

## **TRIP GENERATION BY MAIN MODES OF TRANSPORT: ANALYSIS OF THE HISTORICAL EVOLUTION IN THE METROPOLITAN REGION OF SÃO PAULO (1967-2017)**

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### **Resumo**

A cidade de São Paulo passou por um processo acelerado de desenvolvimento desde o final do século 20, reorganizando seu território e trazendo consequências para o transporte. Este estudo analisa a geração de viagens dos principais meios de transporte e suas tendências ao longo do tempo na Região Metropolitana de São Paulo (RMSP), composta pela cidade de São Paulo (SP) e outras 38 cidades ao redor (RM). Os resultados apontam para uma variação positiva gradual para ônibus, automóveis, veículos escolares, trens, metrô, motocicletas, bicicletas e pedestres, bem como para meios coletivos e individuais (1977-2017). Já para os táxis, houve variação negativa (-78,7% / - 68,1%; SP / RM; 1977-1987) e, posteriormente, intensa variação positiva na RM (-26,6% / 207%; SP / RM; 2007-2017). Adicionalmente, na RM houve um crescimento ainda mais intenso na geração de viagens, empregos e população do que em SP (respectivamente 61,5% / 104,8% / 56,1% e 204,5% / 307,3% / 229,6%; SP / RM; 1977 -2017). O segmento de afretamento, por outro lado, apresentou decréscimo (-22,6% / - 31,7%; SP / RM; 1977-2017). Destaca-se que os meios de transporte individuais apresentaram um crescimento mais expressivo que os coletivos (66,7% / 366,6% individual e 43% / 115,5% coletivo; SP / RM; 1977-2017).

No que se refere à participação de todos os meios de transporte, coletivos e individuais, revelou-se que a RM apresentou aumento enquanto SP apresentou redução. A pesquisa concluiu, assim, que o aumento da geração de viagens acompanhou o crescimento da população e do emprego nesses cenários, principalmente na RM (mais favorável). Observou-se, ainda, que os meios de transporte podem se desenvolver (tendências de crescimento para meios individuais; carros e aplicações) ou se tornar obsoletos (forte diminuição relativa do uso de trólebus e veículos fretados) evidenciando o fenômeno da criação destrutiva na área de transportes.

**Palavras-chave:** Pesquisa OD; Planejamento de transporte; Produção de Viagens; RMSP.

### **Abstract**

The city of São Paulo has undergone an accelerated development process since the late 20th century, reorganizing its territory and affecting transportation. This study analyzes the trip generation by main modes of transport and their trends over time in the Metropolitan Region of São Paulo, comprising the city of São Paulo (SP) and 38 other surrounding municipalities (RM). Results point to a gradual positive variation for buses, cars, school vehicles, trains, subways, motorcycles, bicycles, and pedestrians, as well as for collective and individual modes of transport (1977–2017). In turn, taxis showed negative variation (–78.7%, SP; –68.1%, RM; 1977–1987) and then intense positive variation (–26.6%, SP; 207%, RM; 2007–2017) in the RM. Moreover, the RM showed a higher growth in trip generation, employment, and population than SP (61.5%, 104.8% and 56.1% for SP; 204.5%, 307.3% and 229.6% for RM; 1977–2017). The chartering segment, on the other hand, decreased (–22,6%, SP; –31,7%, RM; 1977–2017). Notably, individual modes of transport had a more expressive growth than collective ones (66.7% and 366.6% for individual modes, SP/RM; 43% and 115.5% for collective modes, SP/RM; 1977–2017). Regarding the share of all modes of transport, collective and individual, the RM had an increase while SP showed a reduction. In conclusion, the increase in trip generation has kept pace with population and employment growth in these scenarios, especially in the (more favorable) RM. Besides, modes of transport can develop (growth trends for individual modes, cars, and application softwares) or become obsolete (strong relative decrease in the use of

trolleybus and chartered vehicles), highlighting the phenomenon of destructive creation in transportation.

**Keywords:** OD Research; Transportation planning; Trip generation; RMSP.

## 1. Introduction

The processes of growth and development of cities and, consequently, their respective structuring generally occur according to factors such as topography, economic activities, accessibility, among others (Gutierrez, 2013).

São Paulo underwent a rapid process of urbanization and industrialization from the late 19th century that completely reorganized its space utilization (Lobo et al, 2010; Viera and Haddad, 2014), turning the São Paulo capital into the main Brazilian industrial hub. The region's population growth also increased considerably, reaching its first million inhabitants in 1928 (Bernal and Ferreira, 2016). Gutierrez (2013) notes, however, that the urban planning developed for São Paulo at the time failed to keep pace with this population growth and urban sprawl itself, resulting in several issues for the modes of transport used by the population.

At a national level, Brazil's process of urbanization and modernization in recent decades saw changes in the social reproduction and consumption needs of a large part of the population, especially the middle class. This segment expanded quantitatively and underwent a profound change in their lifestyle—special education, leisure, hygiene, sports, and travel (Vasconcellos, 2001).

In this scenario of expanding activities and increasing distances, motorized modes of transport and economic resources to pay the costs involved became necessary. Consequently, given the transformations in urban space, the poor conditions of public transportation systems, and the good circulation and parking conditions, the automobile gained economic and sociological importance, becoming an indispensable instrument for its reproduction as a class (Vasconcellos, 2001).

According to Gutierrez (2013), transportation is a promoter of accessibility, that is, it conditions and is conditioned by the city growth; thus, it becomes necessary to develop measures that seek to analyze the growth phenomena and aid in the creation of proposals to promote greater accessibility and mobility to the population (Gutierrez, 2013).

That said, we consider it pertinent to enquire: how did the main modes of transport evolve in the Metropolitan Region of São Paulo, in terms of use, between 1967 and 2017? Are there pertinent differences between the Metropolitan Region and the municipality of São Paulo in this time frame? We assume, therefore, that the region saw a total increase in trip generation (accompanied by population growth). And that those individual modes of transport were consolidated against public transportation—as the latter have significantly increased their share in the total over the years.

Hence, this study seeks mainly to describe the phenomenon of trip generation by the main modes of transport and their respective share and trends developed in time and space—and not necessarily to explain their causes and consequences (although they still serve as a basis for explanations)—, so that, based on this initial exploration, future studies can carry out in-depth analyses and correlations between the activity-mode of transportation and socioeconomic aspects.

For this purpose, we analyzed the trip generation by main modes of transport between the years of the Origin-Destination survey conducted by the São Paulo Metropolitan Company, which began in 1967 and has been repeated every ten years.

