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Revitalization of Railway Lines 9 and 10 of the CPTM, in São Paulo, Brazil

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***Abstract*—This paper deals with a comparative study of two cases of railway revitalization in Lines 9 and 10 to CPTM (São Paulo Metropolitan Train Company), from priority condition of cargo transportation for the nearly exclusive passenger transport, in various stages of deployment in Metropolitan Area of São Paulo (RMSP).**

Keywords; transportatin planning, urban planning; suburban rail; light rail; urban mobility; intermodal integration; railway revitalization;

I. INTRODUCTION

The RMSP is the largest urban center in the southern hemisphere and one of the world's largest. There are in this territory of 8,047 square kilometers, about 19.7 million people, representing 10% of Brazil's population [1]. Low quality and capacity of the mass public transport caused an increase in the use of private vehicles by pressing the road system and resulting in traffic jam. It is being made the revitalize the old rail transport charges for the exclusive transport of passengers in order to meet the population's mobility needs. But the pace of these adjustments shown unbalanced, having already fully modernized systems, while others are still operating on obsolete parameters. The Line 9, modernized initially took to increase the number of passengers carried, resulting in a long period of inactivity and low utilization of installed systems. The Line 10 will still be revitalized because their performance is limited by it`s obsolete operating characteristics. Therefore, the experience gained by CPTM on Line 9 will be important to the success of this venture.

II. TWO DIFFERENT STAGES OF DEVELOPMENT

The Lines 9 - Esmeralda and 10 - Turquoise, makes up part of the railway system for passengers in the Metropolitan Area of São Paulo and is operated by the São Paulo Metropolitan Train Company (CPTM). In Fig. 1, Line 9 is represented in red color while the Line 10 is shown in blue.

The CPTM is a state-owned company, established in 1994 and which has the state of São Paulo as its main shareholder. It was formed by the meeting of several freight railways, built from the mid-nineteenth century to link the areas of agricultural production to the Port of Santos, the chief of Brazil. The range of lines operated by CPTM is 260.8 km, serving 22 municipalities neighboring the city of São Paulo. In these lines there are 92 stations where board every day about 2.8 million passengers. [2]

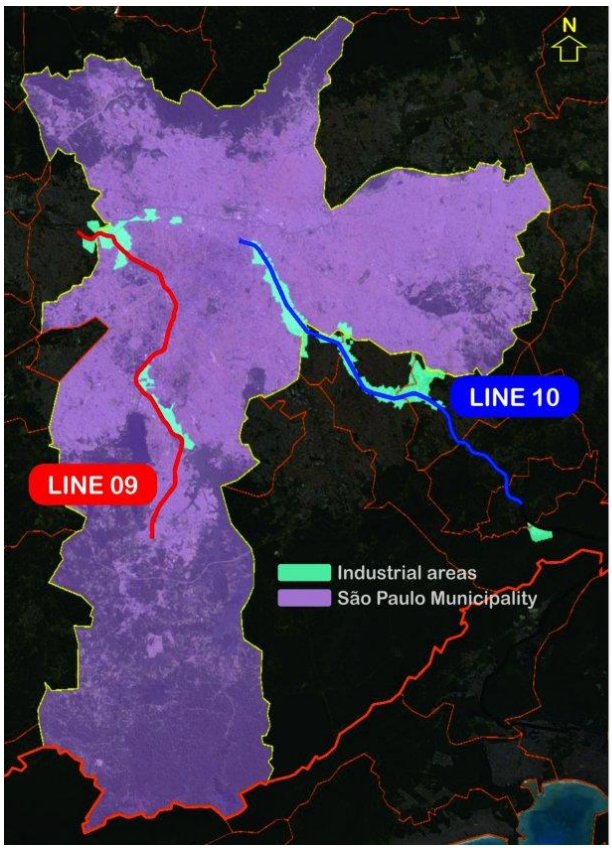

Figure 1 - São Paulo Municipality with Line 9 (red) and Line 10 (blue) - source: Google Earth

The Line 9 is in the process of conclusion in its revitalization, which started in the late 1970's, and its last phase with delivery scheduled by the end of 2017 [4]. Unfortunately there was a gap in the works of improvement, with almost standstill between the 1980s and 1990s that caused delays in completion. The current phase of the revitalization was taken by CPTM in the late 1990's and upon completion, will have the length 36.3 km and a total of 20 filling stations. The average daily number of serviced passengers is currently 570,310.[3] (base 2015) Source: CPTM

The Line 10 is paralyzed with its redeveloped still at an early stage. Currently 34.96 km and 13 stations recently reduced its length of 2.2 kilometers, not

following up the Luz Station, the main railway system of. Still, this line carries an average of 348,268 passengers daily. In the improvement plan prepared by CPTM there are three more stations to be built on Line 10, as well as several modernizations in control and power systems. But there has not been progress.

