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# From Animal Traction to LRV: Public Rail Transportation in Rio de Janeiro

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**Abstract:** ***This case investigated the evolution of public transportation tramway system in Rio de Janeiro, Brazil, from animal traction to the newly Light Rail Vehicle (LRV). It was originally designed to integrate the network modals, rail and waterways. Today, it interconnects bus lines, rail, water, metro, BRT, cruise lines, even cable cars, within a city of approximately seven million inhabitants. The powered animal traction system was launched in 1859, substituted by steam and then electrical vehicles (bondes). Extinct in 1963, the tramway network was then substituted for bus lines. In 2016, for the Olympics, the newly RLV system began transporting approximately 70 thousand passengers per day, on a 15-kilometer network. The newly tramway system abolished entirely catenary overhead line, powered by Alstom's APS ground-level power supply system. LRVs. This single case presents the history of the Tramway system in Rio, as well as featuring the analysis and discussion of the network transport integration and impact to the current Rio public transportation system, in comparison to past ones. Recommendations for future research complete the present work.***

**Keywords:** light rail vehicle (LRV); public transportation; tramway network

## 1. Introduction

This article investigated the case on the tramway system in Rio de Janeiro state, southeastern Brazil, from animal traction to LRVs, as unit of analysis of the descriptive single case study [1].

The tramway network in Rio de Janeiro started its operation on January 30, 1859, at D. Pedro II Imperial Regime (1822-1888). Rio de Janeiro was the second Brazilian capital, from 1763 to 1960 - the first was Salvador, from 1500 to 1763. In 1961 the capital was transferred to Brasilia [2].

Rio de Janeiro state, which capital is Rio de Janeiro City, has near seven million inhabitants [2]. The newly created tramway system (RLV), was designed to transport 70,000 passengers per day, aiming at interconnecting several arrival points in Downtown Rio, such the interstate bus terminal, know as *Terminal Rodoviário Novo Rio*, Rio de Janeiro Port - *Porto do Rio Janeiro*, and Santos Dumont Airport (Santos Dumont Airport), all of them located at the central region.

The current tramway network integrated the *Porto Maravilha Project*, designed to rebuild Downtown Rio for Olympics 2016, regarding Eduardo Paes (Mayor) administration (2009-2017).

Neighborhoods of Saúde, Gamboa and Santo Cristo gained new public transportation services, preserved their history, adapted to the dynamics of Rio. The current tramway system also connects trains, metro, waterway public transportation), bus stations, airport, and cruise lines (port), connecting important areas Rio de Janeiro.

The current RLV system was estimated at BRL 1.2 billion (approximately $350 million). Brazilian Federal Government (BFG financed BRL 525 million (approximately $100 million), and Public Private Partnerships, or private equity companies (PPP), financed BRL 632 million (approximately $150 million).

The public transportation modals and its interconnections in Rio are depicted in Figure 1, as follows:


**Figure 1:** Public transportation network at Rio de Janeiro: modal interconnection. Source: Prefeitura do Rio de Janeiro, 2018.

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

## 2. Research Methods and Limitations

The present study is an interpretive, qualitative research, inductive reasoning, multiple methods combination of descriptive single case study [1], along with archival research, and direct observation. The unit of analysis is the tramway public transportation network in Rio de Janeiro City, since 1859 to these days.

This research also is limited by the following Brazilian Laws: (a) Federal Constitution 1988 [3], Art. 5, item XV: "free locomotion in the national territory in time of peace, and any person, under the law, may enter, stay or leave with their property" [3](XV). Also the Master Plan on Urban Transportation for Rio de Janeiro [4].

The current RLV tramway network is part of the Porto

Maravilha Project, through Law n.° 5.128/2009 [5]. This study is also limited to the following Municipal Decrees: (a) Municipal Decree 6065, from April/2016, which established penalties to the users of RLV system who don't pay spontaneously for the ride [6], and (b) Decree Rio nº 41627 from May 3, 2016, which issues the public passenger transport service by means of light rail vehicles (VLT). The next section presents the Background of LRVs usage in Rio [6].

