

## RAIL TRANSPORTATION IN BRAZIL: CHALLENGES AND OPPORTUNITIES

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### ABSTRACT

In May 2018, the consequences of being highly dependent on highway transportation modal in Brazil became evident. The worst strike in Brazilian history took place, which caused a shortage of food, general supplies, oil, medicines, across the country, due to the nationwide paralysis of roads provoked by the increase of the diesel prices, and consequent truck drivers' strike, causing an unprecedented shortage crisis in the recent history. This article investigated the railway transport in Brazil, in comparison to other modals of cargo transportation, as a solution to avoid the massive dependence on the highway modal. Key findings pointed out the necessity for network expansion, processes improvement, new technologies adoption, among others. The research results were attained through a multiple-methods approach, such as a descriptive case study and extensive archival research. This investigation is useful for managers, railway agents, decision-makers, students, academics, and overall practitioners. Analysis and discussion comprise the present work.

**KEYWORDS:** rail transportation, rail traffic, rail freight

### 1. INTRODUCTION

This paper examines rail transport mode in Brazil, as the unit of analysis (Yin, 1988). It aims to call into question (i) the rail passenger and cargo network in Brazil, in comparison to other transportation modals; (ii) the challenges and opportunities faced in the railway transportation sector in the last decade. We adopted a qualitative, multi-method approach, such as extensive archival research combined with a descriptive case study. In spite of the extensive railway network in Brazil (21 percent of the total transportation modals), the country is still highly dependent on the highway transport mode (61 percent), as illustrated in the following Figure 1. The discrepancy became a real problem in May 2018, when Brazil faced the worst truck drivers' strike in its history (also called the diesel crisis), which caused a shortage of food, general supplies, medicines, oil, and goods across Brazil among others, due to the nationwide paralysis of roads provoked by the increase of the diesel prices, and consequent mainly truck drivers' and, in a lesser extent, oil workers' strike, causing an unprecedented shortage crisis in the history of Brazil.

Concerns have been raised about the highway modal in Brazil, in comparison to other modals, such as railways. Therefore, in this article, we seek to shed light on alternatives to highway transportation in Brazil, focusing on railway networks.

The present investigation has also been primarily motivated by recent studies on transportation modals in Brazil, regarding (i) rail light vehicles in Brazil (Dias, M.O., 2018); (ii) public railway transport (Dias, M.O. & Teles, 2018); (iii) airway modal, such as Congonhas Airport - CGH (Dias, M.O. 2020); Guarulhos International Airport - GRU (Dias, M.O.; 2019); Brasilia International Airport - BSB (Dias, M.O.; 2019b); Rio de Janeiro International Airport Galeão/Tom Jobim - GIG (Dias, M.O. & Albergarias, 2019, 2019b); Santos Dumont Airport - SDU (Dias, M.O., 2019c, 2019d); (iv) air passenger transportation in Latin America (Dias, M.O. & Pessanha, M. T., 2019) and (v) aircraft industry (Cruz, B. & Dias,

M.O., 2020), among other recent studies. Figure 1 depicts the share of transport modals in Brazil, highlighting railway mode:

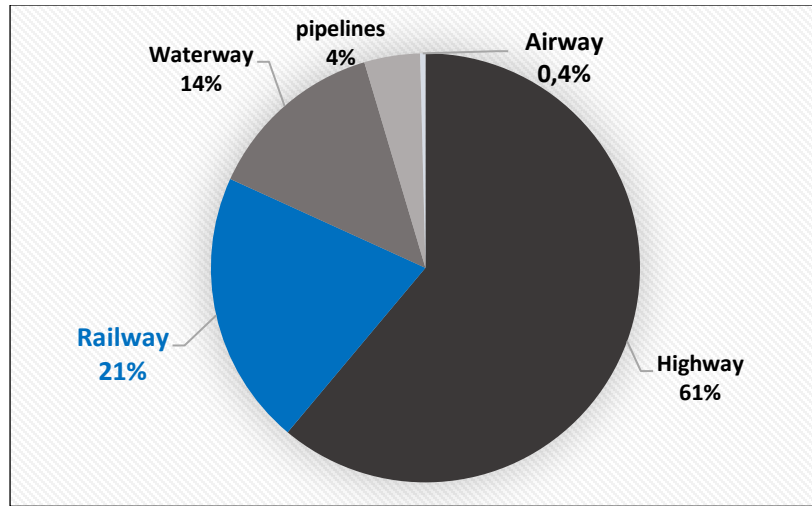


Figure 1: Transport Modals share in Brazil. Source: CNT, 2020.

Observe in Figure 1 that Brazil is mostly dependent on highway transport (61 percent), according to the national representative agency, *Confederação Nacional dos Transportes - CNT* (National Transport Confederation). Railway modal is responsible for 21 percent of the total transportation in Brazil. Figure 2 illustrates the evolution of the Transport GDP, in comparison with the GDP in Brazil, 1996 to 2018, according to CNT, as follows:

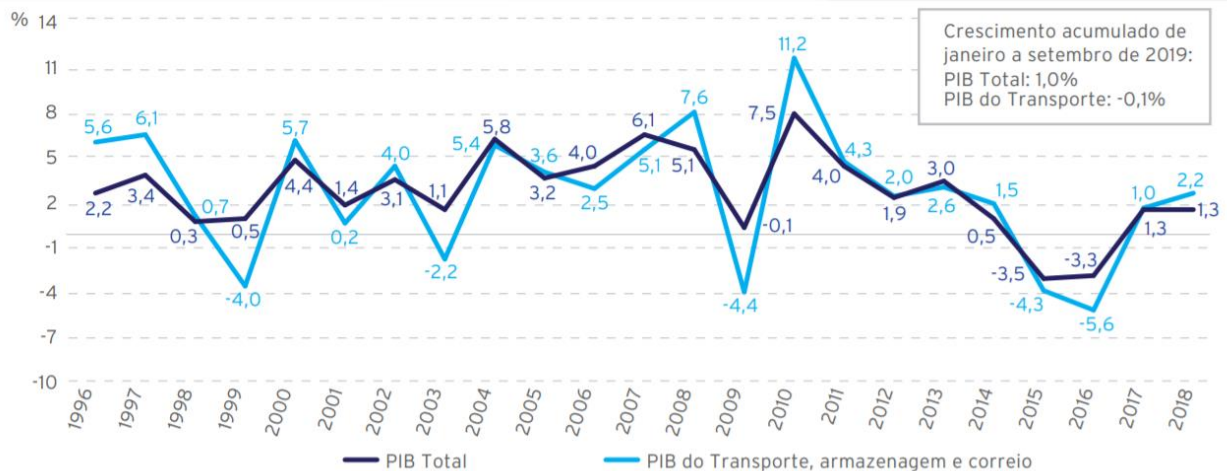


Figure 2: Transportation GDP x National GDP (1996-2018). Source: CNT, 2020.

Observe in Figure 2 that Transportation GDP has been gradually recovered in the period between 2016 to 2018. In 2016, the weak performance of the period aforementioned (-5.6) was due to the unprecedented political and economic crisis, corruption scandals, a former president Lula da Silva convicted to 12.5 years imprisonment for corruption and laundry money, as well as the impeachment of President Dilma Rouseff, on August 31, 2016. Both from left-wing Labor Party (PT). Note that the Transport GDP is directly proportional to the Brazilian GDP.

Last, from September 2016 to December 2018, under Michel Temer office - former vice president, Transport GDP shifted from -5.6 to 2.2, a slow upturn recovering.

