven times more compared to the highway, and the construction of railroads also takes longer (GALDINO, HENRIQUE and GOMES, 2017).

The railway concessionaires send the Triennium Investment Plan within a deadline, for the purposes of regulation that is carried out by the National Land Transport Agency (ANTT).



Chart 5 shows the investment forecast for the three-year period from 2014 to 2016. The planned investment was 18,242,341,861 (eighteen billion, two hundred and forty million, three hundred and forty-one thousand, eight hundred and sixty-one reais).

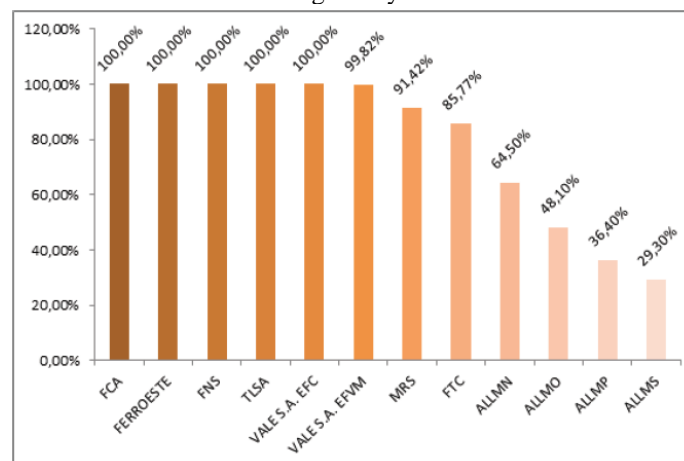
Chart 5 - Investment forecast for the three-year period from 2014 to 2016



Source: ANTT (2016)

Of the total investment forecast foreseen by the railway concessionaires, after ANTT's analysis, only part can be classified as regulatory investment. Graph 6 shows the regulatory investments after the analysis.

Chart 6 - Regulatory Investment

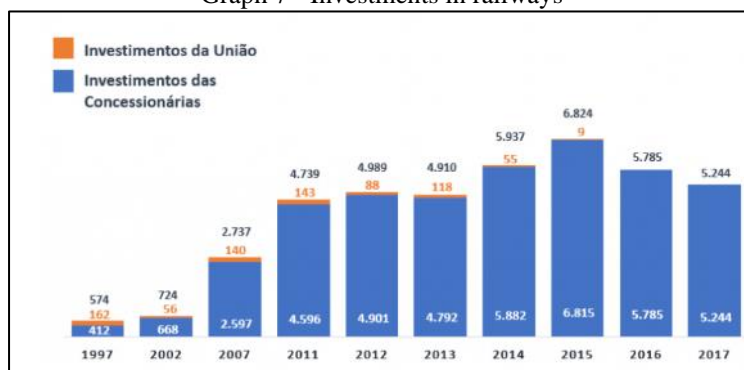


Source: ANTT (2016)

Since the beginning of the concessions, more than 92 billion reais have been invested, which have been allocated to the recovery and improvement of the railway network. In 2017, 5.244 billion reais were

invested, which contributed to the significant growth of the rolling stock fleet. Graph 7 shows the investments made by the federal government and private initiatives.

Graph 7 - Investments in railways



Font: ANTF (2018)

## PIPELINE TRANSPORTATION

Pipeline transportation is the transportation carried out by means of pipelines, and it can be divided into three ways:

Pipelines: transports oil, fuel oil, gasoline, diesel, alcohol;

Pipelines: transports rock salt, iron ore and phosphate concentrate;

Gas pipelines: transports natural gas (ANTT, 2018).