III. URBAN INSECTION OF LINES 9 AND 10 TO CPTM

The Lines 9 and 10 of CPTM, make up this analysis by the different stages of its modernization process and also serve two very different areas of the metropolis of São Paulo that have developed in different economic times.

Both lines had their origin in the need to link the region of the city of São Paulo to the Port of Santos and also served as the axis of development throughout the twentieth century, during the intense process of industrialization in São Paulo. Beside both lines were built several industrial parks, but in Line 10 industries took more intensely its proximity to the railroad, and built many industrial branches

The industrial boom occurred along the Line 9 is more recent, with companies that have not adopted the railway as their primary means of disposal and acquisition of inputs, making this more free line for direct cargo transport between São Paulo and Santos. Also the concentration of industries in industrial parks left gaps along the line, a different effect continuous area industry load on line 10, as shown by white spots in Fig.2.

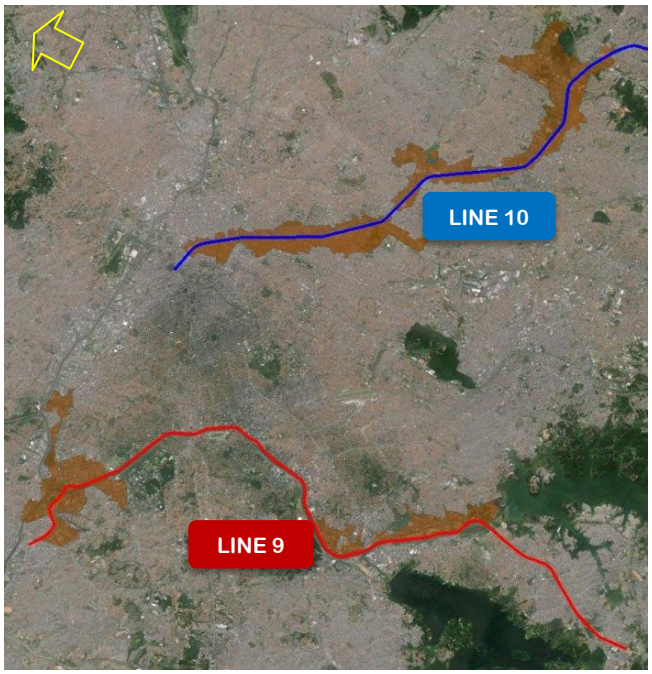

Figure 2 - Lines 9 and 10 fo CPTM and industrial areas (in brown color) attended – source: Google Earth

These differences in industrial occupation along these two lines contributed to the kind of urbanization that occurred adjacent to the railroad edge. The Line 10 runs through six different municipalities, and in each there are central areas, characterized by the concentration of trade and services, residential quarters of various standards in addition to the industrial areas closer to the railroad.

In the City of São Paulo, nearby train edge to the line 10 is far from the city center and has wide area of great extension in disuse, although a still intense industrial occupation, with timid urban changes being initiated as construction residential projects