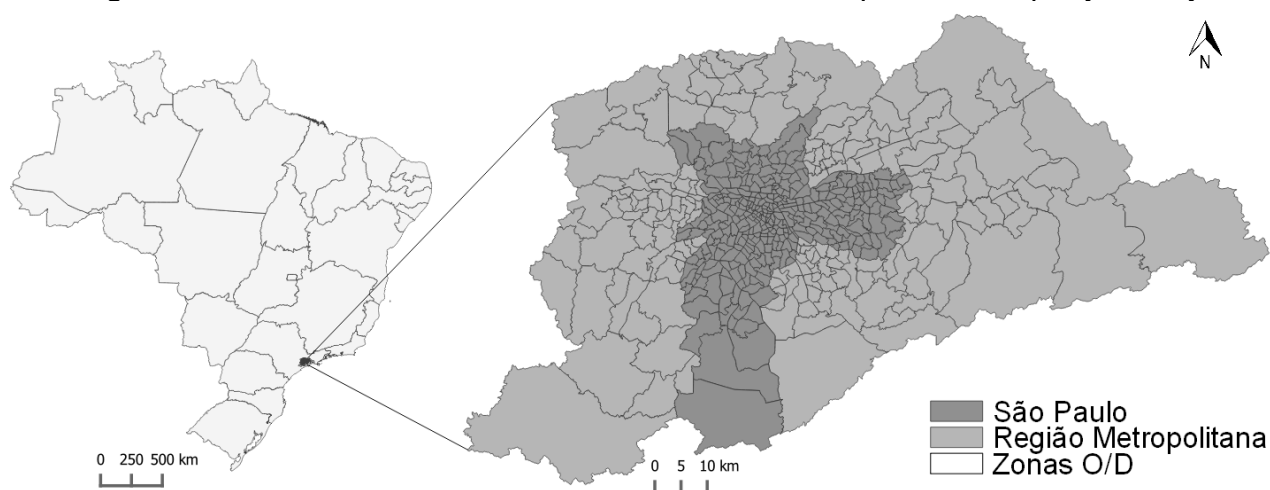
“OD homogenous zones” are defined based on their urban and socioeconomic homogeneity: compatibility with the limits of municipalities and districts in the city of São Paulo; compatibility with the limits of census tracts of the Brazilian Institute of Geography and Statistics (IBGE); homogeneity in the use and occupation of urban space; existing and future transportation system, urban equipment; physical barriers and empty areas (Metrô-SP, 2019).

## **2. Methods**

### **2.1 Study area**

This study used the territorial scope referring to the Metropolitan Region of São Paulo – RMSP (Figure 1), which occupies an area of 7,946.96 km<sup>2</sup> and comprises 39 cities—38 municipalities and the city of São Paulo (EMPLASA, 2019).

Figure 1. RMSP and OD Zones of the São Paulo Metropolitan Company survey



Source: prepared based on IBGE (2020) and Metrô-SP (2017)

RMSP has a population of 21 million inhabitants (2,714.41 inhabitants/km<sup>2</sup>), corresponding to 47.54% of the population of the state of São Paulo. Notably, one in ten Brazilians lives in the RMSP (EMPLASA, 2019).

## 2.2 Data analysis

Data were collected from the São Paulo Metropolitan Company's Origin-Destination survey carried out in 1977, 1987, 1997, 2007, and 2017.

Our main variable was "trip generation" by main modes of transport, namely: bus<sup>1</sup>, charter, school bus, car (driver), car (passenger), taxi<sup>2</sup>, minibus, subway, train, motorcycle<sup>3</sup>, bicycle, walking, others.

We defined two distinct regions for analysis: the city of São Paulo (SP) and the other 38 municipalities that make up the Metropolitan Region (RM), to allow comparisons between both. When combined, the two scopes form the Metropolitan Region of São Paulo (RMSP).

Hence, we calculated the individual shares of each mode of transport regarding total trip generation in the Metropolitan Region of São Paulo (RMSP), and for São Paulo (SP) and the Metropolitan Region (RM) separately.

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<sup>1</sup>For the year 1977, we considered trips made by trolleybus. For the year 1987, we considered trips made by trolleybus and bus. And for the years 1997, 2007 and 2017, only bus trips.

<sup>2</sup>For the years 1977, 1987, 1997 and 2007 we considered only trips made by conventional taxi. For 2017, we considered trips made by ride-hailing application softwares and taxi.

<sup>3</sup>Trips made by motorcycle as both driver and passenger were considered for all years.

We also calculated the variations in trip generation by main modes of transportation in each subsequent year of the survey and the reference year (1977) for the RMSP, São Paulo, and the Metropolitan Region.

Collective and individual motorized trips were then calculated similarly. Collective trips encompass the following modes of transport: bus, charter, school bus, subway, and train. Individual trips consist of the following modes of transport: car (driver), car (passenger), taxi, and motorcycle. As “walking” and “bicycle” are considered non-motorized modes of transport, they were excluded from this last analysis.

Finally, trip generation and variations for each survey year were calculated in total terms (without distinction by mode of transport) in the RMSP, as well as the number of jobs and population and their respective variations, to allow joint observation of the phenomena and trends.

As the 1977 survey had no data for school vehicles—defined as “school bus”—as a main mode of transport, 1987 was chosen as the reference year for this mode.

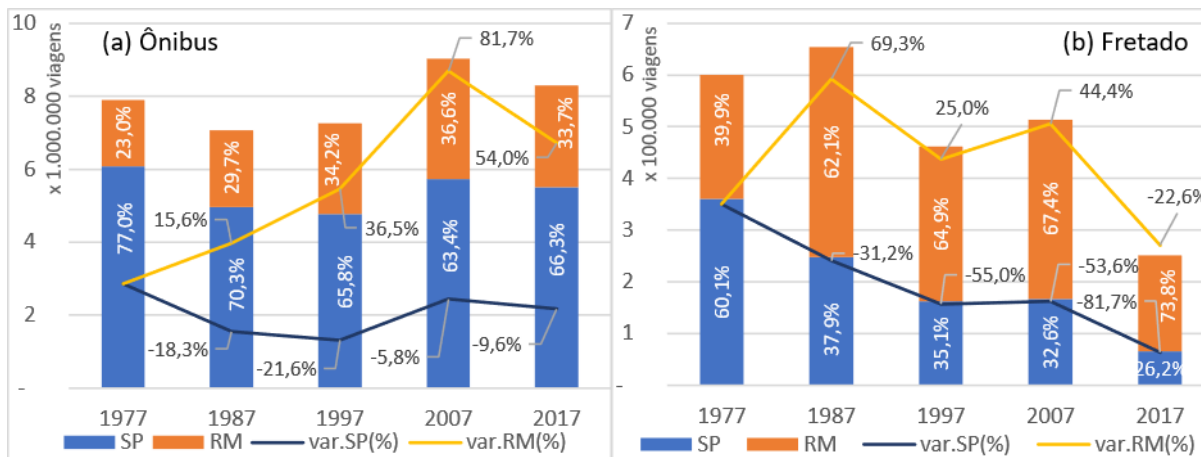
### 3. Results and Discussion

First, we should note the clear positive relationship between income and diversity/number of trips, and between the use of individual transport and income. Besides, individual/family decisions are influenced by external factors: the city’s physical structure, the physical layout of buildings and public areas, the opening hours of activities, and the modes of transport available (Vasconcellos, 2001).