## 3. Background

### 3.1 History of Tram system in Rio de Janeiro

Trams in Rio were initially named *bondes* – adapted from English language *bond* – connect), with the idea of connecting places. The first tram (*bonde*) started its operation on January 30, 1859. The first *bondes* connected a seven-kilometer length route, from Praça Tiradentes (then Largo do Rocio, downtown Rio) to Usina, Tijuca (North zone Rio), according to Figure 2, as follows:


**Figure 2** Tramway routes. Source: Prefeitura do io de Janeiro, 2018

The first trams (*bondes*), were horse-powered, as depicted in Figure 3, as follows:

**Figure 3:** Horse powered trams. Source: Prefeitura do Rio de Janeiro, 2018

Later, the animal-powered trams were substituted for steam-powered trams, who started to operate in 1862. Then, in 1898, overhead catenary-powered trams (electric power), started to circulate, as depicted in the following Figure 4:

**Figure 4:** Electric-powered trams. Source: Prefeitura do Rio de Janeiro, 2018

The current LRV network from today is actually a fraction of the 2,250 km of lines existing in 1940, carrying 1.5 billion passengers per year, in 4,200 passenger cars, 50 percent operated by Canadian companies (approximately 2,200 cars - North American about 900, British, 400 and Brazilians the rest). There were 30,000 employees in these companies, at that time [6].

In a controversial gesture, the former state governor, Carlos Lacerda, issued the State decree N°1,507, from January 19, 1963, promoting buses as the only vehicle admissible in the public transportation system.

On May 21, the *bondes* (trams) were extinct. The substitution proved to be disastrous, since buses are polluting, fossil fuel powered, in comparison to the silent tramway network. The Santa Teresa *bonde* was kept as a *pièce de resistance*, living memory from the most important passenger transportation history in nearly one century [6].

### 3.2 From animal traction to RLV: the evolution of the tramway system transportation in Rio

The decision of tramway system extinction was disastrous. The trams were a non-polluting, cheap fares, popular, covering wide-range routes, when compared with the polluting, fossil fuel, bus system transportation. Traffic in Rio de Janeiro plunged into chaos, in consequence.

In the military dictatorship period (1964-1985), Rio de Janeiro State Government started to build the Metro lines in 1975. The first line operates since May 5, 1979, and transports near 850,000 passengers per day, in 4 lines and 58 km long routes [6].

Later, in 2012, the LRV network was designed to encompass initially two lines and 26 stops, 15,6 km rail extension. RLV system (also called *VLT Carioca*), is part of the Porto Maravilha project, projected to eliminate 60 percent of bus and 15 percent of car traffic in downtown Rio [6].

*Porto Maravilha* had a cost of BRL 3.5 billion

(approximately $ 2 billion). RLV expenditures reached 1.2 billion BRL (approximately 400 million) [6].

Eduardo Paes, Rio de Janeiro City Mayor, opened up the public bidding process, as per Law 8.666/93 and 8.883/94 on the RLV system project, on July 2012, the [8]-[9]. The local process was held on April 30, 2013, won by the VLT Carioca (see Figure 5), formed initially by Invepar, Odebrecht TransPort, CCR, RioPar, Benito Roggio Transporte and RATP, for 25 years term concession.

VLT Carioca consortium is the result of four companies: (a) CCR, 24.4 per cent; (b) Invepar 24.4 per cent; (c) Odebrecht TransPort, 24.4 per cent; (d) Rio Par, 24.4 per cent, and (e) BRT/RATP, 2.25 per cent (RLV system, 2018), as depicted in Figure 5, as follows:

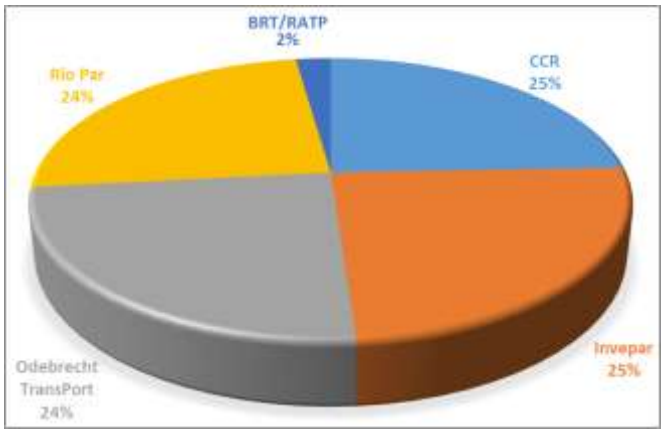


**Figure 5:** VLT Carioca Concessionaire share cdistribution. Source: VLT Carioca, 2018.

Although the RLV was starting its operations in July 2016, the traffic tests on line 1 started in October 2015.