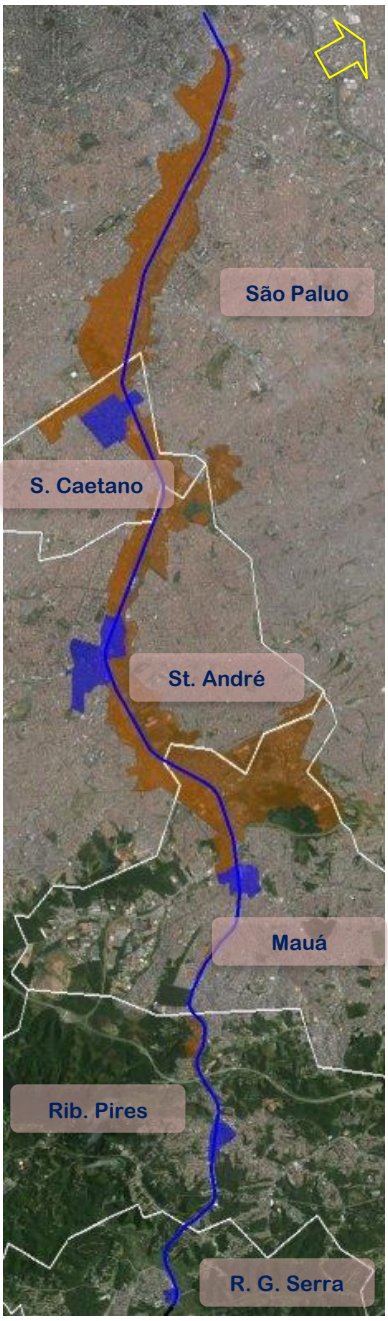

Figure 3 - Cities served by Line 10, its industrial areas (in brown) and its downtown areas (in blue) source : Google Earth

Already the region served by Line 9 has undergone a profound process of economic development, driven by the settlement of the share of the population with higher income.

The distribution of social classes by the city of São Paulo during the twentieth century was not homogeneous [4], and the concentration of the portion of higher income population moving from the city

center to the southwest portion where It is located on Line 9.

The urbanization for the elite began to the north, next to the Luz station, but epidemics of the late nineteenth century changed the direction of urbanization, away from the floodplains of Tamanduatei and Tiete rivers and directing it to the high and healthy lands located southwest of the central area, with new roads formed the second best urban standards. After located on the ridge of the Paulista elite descended the Jardim America and Jardim Europa, on the right side of the Pinheiros River, where is the line 9 of the CPTM.

It is important to understand that the elite location for the evaluation of the activities location patterns in the city in developing countries is explained by the large share of participation of this segment in the composition of aggregate demand consumption and its political importance in the location of companies private (industrial, commercial and services) and institutional facilities of State [5]

With the advent of the "Urban Operation" in 1995, in the area of Avenida Brigadeiro Faria Lima, sponsored by the municipal government, it was consolidated the development process of the region of São Paulo by offering better use of the land upon payment of fees to be specifically aimed at improvements in the region.

Such improvements, primarily applied in the road of the region have increased the attractiveness of the region mainly for commercial enterprises, as shown in the table in Fig. 4.

AREAS USED BY SECTOR (M²)

Sector	MAXIMUN STOCK		CONSUMED STOCK		PERCENTAGE CONSUMED	
	RESITENTIAL	NO RESIDENTIAL	RESITENTIAL	NO RESIDENTIAL	RESITENTIAL	NO RESIDENTIAL
HELIO PELEGRINO	292.445,00	182.505,00	191.612,30	93.019,02	65,52%	50,97%
FARIA LIMA	288.180,00	73.715,00	61.974,84	73.714,27	21,50%	100,00%
PINHEIROS	288.695,00	96.600,00	111.561,99	96.599,98	98,91%	100,00%
OLIMPIADAS	190.440,00	95.565,00	60.293,70	95.563,13	31,66%	100,00%
TOTAL	1506155		764339,23			

Figure 4 – Additional construction stocks were consumed in Dec/2015.[6]

These numbers illustrate the preference of the real estate market by using the additional construction in the most heated demand developments such as malls and commercial / office buildings. Additional construction available and not used for residential developments shows an imbalance between what the purposed Hall and what just actually happening, with the region becoming a generation of polo traffic due to the concentrated jobs in the enterprises of the tertiary sector .

The Line 9 of CPTM, is inserted in this context plays at first a secondary role in the transport of people, as shown in Fig. 4, which shows the number of passengers transported per year from 1997 to 2015 for all six lines of the CPTM. The Line 9 of the last position in performance for the busiest second today.

What is observed is that when you start the construction of new stations in 1997, CPTM took to ascertain results in line 9. These stations were opened during the year 2001 and despite make provision immediate increase in the number of passengers carried, not They provoked the expected effect.