In travel planning, people compare their needs to the various existing constraints and available resources (monetary and time) to define a convenient and possible travel strategy (Vasconcellos, 2001).

Figures 2 to 8 show, for São Paulo (SP) and the Metropolitan Region (RM), the total trip generation (vertical axis count) by main modes of transport for each survey year, as well as the variation compared to the reference year of 1977 (lines). The figures also present the individual shares in each territorial scope (SP and RM) relative to the total (RMSP) for each survey year (bars).

Figure 2. Bus and charter shares in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

When analyzing Figure 2(a), daily bus trip generation, we can observe that SP presented negative variation for all years compared to the reference year, with 1997 showing the highest variation (-21.6%). In the RM, all years had a positive variation when compared with the reference year, with 2007 showing the highest variation (81.7%). We noted a considerable increase since 1997.

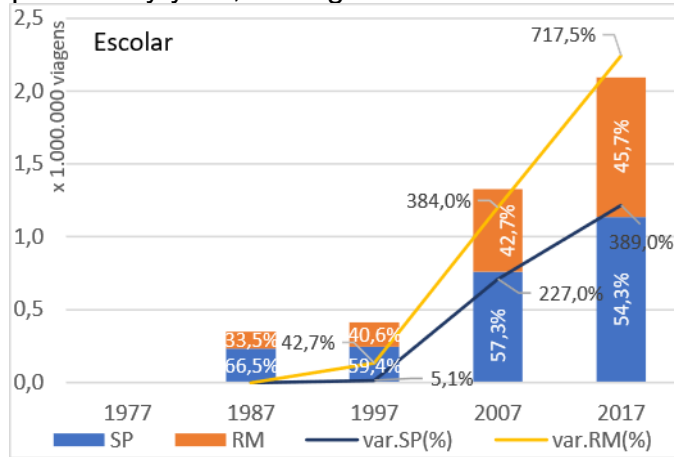
As for the share of bus trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP showed the highest share in trip generation in all survey years, being 1977 (77%) and 2007 (63.4%) the most and least expressive years, respectively.

Looking at Figure 2(b), daily charter trip generation, we can observe that SP presented negative variation for all years compared to the reference year, with 2017 showing the highest variation (-81.7%). The RM showed a positive change from the reference year until 2007, exhibiting a negative jump of -22.6% in 2017.

Regarding the share of charter trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP showed the highest share only in the 1977 survey (60.1%) and then decreased in subsequent surveys until 2017 when it reached 26.2% of the total generated in the RMSP.

Importantly, we found an approximate inversion in the shares between 1977 and 1987, from 60%–40% to 38%–62%, due to the positive variation observed in the RM (69.3%) and the negative variation observed in SP (-31.2%) between the two periods.

Figure 3. School bus share in total trip generation and variation in SP and the RM per survey year, having 1987 as the reference year.

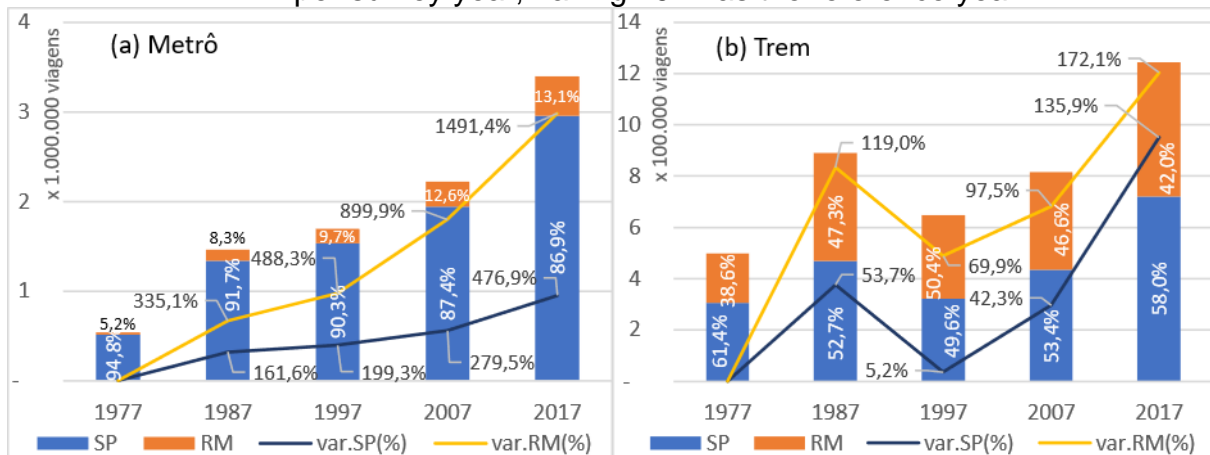


Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

When analyzing Figure 3, daily school bus trip generation, we can observe that SP presented positive variation for all years compared to the reference year, with 2017 showing the highest variation (717.5%). In the RM, all years had a positive variation when compared with the reference year, with 2017 showing the highest variation (389%).

As for the share of school bus trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP showed the highest share in all survey years, being 1987 (66.5%) and 2017 (54.3%) the most and least expressive years, respectively. We thus verified an approximate ratio of 1/3:2/3 to 1/2:1/2.

Figure 4. Subway and train shares in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

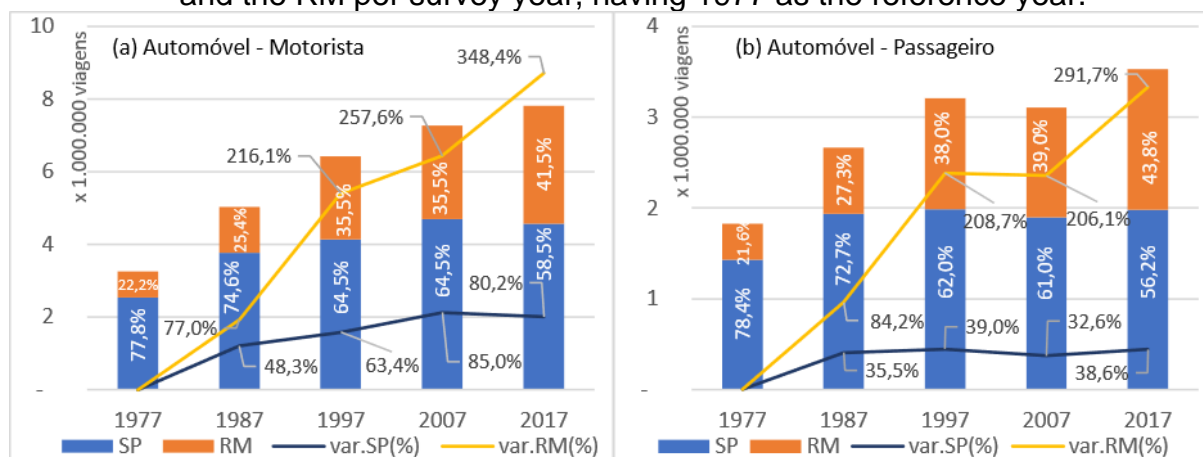
Looking at Figure 4(a), daily subway trip generation, we can observe that SP presented a positive variation for all years compared to the reference year, with 2017 showing the highest variation (1,491.5%, approximately 16 times more). In the RM, all years had a positive variation when compared with the reference year, with 2017 showing the highest variation (476.9%, approximately six times more).