At the end of February 2016, the first test was carried through Av. Rio Branco, with the VLT taking the road from the Bus Station to Cinelândia. Line 2 tests began in the second semester of 2016 (Prefeitura do Rio de Janeiro, 2018; VLT Carioca, 2018).

Finally, the inauguration of the RLV system took place on June 5, 2016, between Santos Dumont and Museums stop, just two months before the Olympics 2016 start. On December 2, 2017, the inauguration of the Praia Formosa stop, the final section of both lines 1 and 2.

### 4.2 RLV routes extension

The newly RLV encompasses lines 1, 2 and 3, as depicted in Figure 7, as follows:


**Figure 6:** RLV system Lines 1,2 and 3. Source: VLT Rio, 2018

**Line 1** started on June 5, 2016, connecting Santos Dumont Airport to Novo Rio Interstate bus station. It performs 6.4 kilometers, with 20 stops, with access to subway lines 1 and 2, the *Providencia* cable car and the Padre Henrique *Otte* bus terminal, as well as the airport, the bus station, and the Pier *Mauá* cruise terminal.

**Line 2** connects Praça XV to the Novo Rio Interstate bus station. It is comprised of 12 stops, with access to the waterways, boat terminal of Praça XV, along with lines one and two of Metro, and trains of SuperVia.

**Line 3** connects Santos Dumont Airport to the Center train hub, on a four km length. Line 3 has ten stops and connects lines 1 and 2.

### 4.3 Alstom Citadis 402 RLVs

The French company Alstom was the responsible for building the 32 modern trams to the RLV system, five were built, at La Rochelle, France, later shipped to Brazil, and 27 at Taubaté, São Paulo state [10].

Each tram has 44 m long, 3.82 m height, 2.65m wide, with a nominal passenger capacity of 415 passengers, average speed of 15 km/h and maximum speed of 50 km/h, bi-directional with air conditioning system, working on a standard gauge (1445 mm gauge), eight doors on each side (16 in total)[10], as depicted in Figure 8, as follows:

**Figure 8:** Alstom Citadis 402. Source: Author's picture.

Figure 9 depicts the final tram stop at the Santos Dumont Airport, as follows:

**Figure 9:** Santos Dumont Airport terminal. The Airport at the bottom. Source: Author 's picture

### 4.4 Citadis 402 Power supply system

The newly RLV Rio has no overhead lines (catenary-free system)[10]. *Citadis 402* has two power systems: (a) APS ground-level power supply system, and (b) on-board supercapacitor-based energy storage (SRS (see Figure 10). Both power supply systems were developed by Alstom [10].

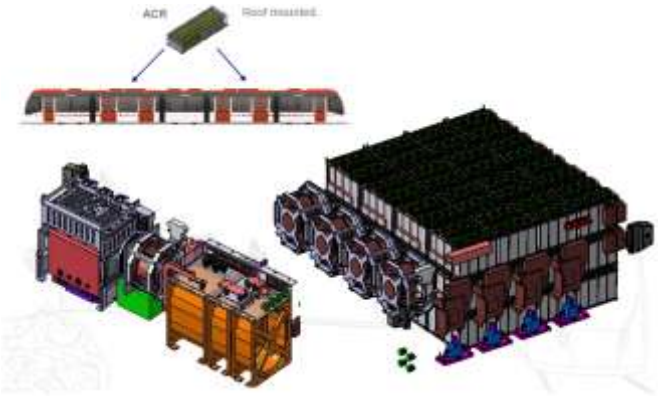

**Figure 10:** Alstom's Supercapacitor. Source: Alstom, 2018. Reprinted under permission

Alstom's APS power supply system preserves Rio de Janeiro's historical heritage, since there are no overhead lines, which pollute the City landscape visually [10].