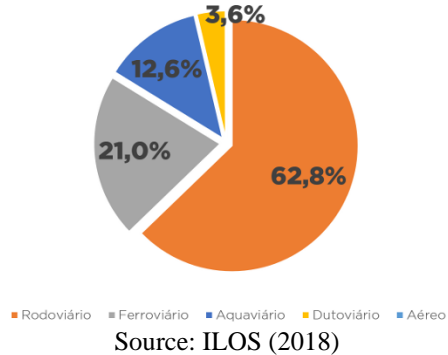
This modal is responsible for more than 3% of the cargo handled in the country, and in the oil and gas sectors it is classified as competitive and fits perfectly into the phases of the logistics chain. The pipelines have particular characteristics, such as a high degree of reliability, and their functionality cannot be affected by meteorological uncertainties or possible congestion. The high investments required for the construction and implementation of pipeline networks end up being compensated by advantages such as low variable costs, and the ability to transport large volumes (ILOS, 2014). The disadvantage of this modal is its slowness, which ends up making it unfeasible to move perishable food (RIBEIRO and FERREIRA, 2002). The pipeline modal has great trends for the movement of oil and oil products in Brazil, however, the pipeline network in the country is still very small. When compared to other countries, it has only 1,592 kilometers of oil mesh size, while oil products have 4,438 km of transportation. Inserting the transfer pipelines, the derivatives network has a dimension of 11,068 km (ILOS, 2014).

## PRESENTATION AND DISCUSSION OF RESULTS

Brazil has concentrated more than 60% of its cargo movements in the road mode, which transports three times more than the rail.

Graph 8 shows the transportation matrix, which shows the percentages that each modal expresses in the movement of cargo in the country.

Figure 8 - Freight Transport Matrix - Brazil 2016

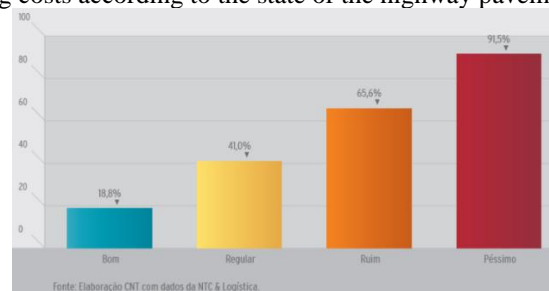


## DEBALANCED TRANSPORT MATRIX

There is a high concentration of demands for cargo handling in the road modal, that is, this fact has made the transport matrix unbalanced, and although this means of transport has a great representation in the Brazilian logistics sector, it has factors that have affected its efficiency and quality. One of the major problems is the lack of expansion of the paved road network, which has a very low percentage as already reported in the literature, in addition, the highway infrastructure is in a precarious situation. These factors lead to variable operating expenses, such as increased fuel use, tire wear, increased routes, among others, which consequently result in higher freight rates.

Graph 9 shows the increase in operating costs according to the quality of the pavement. According to estimates, the inadequacy can generate additional costs for the road freight carrier of up to 91.5% (CNT, 2018).

Graph 9 - Increase in operating costs according to the state of the highway pavement - Brazil (%)



Cast Iron: CNT (2018)

## Impacts

Recently, Brazil faced a major stoppage in the road modal that became known as "the truckers' strike", which practically paralyzed the country, and started from the dissatisfaction of the sector with the

high price of diesel. The shutdown directly affected several sectors of the economy, generating great losses and inconvenience for the population with the interruption of the supply of various products from supermarkets, gas stations, hospitals and the import sector. The impediment of the circulation of perishable foods such as milk and animal protein on the highways generated billion-dollar losses (CALGARO and VIVAS, 2018).

The strike lasted eleven days and took place between May 21 and 31, 2018, and in figure 3 you can see the impacts on the economic indicators that were severely affected. Practically all sectors were affected, and the confidence of entrepreneurs and consumers was shaken (GERBELLI, 2018).

According to the indicators, industrial production fell by more than 10.9% and the retail sector fell by 0.6%.

In view of this scenario, it is clear how dependent Brazil is on the road modal, and how the imbalance of the matrix intensified the impacts of the strike.

Figure 3 - Economic indicators affected by the truck drivers' strike



Source: (Gerbelli, 2018)

## INTEGRATION OF TRANSPORT MODES

It is of great importance that Brazil develops actions and investments to change the current transport matrix, so that rail, waterway and pipeline modes can have a greater participation in cargo handling. First, there is the need to expand the railway network, which can provide the expansion and balance of the matrix (FILHO, 2018).

The integration of modes can be an advantageous option, as well as the exploitation of the distinct advantages of each mode. The use of these benefits strategically can be an important solution to the problems of matrix imbalance.