Regarding the share of subway trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP had the highest share in all survey years, with a slight and subsequent decrease until 2017, being 1977 (94.8%) and 2017 (86.9%) the most and least expressive years, respectively.

When analyzing Figure 4(b), daily train trip generation, we can observe that SP presented a positive variation for all years compared to the reference year, with 2017 showing the highest variation (135.9%). In the RM, all years had a positive variation relative to the reference year, with 2017 showing the highest variation (172.1%).

As for the share of train trip production in SP and the RM compared to the total generated in the RMSP, we noted an approximate proportionality around 60% and 40% (for SP and RM, respectively), except for the 1997 survey in which each scope accounted for half of the share.

Figure 5. Car (driver and passenger) share in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



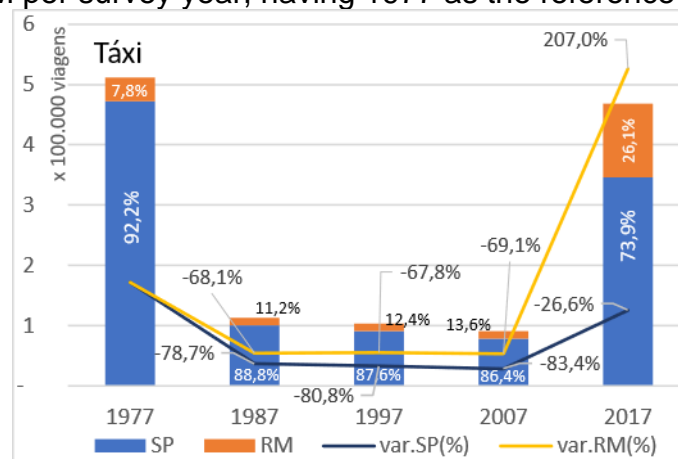
Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

Figure 5 shows the daily car trip generation, as a driver (a) or passenger (b). We can observe a constant growth in the number of trips, except for the passenger status in the 2007 survey, which shows a slight drop in the total number of trips, but still high when compared with the 1977 survey.

Moreover, we found a significant growth for both driver and passenger status (348.43% and 291.70%, respectively) in the RM. The proportionality between SP and the RM changed considerably, with the RM doubling its influence in both options. Growth in SP, on the other hand, is less expressive for both driver and passenger status, increasing 80.21% and 38.60%, respectively.

We can also note that the total number of trips has grown sharply. When adding both statuses (driver + passenger), the total number of trips was around 5 million in 1977, rising to 11.3 million trips in 2017—an increase of about 125%.

Figure 6. Taxi share in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



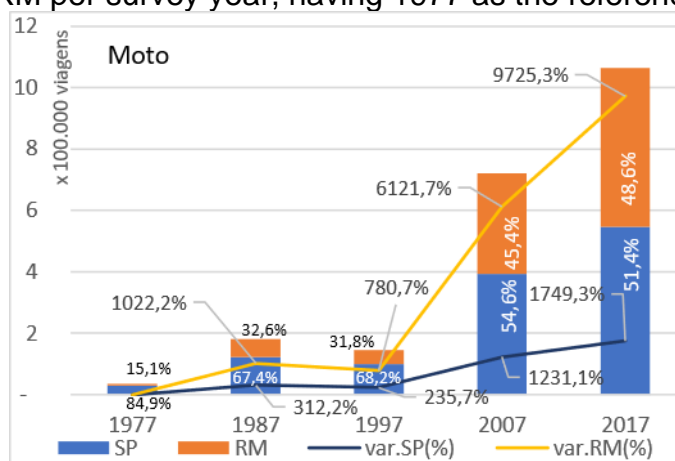
Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

Looking at Figure 6, daily taxi trip generation, we can observe that the RM showed high negative variation for all years surveyed (1987, 1997, and 2007), reaching a variation of -69.1% compared to 1977. From 2007 to 2017, however, the region showed high positive variation (207%) when compared with 1977. São Paulo presented a similar scenario until 2007, but between 2007 and 2017, the variation remained negative, only decreasing its value compared to 1977 (-26.6%).

As for the share of taxi trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP obtained the highest share only in the 1977 survey (92.2%) and decreased in subsequent surveys until 2017 when it reached 73.9% of the total generated in the RMSP.

When analyzing it in total terms of trips generated, we noted a high decrease in taxi use in the 1987, 1997, and 2007 surveys, when the trips dropped by five times—an 80% reduction—, going from just above 500,000 trips per day to around 100,000 trips per day. In the 2017 survey, this figure increased dramatically, almost back to the 1977 level, with values around 470,000 trips per day.

Figure 7. Motorcycle share in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



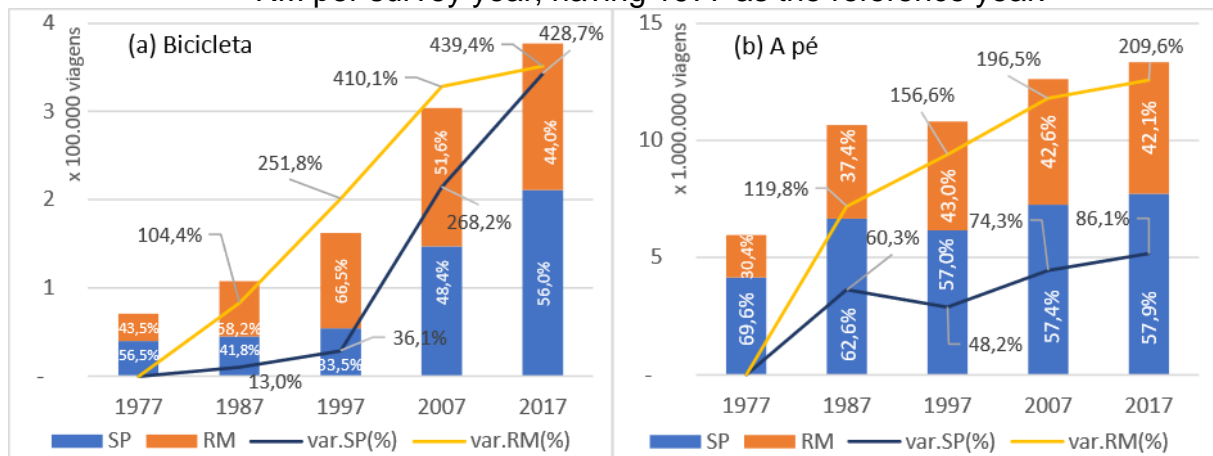
Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

When analyzing Figure 7, daily motorcycle trip generation, we can observe that SP presented a positive variation for all years, reaching the highest variation in the 2017 survey (1,749.3%, approximately 19 times more) when compared to 1977. The RM also showed positive variation for all years, reaching the highest variation in 2017 (9,725.3%, approximately 99 times more).