Figure 11 depicts the APS ground-level power supply system, as follows:

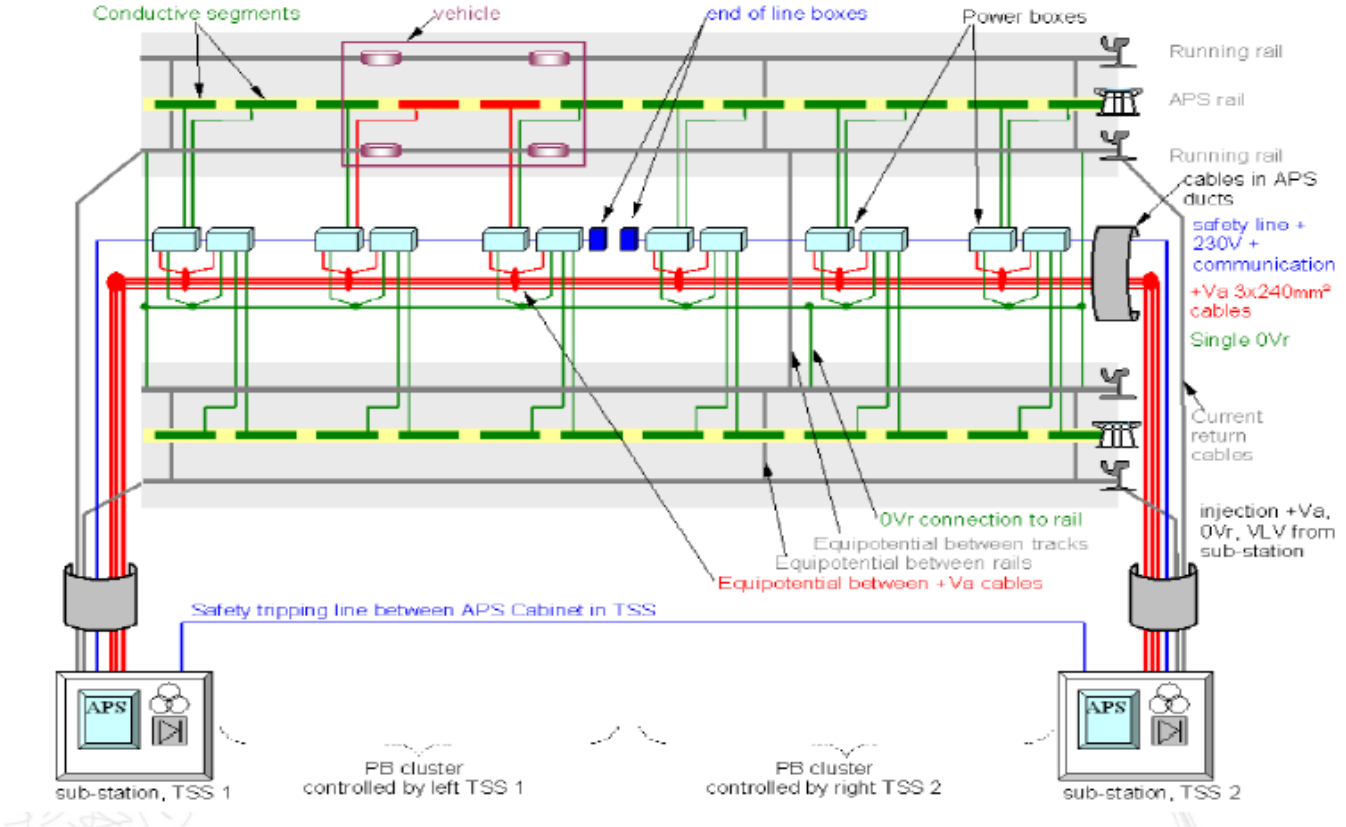


**Figure 11:** APS Ground-level power supply system. Source: Alstom, 2018. Reprinted under permission

In the next section, the case analysis is presented, followed by discussion and recommendations for future research.

## 4. Case Analysis

### 5.1 From XIX to XXI century: the evolution of the tramway system

In Table 1, metro is compared with RLV Rio:

**Table 1:** Comparison between metro and RLV
Source: VLT Carioca, 2018

| Feature | VLT Carioca | Metro Rio (subway) |
|---|---|---|
| Passenger Capacity | 70,000 per day | 850,000 per day |
| No. of composition | 32 | 32 |
| Gauge | Standard (1432mm) | Irish (1600mm) |
| Number of Trains | 32 | 180 |
| Line Extension | 15,6 km | 57 km |
| Speed | 15 km/h | 80 km/h |

The Metro Rio, as depicted in Table 1, carries 10 times more passengers than RLV, and has six times more trains than RLV.