Finally, observe in the following Figure 3, the slow but constant increase of the rail performance in Brazil, in the last decade (2006-2018), per billion ntk (net ton kilometers):

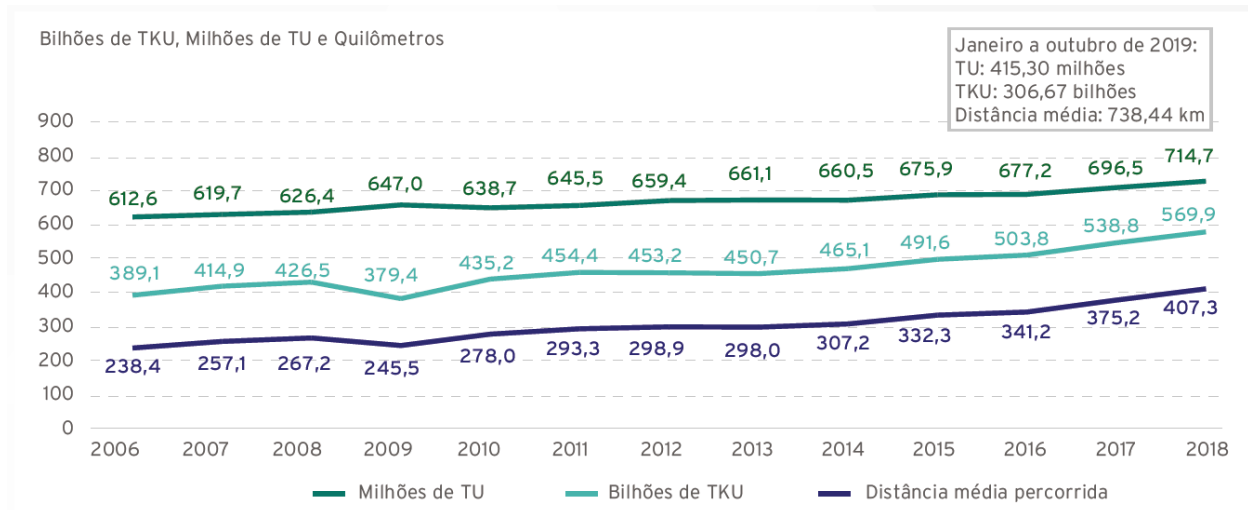


Figure 3: tonnes transported by rail, ntk and average distance traveled in km (2006-2018). Source: CNT, 2020.

Note in Figure 3 that in 2018, cargo transported in the Brazilian railways corresponded to 714.7 billion t, from which 569.9 net ton kilometers, and 407.3 km of average distance traveled. In comparison to the ten countries by rail transport network size, Brazil occupies the seventh position, with 38,743 km of railways, according to the International Union of Railways, sector representative, as illustrated in the following Table 1, as follows:

Table 1: List of the ten countries by rail transport network size

Rank	Country	Length (km)	Data year
1	European Union	218,783	2016-17
2	United States	149.910	2017
3	China	131.000	2017
4	Russia	85.500	2017
5	India	68,442	2019
6	Canada	49,452	2017
7	Brazil	38,743	2014
8	Germany	38,594	2017
9	Argentina	36,917	2014
10	Australia	33,168	2017
11	France	29,273	2017

Source: UIC, 2018

The next section presents the methods and limitations of the present research.

## 2. METHODS AND LIMITATIONS

In this research, we opted for a single descriptive case study, combining multiple qualitative methods approach, such as extensive archival research and case study, in which unit of analysis is the railway transport network in Brazil (Yin, 1988). This article also compiled the inductive reasoning with interpretive approach.

This research is limited to railway transportation, regardless of other transport modals, such waterways, highways, airways, and ultimately pipelines (see Figure 1). This study is also limited to passenger and cargo transportation.

Finally, this study is limited to the Brazilian regulations, norms, resolutions, as well as the respective Federal Laws, such as Law 8,031 / 90, from April 12, 1990.