Regarding the share of motorcycle trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP obtained the highest share in all survey years, with subsequent decreases in the course of surveys. Hence, 1977 (84.9%) and 2017 (51.4%) were the years with the most and least expressive share, respectively.

In total terms of trips generated in the RMSP, we identified that the number of trips increased dramatically in the 2000s and 2010s, passing 1 million daily trips in 2017.

Figure 8. Bicycle and walking shares in total trip generation and variation in SP and the RM per survey year, having 1977 as the reference year.



Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

Looking at Figure 8(a), daily bicycle trip generation, we can observe that SP had a positive variation for all years, reaching the highest variation in the 2017 survey (439.4%) when compared with 1977. The RM also showed positive variation for all years, reaching the highest variation in 2017 (428.7%).

As for the share of trip generation by both modes of transport in the RM and SP compared to the total generated in the RMSP, we observe that the distribution remained the same for both territorial scopes.

In total terms of trips generated in the RMSP, we identified an expressive growth in trips, with bicycle trip generation going from around 70,000 trips per day to almost 380,000 trips per day—a growth of more than 5.4 times.

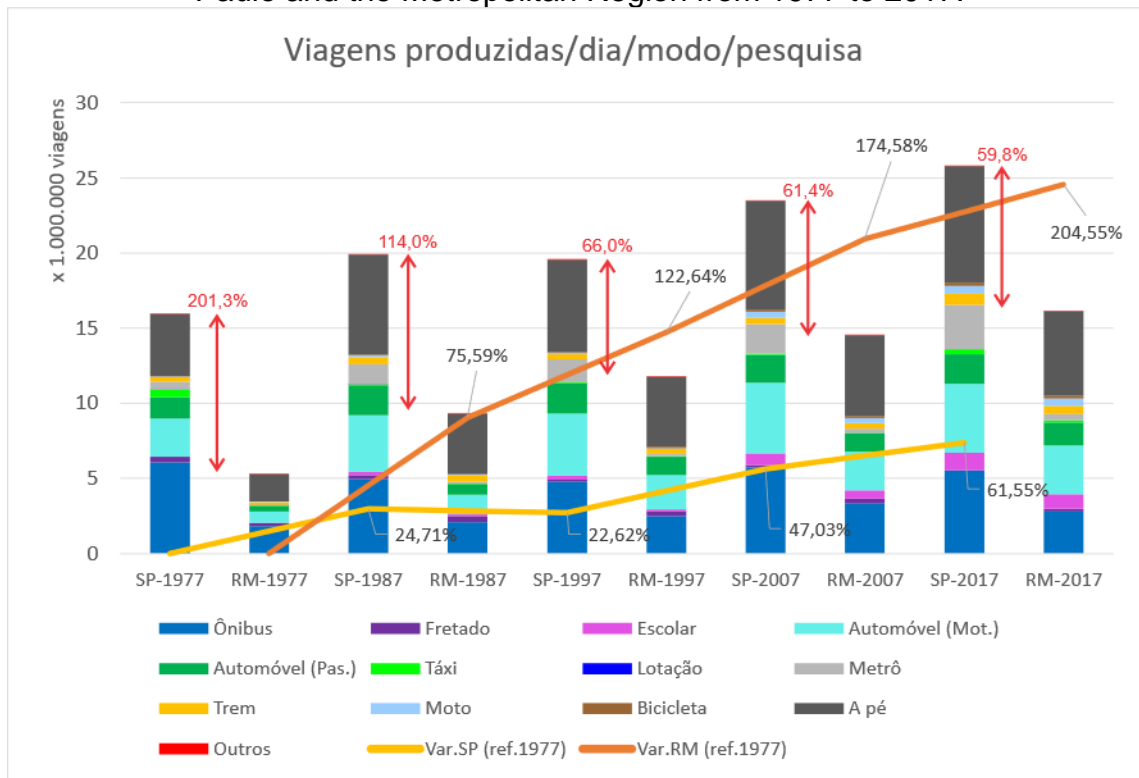
In analyzing Figure 8, daily walking trip generation, we can observe that SP showed a positive variation for all years, reaching the highest variation in the 2017 survey (209.6%) when compared to 1977. The RM also showed a positive variation for all years, reaching the highest variation in 2017 (86.1%).

Regarding the share of walking trip generation in SP and the RM compared to the total generated in the RMSP, we observe that SP obtained the highest share in all survey years, with slight and subsequent decreases until 2007 (2017 showed a slight increase). Hence, 1977 (69.6%) and 2007 (57.4%) were the years with the most and least expressive share, respectively.

While lower-income families make most of their trips on foot (“walking”) and predominantly use the bus, higher-income families predominantly use cars. In lower-income brackets, public transportation is the main motorized transport used. In higher income brackets, on the other hand, we observe the opposite: greater use of cars when compared with public transport and, therefore, are the social groups most dependent on private transportation (Vasconcellos, 2001).

In total terms of trips generated in the RMSP, walking trip generation went from 6 million per day to around 13.3 million per day, that is, it more than doubled.

Figure 9. Shares and variations of trip generation by main modes of transport in São Paulo and the Metropolitan Region from 1977 to 2017.



Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

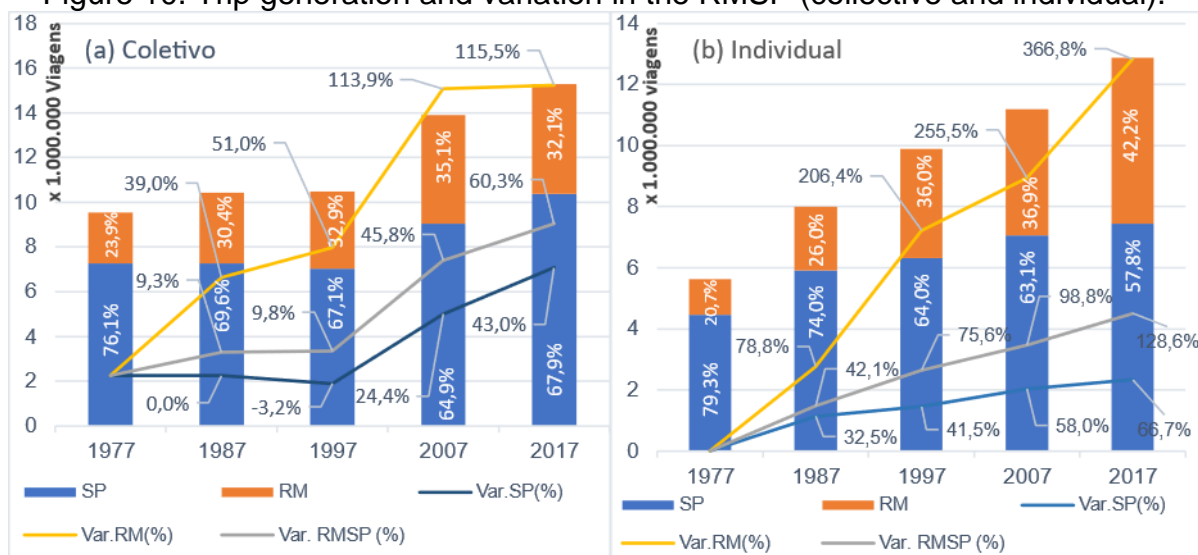
Based on Figure 9, we can identify how the trip generation by main modes of transport varied in time for the “São Paulo” (SP) and “Metropolitan Region” (RM) scopes and the total variation compared to the 1977 survey (reference year).

