



# Changing urban mobility habits in São Paulo: An analysis from 2017 to 2022

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**Abstract:** The COVID-19 pandemic had a significant impact on urban mobility and public transportation. While some restrictions have eased, passenger volumes remain lower than pre-pandemic levels. In 2022, global averages were 26% below 2017 figures. Public transport is crucial for urban sustainability and citizens' rights, but it relies on passengers for viability. Our study focuses on the Metropolitan Region of São Paulo, analyzing passenger numbers from 2017 to 2022 for subways, urban rail, city buses, and metropolitan buses, along with individual motorized transport. The data reveals decline during the pandemic and a gradual recovery in 2022, with drops of 15% in subways, 28% in urban rail, 32% in city buses, and 20% in metropolitan buses compared to 2017. This study underscores the challenges and prospects for mobility in the region, reflecting changing habits.

**Keywords:** Urban Mobility; Public Transport; Pandemic Recovery; Mobility Challenges; MRSP.

## 1. Contextualization

Urban Public Transport (TPU) plays a fundamental role in urban mobility, being crucial for the sustainability of cities and guaranteeing the "right to the city", which involves not only access to urban locations, but also participation in decisions that affect urban life. Mobility plays a crucial role in this right, allowing the interconnection between people and spaces to meet their basic social needs, such as food, work, education, health and leisure [1].

At the end of 2019, the World Health Organization (WHO) received alerts about the new strain of Coronavirus in humans, with the first case of Covid-19 in Brazil reported in February 2020 [2, 3]. The WHO declared a pandemic situation in March 2020 [4], the pandemic financially disrupted mobility, forcing cities to impose extreme measures, the State of São Paulo decreed quarantine at the end of March. Social isolation and travel restrictions have impacted the way people work, shop, study and have fun, significantly reducing the use of public transport. There were three waves of Covid-19 in Brazil [5], with the São Paulo Metropolitan Region (RMSP) recording 2 million infections and 80 thousand deaths by the end of 2022 [6]. At the end of the pandemic period, transport systems have not fully recovered, raising the question of whether pre-pandemic passenger volumes will be restored.

Another relevant factor in the reduction in urban travel is the change in consumption habits in cities, with migration to online services for shopping, entertainment, access to services and money, selected since 2010 [7]. Furthermore, there is a resumption of commerce in neighborhoods to the detriment of commerce in large, outdated establishments, such as hypermarkets and department stores [8]. A comparison of 2022 compared to 2019 showed a drop of around 10% in the volume of passengers transported in subway systems in several cities around the world with 13% lower revenue, showing that the systems could enter in moments of scarcity of investments, with growing slow

**Citation:** Daroncho, C.; Martinez, P. J. P. Artigo TPU SP. *SUPTM 2024 conference proceedings* xx.

<https://doi.org/10.31428/xxxxx>

**Publisher's Note:** UPCT and Sciforum stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



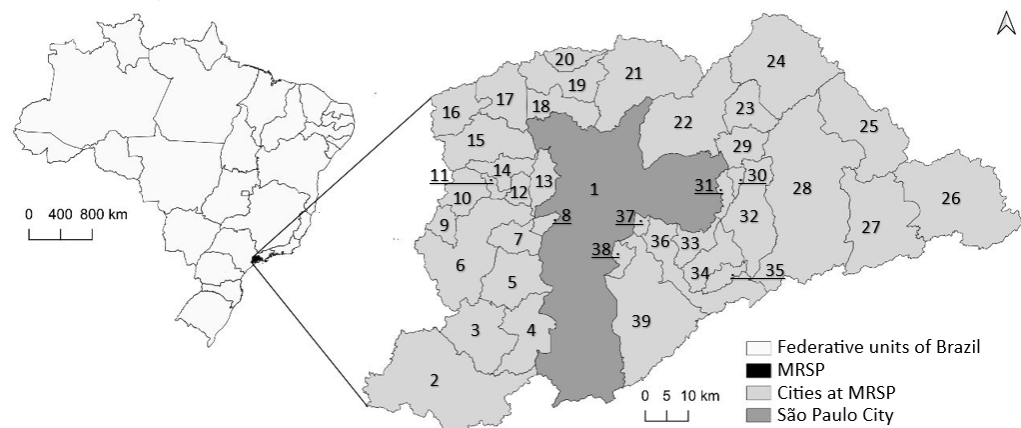
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development of networks and services [9]. In Brazil, in urban bus systems, there was a drop in 2013, remaining in 2022, on average, 24.4% below 2019 [10].