This study is limited to (i) the eleven countries regarding network size (ii) percentage participation (%) of groups of goods in the total volume transported; (iii) national x transportation GDP; (iv) principal concessionaries operating the railway system; (v) market share; (vi) cost per ton transported per modal, as well as relevant facts and figures regarding the railway activity in Brazil.

### 3. RAILWAY NETWORK IN BRAZIL

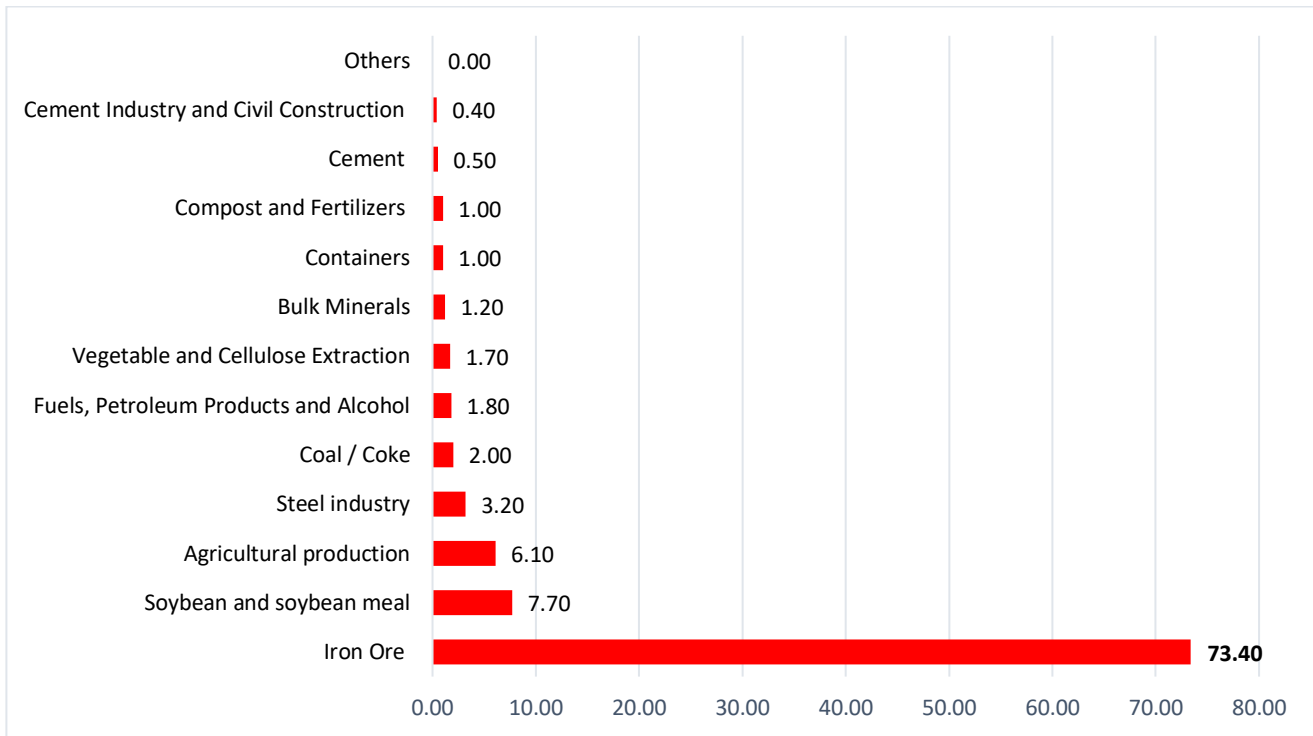
Iron ore is the most transported cargo in Brazil for the last five years (73.4 percent of the total railway transport, from 2015 to 2019), as illustrated in Table 2, as follows:

**Table 2: Percentage participation (%) of groups of goods in the total volume transported of useful tons per railways - Brazil - 2015 to 2019**