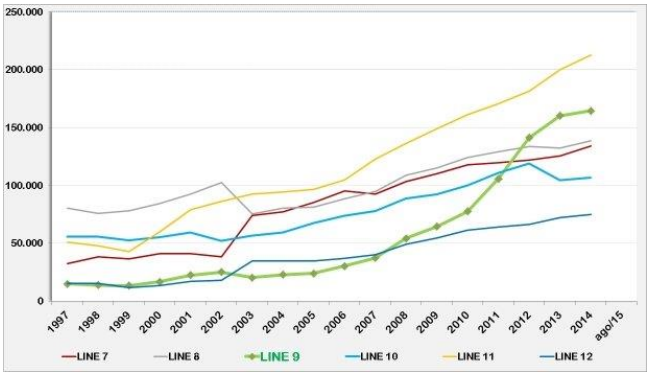

Figure 5 - The number of passengers transported by de progression mesh CPTM - In evidence Line 9 [7]

In the same graph in Fig. there is little growth from 2001 in the number of passengers remained virtually stagnant until 2005 when resumes growth trajectory equivalent to the other lines of the CPTM.

The extension of Line 9 to Grajaú Station, located in a densely populated neighborhood in the south of São Paulo, incorporated a large number of passengers from April 2008, as shown in the graph of Figure 5. This process also consolidated for the Line 9 pendulous movement profile passenger, observed in other lines of CPTM, leading people from sleeping quarters to their workplaces in areas whose development was driven by the Urban Operation Syndicated Faria Lima.

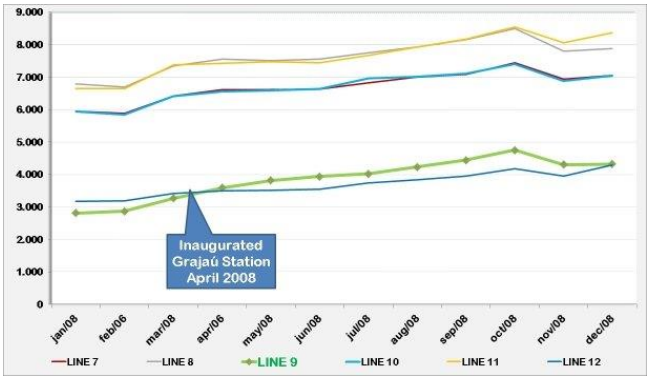

Figure 6 - Passengers transport per month (x1000) in mesh CPTM in 2008 [8]

IV. INTEGRATION WITH THE METRO SYSTEM

The region of the Pinheiros neighborhood plays a historical role of regional centrality of São Paulo, focusing extensive commercial activity, especially in the vicinity of Largo da Batata. Wide functions as the end point of several urban bus lines bringing

passengers from various districts of west and south of the metropolis of São Paulo in addition to having a subway station, Faria Lima Station. The train station Pinheiros, integrated the subway station of the same name is the busiest station of Line 9 also being located near the Largo da Batata.

In 2011 it was inaugurated the integration between Pinheiros CPTM stations and the São Paulo Metro Line 4 in its new, built to connect the downtown area with its west.

The Line 4 reorganized the area of passenger flow west, attracting to their stations several urban bus lines that before followed by Pinheiros. The integration between the railway and the metro facilitated access to other poles of city employment concentration as the central area and the area of Paulista Avenue.

The connection to the subway also facilitated the access of people from the areas north, east and other cities, for the area of Urban Operation Faria Lima. That is, the Metro Line 4 promoted the interconnection between the two regions with the highest concentration of employment in the city of São Paulo increasing the convenience of Line 9 was so far underutilized relative to its previously installed capacity.

The graph of Fig. 7 illustrates the sudden evolution of the number of passengers transported by Line 9 occurred with the integration of Metro Line 4.