This study evaluates the situation and resumption of public transport in the RMSP, analyzing passenger volumes from 2017 to 2022 in the metro, rail and urban bus systems.

## 2. Study location and transport systems analyzed

The RMSP is made up of 38 cities (RM – Metropolitan Region) plus the city of São Paulo (Figure 1), being the fourth largest urban agglomeration in the world, with a population of approximately 21 million people in an area of 7.9 thousand km<sup>2</sup>, with GDP per capita of R\$47 thousand [11, 12, 13]. RMSP has a subway network (104,2 km and 91 stations), a railway network (273 km and 96 stations) and two main bus systems, one in the city of São Paulo (1347 lines and 11925 buses) and the other in RM (479 lines and 260 buses). Metro, 2023b) [14, 15, 16].



São Paulo (1); Juquitiba (2); São Lourenço da Serra (2); Embu-Guaçu (4); Itapeverica da Serra (5); Cotia (6); Embu das Artes (7); Taboão da Serra (8); Vargem Grande Paulista (9); Itapevi (10); Jandira (11); Carapicuíba (12); Osasco (13); Barueri (14); Santana de Parnaíba (15); Pirapora do Bom Jesus (16); Cajamar (17); Caieiras (18) Franco da Rocha (19); Francisco Morato (20); Mairiporã (21); Guarulhos (22); Arujá (23); Santa Isabel (24); Guararema (25); Salesópolis (26); Biritiba Mirim (27); Mogi das Cruzes (28); Santo André (29); Poá (30); Ferraz de Vasconcelos (31); Suzano (32); Mauá (33); Ribeirão Pires (34); Rio Grande da Serra (35); Santo André (36); São Caetano do Sul (37); Diadema (38); and, São Bernardo do Campo (39).

Figure 1. Location of the counties of RMSP [17]

## 3. Analysis of mobility data in the RMSP TPU

In possession of the volumes of passengers transported by each of the urban transport systems from 2017 to 2022 [18, 19, 20, 21] (the raw data was not presented here in table form due to lack of space), as can be seen In Figure 2, it is possible to see the drop that occurred in March 2020 and the recovery that occurred from August 2020, as well as the drops in waves 2 and 3 of Covid and subsequent recoveries. Furthermore, it is possible to see the monthly fluctuations since 2017 and the annual average (dashed lines).

In 2017, the TPU transported almost 5.5 billion passengers and in 2022 it transported just over 4.0 billion passengers (Table 1), a drop of 26.3%, but it can be seen that this downward trend occurs in practically all systems since 2018, an exception for the subway system, which only experienced a decline during the pandemic, achieving the best recovery in 2022. Figure 3(a) shows the absolute comparison of the values of each of the systems, forming the TPU and Figure 3 (b) shows the variation in values based on the year 2017.

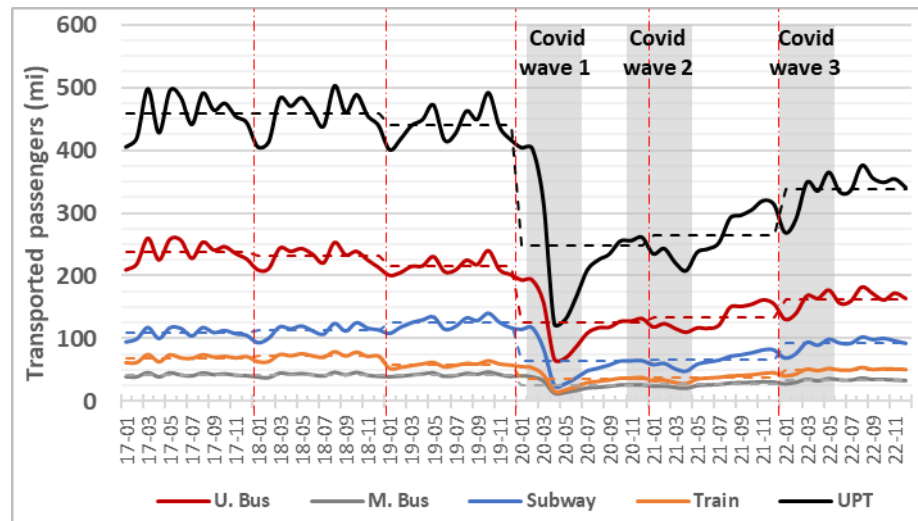
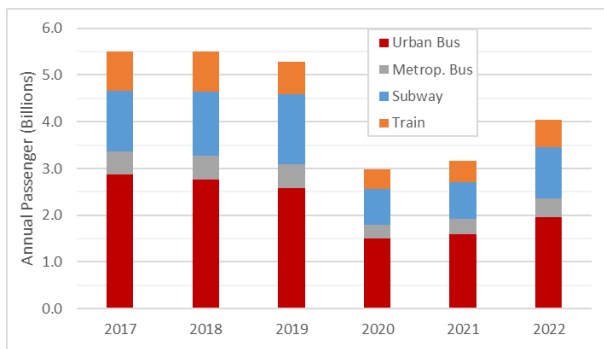