<i>Goods transported</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>2019</i>
Iron Ore	77,00%	78,90%	77,30%	77,50%	73,40%
Soybean and soybean meal	4,70%	4,50%	5,60%	6,80%	7,70%
Agricultural production	5,9% 4	4,90%	6,00%	4,80%	6,10%
Steel industry	3,10%	2,90%	2,90%	2,80%	3,20%
Coal / Coke	2,30%	1,90%	1,90%	1,90%	2,00%
Fuels, Petroleum Products and Alcohol	1,90%	1,70%	1,60%	1,50%	1,80%
Vegetable and Cellulose Extraction	1,10%	1,10%	1,20%	1,40%	1,70%
Bulk Minerals	1,50%	1,40%	1,40%	1,20%	1,20%
Containers	0,80%	0,70%	0,70%	0,80%	1,00%
Compost and Fertilizers	0,70%	0,90%	0,70%	0,70%	1,00%
Cement	0,60%	0,60%	0,50%	0,40%	0,50%
Cement Industry and Civil Construction	0,60%	0,40%	0,30%	0,30%	0,40%
Others	0,00%	0,00%	0,00%	0,00%	0,00%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

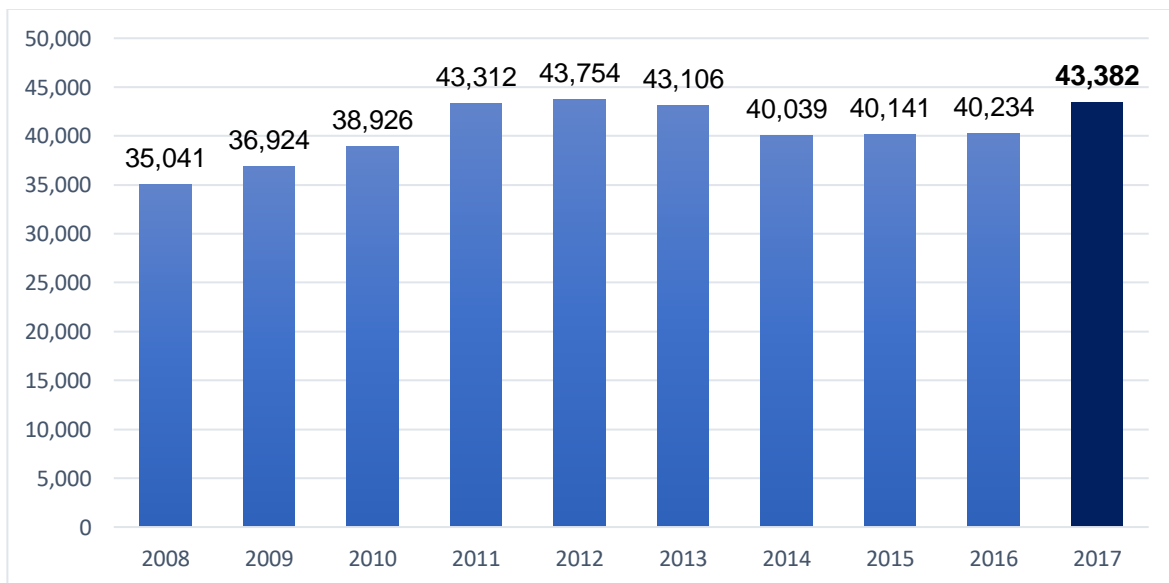
Source: CNT, 2020

Figure 4 depicts the total share cargo transported in 2019, according to the CNT (2020). Observe in the following Figure 4 that iron ore is the most transported cargo in 2019. Note that besides iron ore, soybean, agricultural production, steel industry, and coal correspond to 92.4 percent of the total cargo transported in the Brazilian railways in 2019. In other words, the production of raw material is widely transported in Brazil, interconnected to other modes of transport, such as waterways, airways, and highways. Cement, containers, bulk materials, vegetables, and cellulose are essentially transported in highways. Therefore, the trucker's strike in 2018 caused a significant impact on supply in Brazil, once goods such as medicines, food, oil, among others, are primarily transported in highways, not railways.