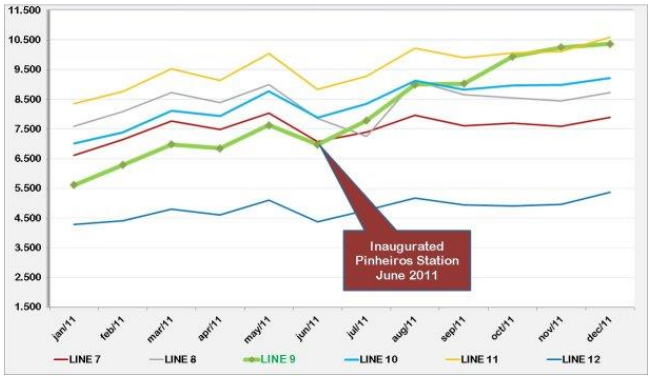

Figure 7 - Passengers transported per month (x1000) in mesh CPTM in 2011 [9]

The data indicate that despite the large number of commercial enterprises along the Line 9, being a potential corridor for job creation that could influence an increase in the volume of passengers carried, this increase only became real with the relationship between CPTM and Metro in Pinheiros. From this event is that a significant portion of the population now has in Line 9 a convenient transportation option. Not the inauguration of Grajaú Station in 2008, expanding the CPTM is promoting toward the extreme south of the capital, caused as abrupt effect on the number of passengers carried.

V. Operation Performance – Comparing Line 9 and Line 10

To evaluate the performance that any systems are necessary benchmarks expressing relevance to the assessment and are measurable for measurement of that was assessed.

In CPTM rail segments are in various stages of adaptation. As a representative of the initial stage is Line 10, with a few modifications and deployed significant delay in its modernization. At the other extreme is the Line 9, already running on roads and modernized and close facilities of full completion of its expansion works

In the CPTM system, the Line 09 - Emerald offers a standard of service characterized by greater proximity between stations, higher standard of quality of facilities and shorter interval between trains. Already Line 10 still retains its unchanged operational characteristics, sharing the roads with freight trains as well as stations located at greater distances and schedule deviations that do not meet the operational contingencies as are designed to provide access for freight trains to industrial areas

Despite these deficiencies are potentially harmful to the performance of Line 10, the growth in the number of passengers carried is similar to the average of the other lines of the CPTM system. Line 10 was also not sensitive to special events such as occurred in the Pinheiros Station at the opening of integration with the Metro. The integration between the two systems occurred on Line 10 in Tamanduateí in 2010, not added a significant number of passengers on the line, which can be seen in the Figure 7 graph.

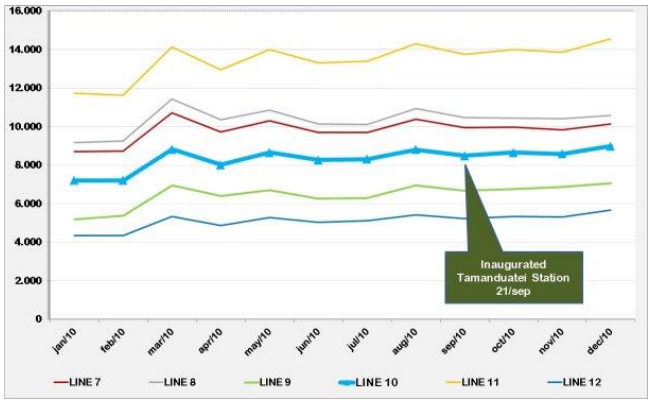

Figura 8 - Passengers transported per month (x1000) in mesh CPTM in 2010 [10]

It is observed that the simple integration between transport modes does not cause an increase in its use. Other relevant factors must be present, associated with prior capacity of the line transport. In the case of Line 9, the prior preparation through the construction of stations and availability of more compositions was important to meet the surge in demand that came with the connection to the subway station in Pinheiros.

VI. Final Considerations

The Line 9 of CPTM was the first to be completely remodeled and currently operates within the limits of its capacity. It is observed that the passenger number growth was suddenly, mainly by increasing the convenience of this line when your connection to the subway through the line 4, which facilitated the establishment of mutual access to concentrations of jobs, either along the own line 9, as well as in the area of Paulista Avenue, in the central area of the city of São Paulo, improving the distribution of passengers around the metropolis of São Paulo.

The convenience of transportation and meeting the demands is associated with various actions, planned for a better use of the installed systems. Including the targeting of urban bus lines to the subway / railway stations.

The related to the transport system planning of São Paulo metropolis rails failed to antecipate the modernization of Line 9 without the existence of demand. On the other side, this advance may have been decisive in the success with which the Line 9 dealt with the sudden increase in the number of passengers, since its facilities were sufficiently tested.

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