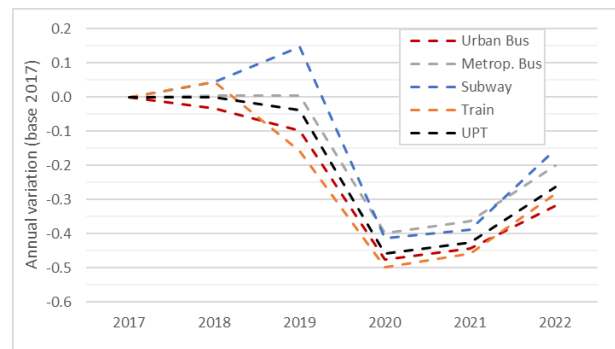
Figure 2. Passageiros transportados por mês e média anual de passageiros transportados em cada um dos sistemas de transportes da RMSP. As linhas verticais vermelhar informam a divisão dos anos e as colunas cinza mostram as três ondas de covid no Brasil [5].

Table 1. Annual volume of passengers carried (millions) and change based on 2017 for each transport system and by UPT.

Year	Urban Bus [18]	Var. (2017)	Metrop. Bus [19]	Var. (2017)	Subway [20]	Var. (2017)	Train [21]	Var. (2017)	UPT	Var. (2017)
2017	2,863	-	504	-	1,303	-	828	-	5,497	-
2018	2,769	-3.3%	506	0.4%	1,359	4.4%	863	4.3%	5,498	0.0%
2019	2,581	-9.8%	506	0.4%	1,495	14.7%	697	-15.8%	5,279	-4.0%
2020	1,500	-47.6%	303	-39.9%	764	-41.3%	415	-49.9%	2,981	-45.8%
2021	1,596	-44.2%	321	-36.3%	797	-38.8%	448	-45.9%	3,162	-42.5%
2022	1,949	-31.9%	403	-20.0%	1,104	-15.2%	593	-28.3%	4,049	-26.3%



(a)



(b)

Figure 3. Passengers transported in RMSP transport systems: (a) Absolute composition of each mode of transport, forming the TPU; (b) Annual variation based on 2017 data.

#### 4. Conclusion

The pandemic triggered by Covid-19 had a drastic impact on urban mobility, reflected in the abrupt drop in the number of passengers in March 2020. However, there was a notable recovery from August 2020 onwards, indicating resilience in the public transport system. Despite the subsequent waves of the pandemic, the data reveal monthly oscillations and an annual average that denote a gradual and continuous adaptation to the new conditions imposed.

The comparative analysis between the different modes of transport reveals that the metro system stood out, presenting the best recovery in 2022, while the bus and rail

systems demonstrated considerable variations throughout the period studied. The annual variation based on 2017 highlights a downward trend since 2018, with the exception of the metro system, corroborating the complexity of interactions between the pandemic, changes in consumption patterns and the specific resilience of each mode of transport.

In addition to the direct influence of the pandemic, the study points to structural changes in urban consumption habits, with the increase in online services and a resumption of commerce in neighborhoods. These factors, combined with the drop in passenger volumes, raise concerns about sustainability and investments in urban public transport systems.

Given this panorama, it is crucial that authorities and public transport managers consider innovative strategies to face the challenges posed by the current situation. The search for solutions that promote efficiency, sustainability and adaptation to new mobility paradigms is essential to ensure not only the recovery, but also the strengthening and continuous evolution of urban public transport in the RMSP.

**Funding:** “This research received no external funding”.

**Conflicts of Interest:** “The authors declare no conflict of interest.”

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