### Integration of road and rail modes

The integration of road and rail modes, which have different characteristics, can be a great advantage. The road has agility and the rail has the capacity to transport large volumes of cargo. The movement of goods over long distances can be carried out through the railways to a certain location, then

passed on to the truck that would carry out the distribution to the end customers as illustrated in figure 4, with this competitiveness would increase and consequently freight values would suffer reductions (FILHO, 2018).

Figure 4 - Integration of rail and road modal



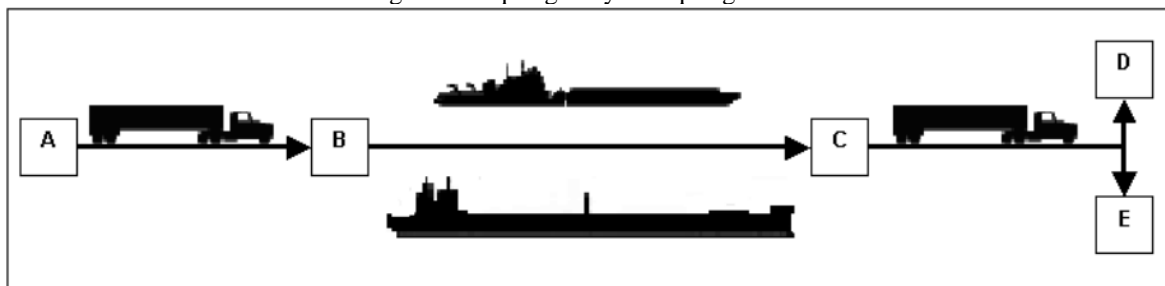
Source: Prepared by the author himself (2018)

### Integration of road and waterway modes

The combination of these two modes takes advantage of both the advantages of the road, which has a great practicality of locomotion, and that of the waterway, which can transport a large amount of cargo.

Figure 5 shows the illustration of the operation between these two, where the road modal collects the cargo from the point of origin, and moves it to the port, where the transfer is made to the waterway modal, which transports it to another port. The last step is the transfer of the cargo to the road modal, which is responsible for distribution to the final destination (CALABREZI, 2005).

Figure 5 - Squeeze-hydro-squeeze flow



Fonte: CALABREZI (2005)

In addition to the benefits of reducing freight costs, with the integration of modes, it is possible to have great benefits such as increased competitiveness in cargo transportation, reduction of freight value.

### FINAL THOUGHTS

In view of the scenario studied, it is possible to perceive the need for investments in the road sector, which is responsible for more than 60% of the country's cargo movements. As shown in the literature, the federal government's investments have been falling and are far behind when compared to the



demand that is concentrated in this modal. In addition, the infrastructure contains quality problems, and the paved network has a very small extension. The circumstances of the state of the highways could push freight prices up to a further 26.7%.

The problems related to the imbalance of the matrix are visible through the results left recently by the crisis that occurred in the road sector, where it affected important indicators of the economy, and left the country practically without essential products such as food, cooking gas and fuel. The severity becomes greater when even hospitals are no longer supplied with oxygen, and pharmacies are no longer supplied with medicines.

It is concluded that measures need to be taken to expand and diversify the Brazilian transport matrix, considering that the current situation offers great risks to the economy, inconvenience to the population and directly implies the country's competitiveness. It is necessary to promote and encourage investments in the sector by the federal government. Undoubtedly, the integration of modes and the expansion of railways may be the best path to take for the balance of the matrix. In addition, the expansion of the road network is indispensable, as well as the application of investments to improve the quality of existing pavements.

With these measures, it is expected the balance of the matrix, better quality of the highways, expansion of the road and rail network and consequently the reduction of freight, considering that the direct and indirect costs are part of the composition of the final value of the products.