Regarding the total trip generation (in all modes of transport), we observed an increase in the number of trips generated in all analyzed years compared to the total generated in the 1977 survey.

In observing the lines of variation—“Var.SP” and “Var.RM”—, we see an increase of 61.55% and 204.55% respectively, that is, for the RM, total trip generation tripled when compared to the 1977 survey. In turn, São Paulo showed a smaller increase, reaching about 2/3 more than the total number of trips generated in 1977 for this scope.

We can also observe that the difference (red vertical arrows) in the total trip generation between São Paulo and the Metropolitan Region has decreased over the surveys, with the 1977 survey showing the highest value (201.3%), dropping to 59.8% in the 2017 survey.

Figure 10. Trip generation and variation in the RMSP (collective and individual).



Source: prepared based on Metrô-SP (1977, 1987, 1997, 2007, 2017)

Figure 10 shows the trip generation in SP, the RM, and the RMSP (total), always having the 1977 survey as reference. We note that the RM had quite a significant growth, for both collective and individual trips, with collective trip generation doubling (11.45%), while individual trips almost quintupled (366.76%).

While lower-income families make most of their trips on foot (“walking”) and predominantly use buses, higher-income families predominantly use cars. Up to the third income bracket, public transportation is the main motorized transport used. Conversely, the two highest income brackets make motorized trips mainly by car, being the social groups most dependent on private transportation.

Table 1 provides the values of total trips generated, population, and employment for SP, the RM, and the RMSP.

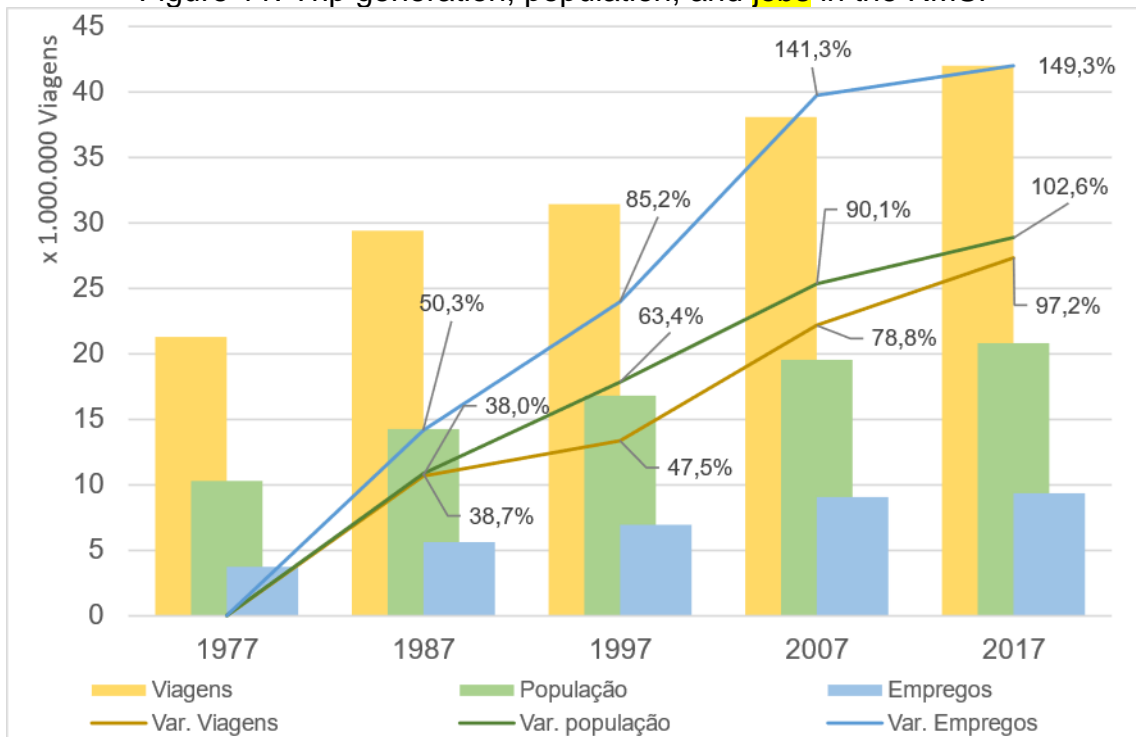
**Table 1.** Trip, population, and job data for SP, RM, and RMSP

Year	SP data			RM data			RMSP data		
	Trips	Population	Jobs	Trips	Population	Jobs	Trips	Population	Jobs
1977	15,927,545	7,520,352	2,931,932	5,286,848	2,755,251	825,533	21,214,393	10,275,603	3,757,465
1987	19,891,306	9,127,421	4,001,965	9,295,938	5,120,413	1,645,426	29,187,245	14,247,834	5,647,390
1997	19,568,841	9,856,853	4,626,885	11,766,110	6,935,568	2,332,510	31,334,950	16,792,421	6,959,395
2007	23,487,207	10,896,639	5,930,445	14,545,702	8,637,981	3,135,291	38,032,909	19,534,620	9,065,736
2017	25,774,471	11,739,241	6,003,967	16,120,473	9,082,430	3,362,804	4,894,943	20,821,671	9,366,771

Source: prepared based on IBGE (2020) and Metrô-SP (1977, 1987, 1997, 2007, 2017)

Figure 11 presents the calculated variations by survey year (starting in 1977) for the same territorial scopes.

**Figure 11.** Trip generation, population, and jobs in the RMSP



Source: prepared based on IBGE (2020) and Metrô-SP (1977, 1987, 1997, 2007, 2017)

In analyzing Table 1 and Figure 11, we observe that all three variables showed growth with relatively similar trends. Although we cannot assert a casual relationship, the results indicate a potential correlation between both. Hence, statistical methods are

needed to prove the degree of this correlation: trip generation (dependent variable) and socioeconomic variables (independent variables). We may also establish an inverse correlation, given the clear synergy between the phenomena (both influence and are influenced).