**Figure 4: Percentage participation (%) of groups of goods in the total volume transported of useful tons per railways in 2019.**  
Source: CNT, 2020.

In 2017, there were 43,282 workers employed in the sector, as highlighted in the following Figure 5, as follows:



**Figure 5: People employed in the railway sector in Brazil, from 2008 to 2017.** Source: CNT, 2020.

Observe in the previous Figure 5 that the highest rates of employment occurred in 2012, while from 2014 to 2016, the employment rates decreased and stabilized around the 40 thousand workers. Conversely, in 2017, the sector grew approximately 7.8 percent, in comparison with 2016. Until 2018, the Brazilian railways were operated by 4,312 locomotives, and 100,858 wagons (CNT, 2020). In total, the 407,301 t were transported by the following twelve concessionary operators regarding the railway network in Brazil, illustrated in Table 3:

Table 3: Volume transported in t per concessionary

Concessionary	2008
RMN - Rumo Malha Norte	35.280
RMO - Rumo Malha Oeste	879
RMP - Rumo Malha Paulista	4.980
RMS - Rumo Malha Sul	14.391
EFC - Estrada de Ferro Carajás	184.376
EFVM - Estrada de Ferro Vitória a Minas	69.752
FCA - Ferrovia Centro-Atlântica	24.548
EFPO - Estrada de Ferro Paraná Oeste	159.201
FNS - Ferrovia Norte-Sul - Tramo Norte	8.299
FTC - Ferrovia Tereza Cristina	220
MRS - MRS Logística	63.765
FTL - Ferrovia Transnordestina Logística	610
<b>Total</b>	<b>407.301</b>

Source: CNT, 2020

Note in Figure 6 the railway market share, regarding the operators of the sector:

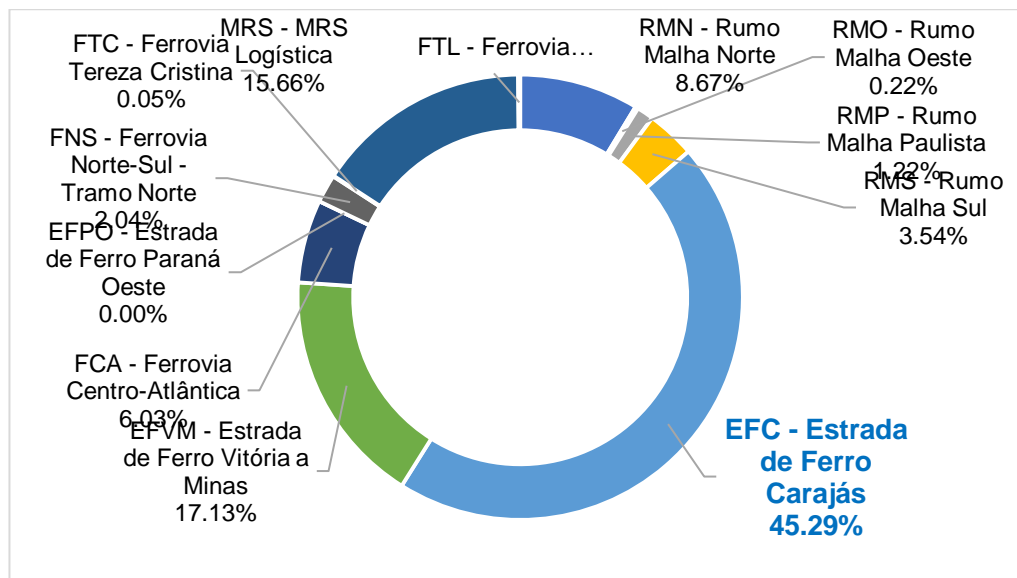


Figure 6: Brazilian railway market share by concessionary. Source: CNT, 2020.