## REFERENCES

- Agência Nacional de Transportes Terrestres - ANTT. (2016). Plano Trienal de investimentos das concessões ferroviárias 2014 a 2016. Retrieved November 15, 2018, from <http://www.antt.gov.br>
- Associação Nacional dos Transportadores Ferroviários - ANTF. (2018). O Setor Ferroviário de carga brasileiro. Retrieved November 17, 2018, from <https://www.antf.org.br/informacoes-gerais/>
- Associação Nacional dos Transportadores Ferroviários - ANTF. (2016). Mapa Ferroviário. Retrieved November 17, 2018, from <https://www.antf.org.br/wp-content/uploads/2016/12/mapa1.pdf>
- Calabrezi, S. R. D. S. (2005). A multimodalidade para o transporte de cargas: identificação de problemas em terminais visando à integração dos modais aéreo e rodoviário.
- Calgaro, F., & Vivas, F. (2018). Greve dos caminhoneiros causa prejuízo de R\$ 3 Bilhões ao setor de proteína Animal. Retrieved December 14, 2018, from <https://g1.globo.com/economia/noticia/greve-dos-caminhoneiros-causa-prejuizo-de-r-3-bilhoes-ao-setor-de-proteina-animal-diz-entidade.ghtml>
- Colavite, A. S., & Konishi, F. (2015). A matriz do transporte no Brasil: uma análise comparativa para a competitividade. SIMPÓSIO DE EXCELÊNCIA EM GESTÃO E TECNOLOGIA, 12, 28
- Confederação Nacional do Transporte - CNT. (2018). Cresce demanda por Transporte aéreo em 2017. Retrieved December 10, 2018, from <http://www.cnt.org.br/imprensa/noticia/cresce-demanda-transporte-aereo-2017-anuario-cnt>
- Confederação Nacional do Transporte - CNT. (2018). Somente 12% da malha rodoviária brasileira é pavimentada. Retrieved November 21, 2018, from <http://www.cnt.org.br/imprensa/noticia/somente-12-da-malha-rodoviaria-brasileira-pavimentada>
- Confederação Nacional do Transporte - CNT. (2018). Condições das Rodovias Elevam em 26,7% os custos dos transportadores. Retrieved November 21, 2018, from <http://www.cnt.org.br/imprensa/Noticia/condicoes-rodovias-elevam-custos-transportadores>
- Confederação Nacional do Transporte - CNT. (2017). Transporte Rodoviário: Desempenho do setor, infraestrutura e Investimentos.
- Costa, E. (2014). Transporte Dutoviário de Combustíveis no Brasil: Desafios e oportunidades. Retrieved December 13, 2018, from <http://www.ilos.com.br/web/transporte-dutoviario-de-combustiveis-no-brasil-desafios-e-oportunidade/>
- Departamento Nacional de Infraestrutura de Transporte - DNIT. (2018). Infraestrutura Ferroviária. Retrieved November 17, 2018, from <http://www.dnit.gov.br/modais-2/ferrovias>
- De Lima, M. G., & Belderrain, M. C. N. (2008). O fluxo logístico da carga aérea internacional brasileira.
- Eller, R. D. A. G., Sousa Junior, W. C., & Curi, M. L. C. (2011). Custos do transporte de carga no Brasil: rodoviário versus ferroviário. *Journal of Transport Literature*, 5(1), 50-64.





- Filho, A. M. (2018). Desequilíbrio congestionamento matriz de Transporte Brasileira. Retrieved December 15, 2018, from <https://www.unicamp.br/unicamp/ju/noticias/2018/06/15/desequilibrio-congestionamento-matriz-de-transporte-brasileira>
- França, V. (2014). Malha Ferroviária do Brasil é a mesma do Império. Retrieved November 23, 2018, from <https://economia.estadao.com.br>
- Galdino, P., Henrique, G., & Gomes, L. (2017). Dificuldades do modal ferroviário no Brasil.
- Gerbelli, G. L. (2018). Greve dos caminhoneiros provoca estragos na economia e deve dificultar a retomada. Retrieved December 14, 2018, from <https://g1.globo.com/economia/noticia/greve-dos-caminhoneiros-provoca-estragos-na-economia-e-deve-dificultar-retomada.ghtml>
- Instituto de Pesquisa Econômica Aplicada - IPEA. (2011). Gargalos e Demanda da Infraestrutura Rodoviária e os Investimentos do PAC: Mapeamento IPEA de obras Rodoviárias.
- Ribeiro, P. C. C., & Ferreira, K. A. (2002). Logística e transportes: uma discussão sobre os modais de transporte e o panorama brasileiro. XXII Encontro Nacional de Engenharia de Produção, 8.
- Vilaça, R. (2013). Infraestrutura e Competitividade logística. Retrieved November 20, 2018, from <http://www.tecnologista.com.br/portal/artigos/63523/infraestrutura-e-competitividade-logistica>