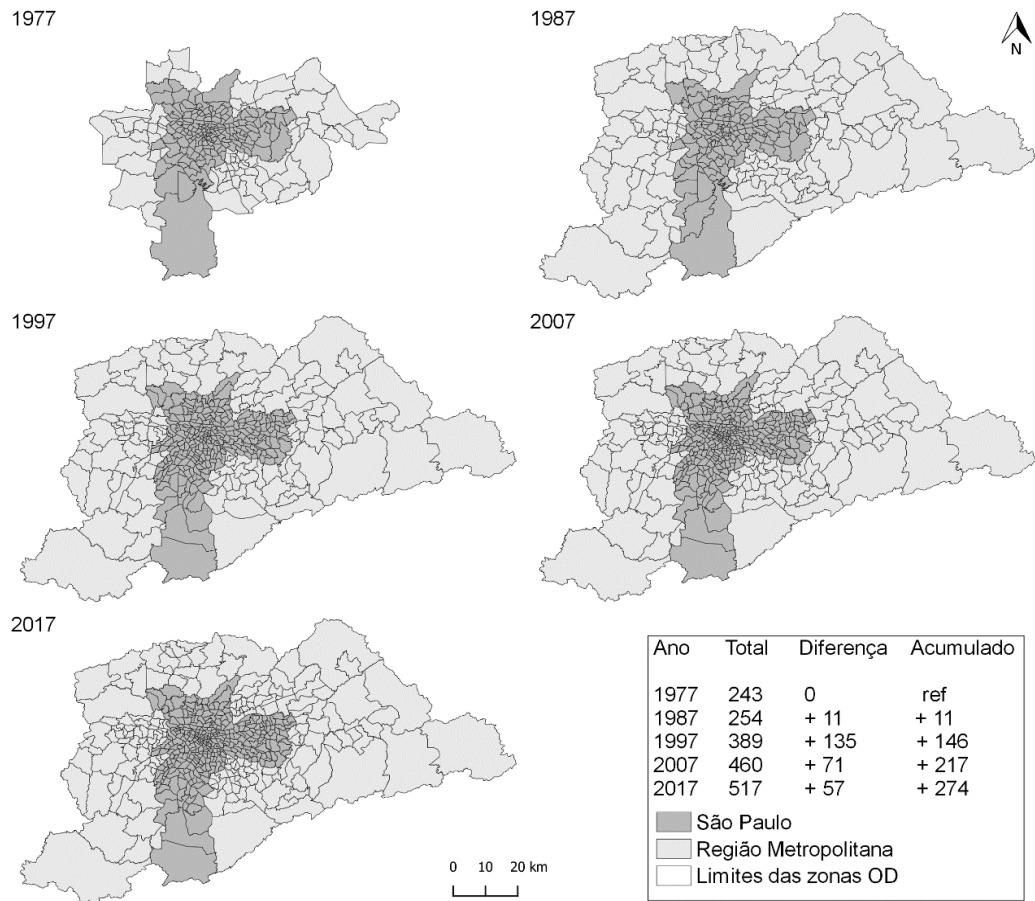
Transportation is, however, widely defended as an essential ancillary activity for the economic development of any territory.

According to SACTRA (1999), there are several significant mechanisms by which such transport improvements could, in principle, improve economic performance: reorganization or rationalization of generation, distribution, and land use; effects on workforce recruitment and consequently on labor costs; increased output resulting from lower production costs; promotion of inward investment and unblocking of inaccessible locations, for example.

Likewise, Barat (1978) argues that investments in transport affect the time (development) and spatial (regional-urban organization) dimensions—the latter involves structuring the geo-economic space by conditioning patterns of territory organization and location of activities.

Figure 12 illustrates the territory covered by SP, the RM, and the RMSP with the respective OD zones defined in the Metro-SP survey (1977, 1987, 1997, 2007, 2017).

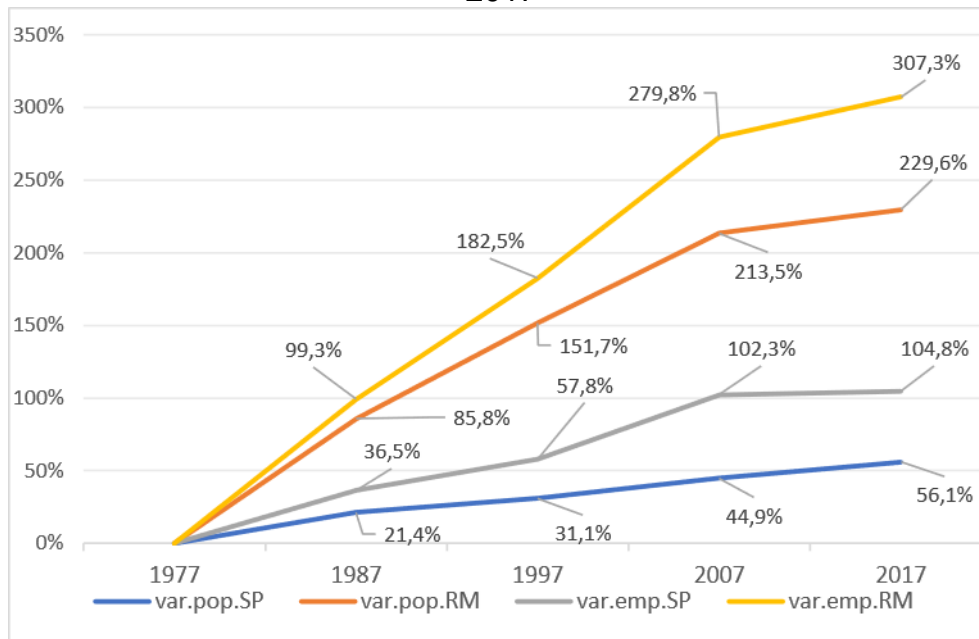
Figure 12. Evolution of RMSP limits and respective OD zones between 1977 and 2017.



Source: prepared based on Metrô-SP (1977, 1987, 1997, and 2007)

We can observe an increase in the total area of the RMSP between 1977 and 2017. Moreover, 274 new OD zones were created and reorganized in each survey analyzed, elapsed in 50 years, thus corroborating the results of Figures 2 to 11 and the references cited.