#### 4. DISCUSSION

The current investigation, in comparison to the previous body of research, has the merit of compiling sparse data regarding railways in Brazil, providing a comprehensive overview on the present economic sector, useful to students, academics, decision-makers in the air cargo sector, managers, and other practitioners. This research has implications in other fields of research, such as (i) aircraft manufacturer industry (Cruz, B.S. & Dias, M.O., 2020; Dias, M.O., Teles, and Duzert, 2018; Dias, M.O. and Duzert, 2018), (ii) mining industry (Dias, M.O., & Davila, 2018); (iii) e-business negotiation (Dias, M.O. & Duzert, 2017); (iv) automobile industry (Dias, M.O., Navarro and Valle, 2013, Dias, M.O., et al., 2014; Dias, M.O., et al., 2013); (v) non-market forces (Dias, M.O. & Navarro, 2018); craft beer industry (Dias, M.O. & Falconi,



2018; Dias, M.O., 2018); (vi) public administration (Dias, M.O., 2018); (vi) Non-governmental organizations (Paradela, Dias, M.O.; Assis; O., J.; Fonseca, R. (2019); (vii) governmental negotiations (Dias, M.O. & Navarro, 2017); (viii) copier manufacturer industry (Dias, M.O., 2012); (ix) streaming film industry (Dias, M. O., & Navarro, 2018), (x) craft beer industry (Dias, M.O., 2020; Dias, M.O. & Falconi, 2018), among others. Law 8,031 / 90, from April 12, 1990, instituted the National Privatization Program (PND), representing the privatization in the railway sector. The process of privatization of the railway sector started in October 1992, after the inclusion of *Rede Ferroviária Federal S.A.* (RFFSA) in the PND, by Decree 473/92 (ANTT, 2020). Former state-owned company, responsible for the operation of 18 major railways in Brazil, *Rede Ferroviária Federal Sociedade Anônima* (RFFSA), was founded in 1957 with the authorization of Law No. 3,115/57, and dissolved in accordance with Decree No. 3,277/99, extinct officially under Provisory Measure (MP) 353, of January 22, 2007, converted into Federal Law No. 11,483, from May 31, 2007 (Brasil, 2007). The major concessionary can be observed in Figures 5, and their share in the Brazilian railway system in Figure 6, as aforementioned.

Therefore, the railway network in Brazil was privatized in the last decade. However, according to the National Land Transportation Agency (Agência Nacional de Transportes Terrestres - ANTT), from January to October 2019, railway production total Brazilian production fell 11.8% in comparison with the same period of 2018 (ANTT, 2020), and the accumulated in 2019 was 415.30 million t. In terms of railways per territorial area, Brazil has a long path into development: Brazil occupies a territorial area of 8.511.000 km<sup>2</sup>, with 38,743 km of railways, or approximately 0,0045 km of railways per km<sup>2</sup>. France, for instance, has a territorial area 643.801 km<sup>2</sup> (Brasil is approximately 13 times larger than France), with 29,273 km of railways, or approximately 0,045 km of railways per km<sup>2</sup>. In comparison, roughly speaking, France has ten times more railways per km<sup>2</sup> than Brasil.

One of the reasons for the discrepancy can be expressed by the Plano Nacional da Indústria Automobilística (National Plan for The Automotive Industry), through Decree nº 41.018/1957, when the Brazilian Government, under Juscelino Kubistcheck office (1955-1960), decided to invest heavily in automobiles, and therefore, highways, rather than increasing the investments on railways. It helps to explain why Brazil depends on highways. The Brazilian railway network is highly ineffective and expensive: while in the USA, the cost per net ton transported per kilometer (ntk) is USD, in Brazil, costs USD 74 (Fiesp, 2020). According to the Center for Studies in Logistics and Management (Centro de Estudos de Logística e Gestão - CELIG), from Federal University of Rio de Janeiro (UFRJ), the cost of highway transportation is six times more expensive than the cost of the railway transportation, per km (UFRJ, 2020). The Brazilian government has spent more investments in the highway infrastructure than in railway ones, which consequences were felt on the trucker's strike mentioned above, in May 2018. Considering the transportation of 1 thousand tons per kilometer, the cost of transportation in the railways is approximately USD 10, in the highways USD 60, by waterways USD 15, for airways USD 399, and the pipelines USD 17, as illustrated in the following Figure 7:

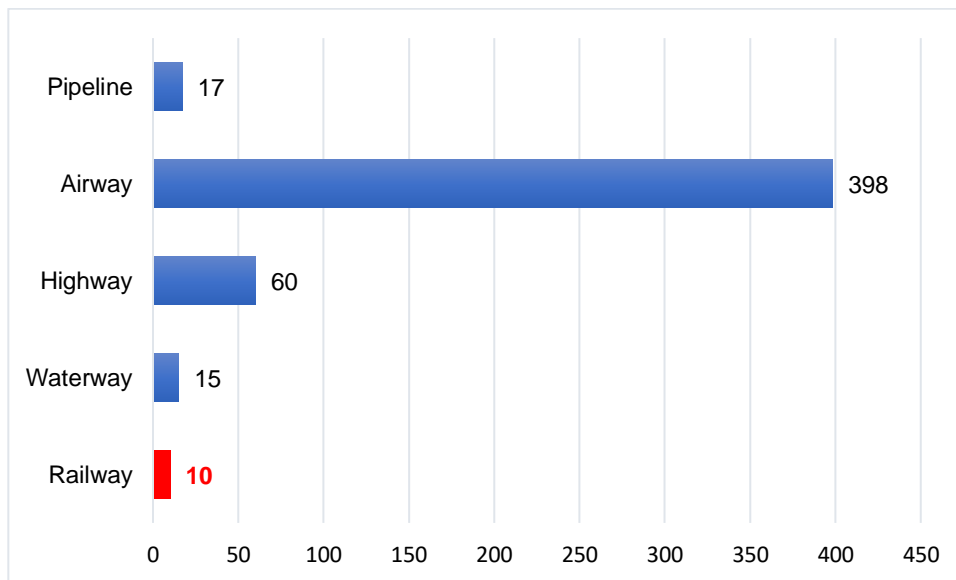


Figure 7: Cost per km transported in different modes of transportation in Brazil. Source: UFRJ, 2020.

Observe in Figure 7 that railway transportation is the most economically viable in Brazil. The Brazilian Government should invest in railways, to increase the effectiveness of Brazilian transportation, in comparison to other countries. To make transportation costs cheaper in the country. Since 2017, the economy Brazil has been registering growth rates favorable, after a retraction accumulated 6.7% in the biennium 2015-2016 (CNT, 2020). Technically, Brazil left the recession, but it is not enough to counterbalance the process of economic recovery.

A robust Modernization in the current railway infrastructure is recommended, as well as unification of the gauge system in Brazil (in Brazil, there are three-gauge systems, metric (1000 mm), standard (1435 mm), and the Irish system (1600 mm), while in most Europe, for instance, only the standard gauge system was adopted, what makes difficult the interchange between gauges. Simplifying, a train designed to operate an Irish gauge does not operate in a metric gauge, unless the three systems are available, increasing, even more, the final cost for rail transportation in Brazil.

## **5. FUTURE RESEARCH**

Future research is encouraged on the railway transport modal in Brazil, regarding the acceleration of the statistics compilation (in 2020, only 2018 statistics on the sector are available in the official database, for instance), to bring data to more fundamental research. We also encourage research on rail fleet expansion; modernization of the railways in Brazil, increasing the number of passengers transported in even more populated cities. Finally, further studies on the railway transport network performance in Brazil regarding the other transport modes' new investment opportunities are strongly stimulated.

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