Nevertheless, Metro Rio does not have routes encompassing the port areas, covered by RLV, four times longer, and 6 times faster than RLV. Both systems are complementary. Evidence suggests non-excluding systems [12].

The National Council on Environment (*Conselho Nacional sobre o Meio Ambiente*, Resolution nº1 from January 23, 1986 [11], issued established the minimum requirements to pollution in urban environments. RLV comply with all of them, such as non-air-polluting and low-noise pollution.

## 5. Discussion

From past *bondes* to RLVs, there are roughly one hundred years of evolution. Within this period, the traffic enlarged more than 100 times, Rio population more than 20 times. Nevertheless, RLV proved to be the right choice to passenger transportation in Rio, as complementary one, integrated to other modals of public transportation.

RLV tramway system actually reduced the number of private vehicles the streets of the downtown Rio. Connects properly train hubs, subway and waterways, and proved to be a reasonable alternative to the former bus dependence, and therefore, optimized the public transportation system.

Finally, after one hundred years of changes in the public transportation in Rio, the objective of collectivization of human mobility has been achieved. It also preserved the historic landscape from City of Rio de Janeiro.

## 6. Future research

For future research, it is encouraged further studies on service supply, contrasted to its demand, and reliability of the public transportation system in general. Also monitoring the service quality to the overall native population.

## References

[1] Yin, R. (1988) Case Study Research: Design and Methods. Newbury Park, CA: Sage Publications.
[2] IBGE (2018). *Estimativa populacional*. Instituto Brasileiro de Geografia e Estatística (IBGE). Retrieved from www.ibge.gov.br, on October 23, 2018.
[3] Brasil (1988). Federative Republic of Brazil Federal Constitution 1988.
[4] Rio de Janeiro (2014). *Atualização do Plano Diretor de Transporte Urbano da Região Metropolitana do Rio de Janeiro – PDTU*, Retrieved from http://www.rio.rj.gov.br/dlstatic/10112/5333332/4139325/25PDTUGovEstado092014.pdf, on October 24, 2018.
[5] Rio de Janeiro (2009) Lei n.° 5.128, de 16 de dezembro de 2009. *Concede benefícios fiscais relacionados com a Operação Urbana Consorciada da Região do Porto do Rio, na forma que menciona*. Retrieved from https://portomaravilha.com.br/conteudo/legislacao/leis-ordinarias/LEI5128_-_16122009_-_Concede_Beneficios_Fiscais.pdf, on October 23, 2018.
[6] Rio de Janeiro (2016). Decreto Rio nº 41627 de 3 de maio de 2016. *Dispõe sobre a regulamentação do serviço público de transporte de passageiros por meio de veículo leve sobre trilhos*. Retrieved from http://smaonline.rio.rj.gov.br/legis_consulta/51824Dec%2041627_2016.pdf on October 23, 2018.
[7] Prefeitura do Rio de Janeiro (2018). *RLV system*. Retrieved from http://www.prefeitura.rio/web/vltcarioca, on October 23, 2018.
[8] Brasil (1993). Lei Nº 8.666, de 21 de junho de 1993. Regulamenta o art. 37, inciso XXI, da Constituição Federal, institui normas para licitações e contratos da Administração Pública e dá outras providências. Retrieved from http://www.planalto.gov.br/ccivil_03/LEIS/L8666cons.htm, on October 23, 2018.
[9] Brasil (1994). Lei no. 8.883, de 21 de junho de 1994. Altera dispositivos da Lei nº 8.666, de 21 de junho de 1993, que regulamenta o art. 37, inciso XXI, da Constituição Federal, institui normas para licitações e dá outras providências. Retrieved from http://www.planalto.gov.br/ccivil_03/LEIS/L8883.htm, on October 23, 2018.
[10] Alstom (2018). Citadis, 402. Retrieved from https://www.alstom.com/, on November 8, 2018.
[11] CONAMA (1986). Resolução no 1, de 23 de janeiro de 1986. Retrieved from http://www.siam.mg.gov.br/sla/download.pdf?idNorma=8902, on October 24, 2018.
[12] CCR (2017). *Estudo preliminar e provisório de implementação do veículo leve sobre trilhos na região portuária e centro do rio de janeiro.* Retrieved from http://www.portomaravilha.com.br/conteudo/estudos/estudo_tecnico_preliminar_vlt_ccr.pdf, on October 23, 2018.

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