Figure 13. Population and employment variations in SP and the RM between 1977 and 2017

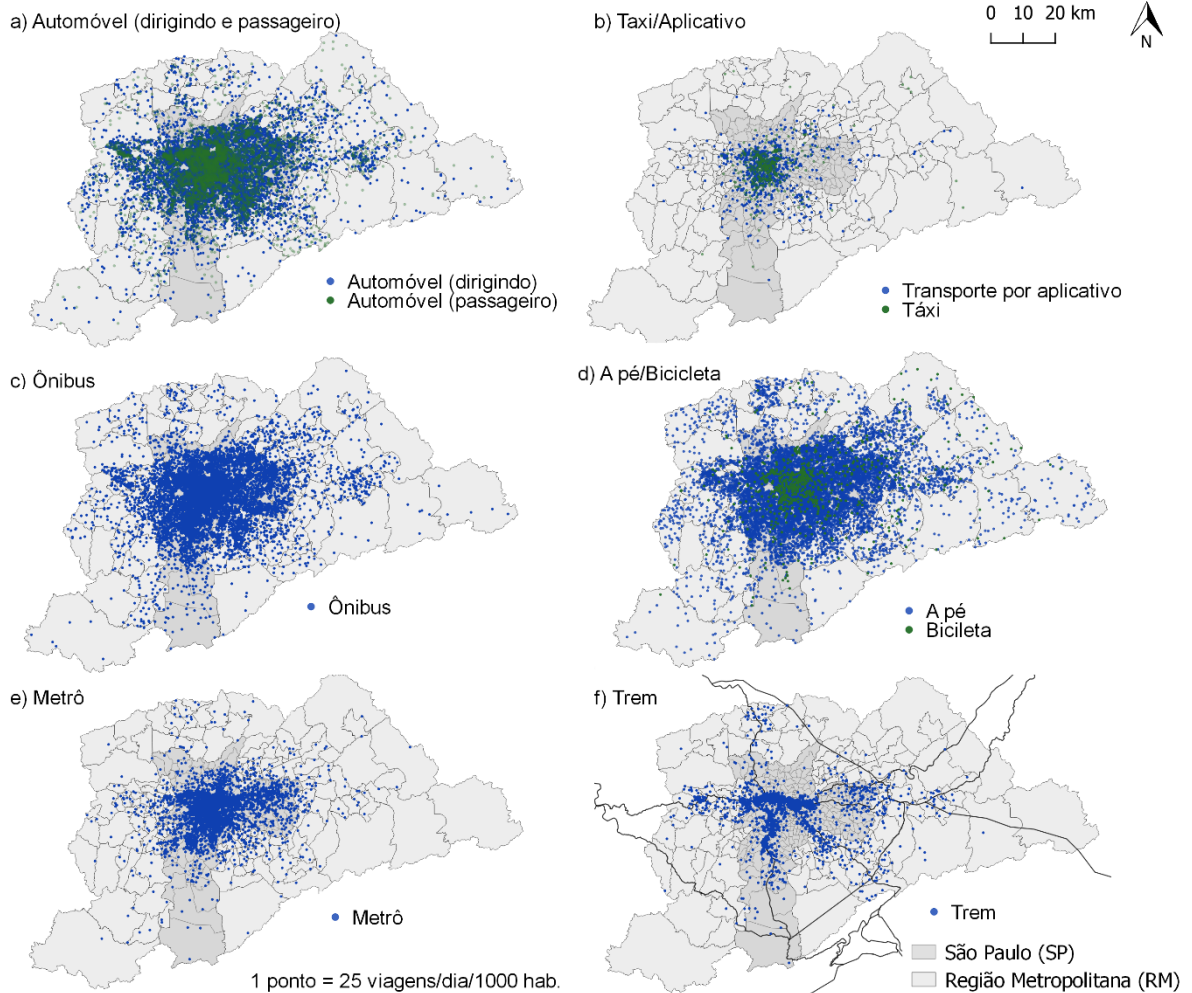


Source: prepared based on Metrô-SP (1977, 1987, 1997, and 2007)

Figure 13 highlights the more accentuated expansion scenario in the RM compared to SP, due to the high growth in both population and jobs. This scenario corroborates the different results obtained for the territorial scopes in terms of variation (Figures 1 to 11) and the territorial expansion of the Metropolitan Region (Figure 12).

Figure 14 presents the trip generation by main modes of transport in the RMSP's OD zones in 2017. Each plotted point represents 25 daily trips per thousand inhabitants in the OD zones.

Figure 14. Trip generation by main modes of transport in the RMSP in 2017



Source: prepared based on Metrô-SP (2017)

We should note, therefore, that despite this scenario of higher growth in the RM compared to SP, the highest concentration of trip generation in 2017 is still located in the RMSP's central region—a gradual loss of share in SP's trip generation since 1977, highlighted by Figures 1 to 8.

#### 4. Final considerations

Regarding the modes of transport analyzed individually, in terms of variation per survey year, buses, cars, school bus, subway, train, motorcycle, walking, and bicycle showed a gradual increase over the 50 years of the survey, highlighting a consolidation scenario for these modes of transport.

Conversely, chartered transport has shown a gradual decrease over the past decades, indicating the disuse of this mode of transport over time. This is also the case for the trolleybus, which accounted for the total trip generation of this type of mass transport only in 1977. In the 1987 survey, this mode of transport already shared trip generation with diesel buses. By 1997, there were no more records on trolleybus trip generation, as this mode of transport became obsolete against the new technology, especially the greater versatility of diesel buses.

Another point that deserves attention is the taxi. For this mode of transport, we considered trip generation from conventional taxis only until 2007, and from 2017 onwards, ride-hailing applications were included in the sum—before 2017, such technology did not exist. Thus, we observed an intense negative variation between 1977 and 1987, and then an intense positive variation between 2007 and 2017.

This first finding may be explained by the high variation in taxi fares in the decades from 1980 to 2000, the regulation and control to which taxis were subjected, as well as the monopoly that came to exist. The positive variation, seen since the 2010s, stems from the emergence of ride-hailing applications (Uber, Cabify, 99 Easy Taxi, BlaBlaCar, etc.), generating greater accessibility and quality for users, cheaper fares, and greater competition among service providers.

As for trip generation by collective and individual modes of transport, we observed a gradual increase for SP, the RM, and consequently the RMSP. We highlight that the individual modes of transport showed higher growth than collective ones, which may result from several factors, such as precarious public transportation, lack of infrastructure and maintenance of the existing network, cheap individual modes of transport that compete with public transportation, etc.

Importantly, the RM presented a much higher positive variation in trip generation (main modes of transport and collective and individual categorization) compared to SP. Confronting these results with Figure 13, we observed that the RM also had positive variations in employment and population much higher than SP, highlighting a more susceptible scenario for trip generation growth.

Despite this favorable scenario for expansion of the RM, most of the trip generation is concentrated in RMSP's central region, where São Paulo is located.

That said, we argue that trip generation is correlated with the RMSP's economic growth and, therefore, is a necessary condition—a character of permissiveness—but not sufficient by itself to trigger growth (and vice-versa), with many other factors

(political, environmental, social) and basic investments (sanitation, education, security, etc.) influencing the development of socioeconomic characteristics and transport infrastructure of a given region.

Finally, our findings answered the two questions posited in the problematization and confirmed the initial hypotheses: in general, the increased trip generation (except for charter) correlated with variations in population and employment, but with significant differences between SP and the RM.

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