

**The use of urban public transport in Brazilian medium cities: a case study
on the number of passengers in Juiz de Fora, MG**

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SUMMARY

The transport system is one of the main factors that redefine the Brazilian medium cities' domains by structuring flow-networks of products and people. Within this system, urban public transport (UPT) ensures the right to the city, promoting the urban mobility of citizens and social inclusion. In the city of Juiz de Fora, Minas Gerais, since 2013, there is a scenario of dissatisfaction of users with the services provided by bus companies, with protests advocating fare stagnation and better transport conditions. Given this, this work aims to analyze the number of UPT passengers in Juiz de Fora, considering factors that may influence this contingent. We used data from 2013 to 2019, and the (a) number of UPT passengers was established as the primary variable, being related to three secondary variables: (b) UPT fare, (c) private car fleet and (d) city population. A reduction was observed in the primary variable while there was a growth in the secondary ones. The correlation between the variables was verified by Pearson's Correlation method, which pointed to strong correlations between the three pairs of variables: (a)–(b), (a)–(c) and (a)–(d). For greater understanding of the decrease of number of passengers, other factors were considered, such as the introduction of on-demand ride services in the city and the exchange of the UPT consortium, both occurred in 2016. Therefore, this work refers to the first analyses on the subject and points out possible paths for the future of the UPT.

KEYWORDS: Urban public transport. Urban mobility. Medium cities.

INTRODUCTION

The means of urban transport enable the organization of flow-networks of people and products, being fundamental elements in the structuring of a city. Based on the developed transport networks — which includes road infrastructure, terminals, stops, and vehicles — the urbanization process is boosted, and a diversified and active system is created (PONS; REYNES, 2004).

In Brazil, the intensification of urban growth in the last 60 years (PACHECO; AZEREDO, 2019) consolidated deep socioeconomic inequalities in spatial occupation, which is also reflected in how journeys are held.

The most favored social classes occupied the most central and developed regions, as the less privileged social classes began to occupy peripheral areas. Thus, urban public transport (UPT) plays a primary role in guaranteeing the right to mobility and citizenship (BRASIL, 2012) by connecting residents of the peripheries to other regions to carry out activities concentrated in other areas.

However, public policies for economic and urban mobility have not been able to contain the growth of UPT costs, as well as to cover 100% of the urban areas of Brazilian cities, as pointed out by a report by the now extinct Ministry of the Cities (BRASIL, 2004).

From June 2013, urban mobility became a frequent topic in the Brazilian agenda. During this period, the June Days (*Jornadas de Junho*, in Portuguese) occurred, a set of popular manifestations motivated by the increase in the UPT fare in São Paulo, SP. Later, it became a national movement, scoring other popular interest issues besides UPT (AUGUSTIN, 2018).

In the context of contemporary Brazilian medium cities, the transport system is one of the main factors that reaffirm its domains, leading to new configurations that impact the space of society (BOGNIOTTI, 2017). It should be clarified that the concept of medium-sized cities differs from medium cities. According to the Brazilian Institute of Geography and Statistics (IBGE), the definition of a medium-sized city is based on its demographic dimension, classifying as such cities with between 100 and 500,000 inhabitants (FRANÇA, 2007; IBGE, 2010). At the same time, the condition of the medium city considers the cities as "strong centralities that are

materialized through flows, to the point of contributing to the planning of the regional space in which they are located" (TRINDADE JÚNIOR, 2011, p.136, free translation from Portuguese).

In this scenario, the city of Juiz de Fora, in Minas Gerais state, could be classified as a large city because it has more than 500,000 inhabitants (IBGE, 2020), although it is understood as a medium city due to its regional influence (BARROS, 2019; IBGE, 2008). Juiz de Fora is located in the mesoregion of Zona da Mata Mineira, with an estimated population of 573,285 people (IBGE, 2020). It occupies an area of 1,433.87 km² with only 440.72 km² of urban area, divided by the city headquarters and 11 more districts (PREFEITURA DE JUIZ DE FORA, 2018). In the economic sphere, it stands out for the tertiary sector, presenting a great diversity of commercial activities and specialization of health services. In addition, it has public and private institutions of higher education, which impact the real estate market and promote migration to the city. This infrastructure ensures it as a regional hub, developing subordination relations with nearby cities (BARROS, 2019; IBGE, 2008).

Thus, the UPT is essential to assist the journeys of inhabitants from peripheral regions and people who travel to the city to perform some activity. That said, the June Days protests held in the city sought the stagnation of the bus fare without the expected inflationary replacement (MEIRELES, 2013). Regarding the UPT fare in the city, the price was maintained until April 2014, when there was a new protest railing against the adjustment (DONIZETE, 2014). In 2016, the Juiz de Fora City Council (PJF, which stands for *Prefeitura de Juiz de Fora*, in Portuguese) conducted the bidding for a new consortium of UPT companies, which began operations in the same year and had among its objectives: (1) the adequacy of 100% of the fleet for people with disabilities; (2) the insertion of minibusses routes to places of difficult access; (3) the implementation of free internet in vehicles; and (4) the circulation of vehicles with a maximum age of 10 years and average fleet age of 5 years (PJF, 2015; 2016a; 2016b). In the previous consortium, the bus lines were labeled by color, according to the area of the city in which they circulated; in the new consortium, however, the new companies did not maintain the visual identity of the routes, making it difficult for the population to recognize the routes, especially the illiterate parcel (VALENTE, 2017a).

Other requirements agreed in the contract encounter difficulties in their compliance, such as the installation of wi-fi internet (VALENTE, 2017b) and the constant renewal of the fleet, causing companies to be frequently fined by the PJF (DELGADO, 2019). According to the Sustainable Cities Survey 2020 (originally known as *Consulta Cidades Sustentáveis 2020*, in Portuguese), the dissatisfaction of UPT users is a scenario that remains, with an index of 87.02% of disapproval (sum of the answers "disagree" and "strongly disagree" in the graph 4, p. 57, COLAB; UN-HABITAT, 2020).

According to Dias e Santos (2018):

the provision of mobility becomes a commodity, passengers become consumers, and the access to a fairer, balanced, and the harmonious city is contrasted by an unequal, sprawled, and segmented city, commanded by transport oligopolies that define and command the journeys in the cities and at the regional and interstate level, because much of the problems related to the right to mobility permeate all types of service provided, whether urban road. (DIAS; SANTOS, 2018, p. 10, free translation from Portuguese)

One factor that may have contributed to dissatisfaction with the service provided by UPT companies is the comparison with *on-demand ride services* (ODRS), introduced in the city in 2016 by the North American company Uber (ALMEIDA, 2016). This mode of transport uses applications to connect drivers to users and offers a better cost-benefit ratio than UPT, primarily when used in a shared way. Since then, other companies have been operating in Juiz de Fora, such as the 99 (99, 2021) and Sity (SITY, 2021). From what has already been verified in other Brazilian cities, the increasing support for this means of transport commonly contributes to the migration of bus users and an increase in the fleet of private cars used for ODRS, resulting in a drop in the number of UPT passengers (MARTINS et al., 2019).

With a history of disapproval marked by protests and noncompliance of companies, the crisis in the UPT sector peaked in Juiz de Fora in 2020, triggering eight shutdowns throughout the year (ANDRADE, 2020). One of the aggravating factors was the global pandemic caused by COVID-19, which directly affected the demand for UPT (BORGES, 2020). The restrictions of social isolation changed the daily life of citizens, paralyzing classes in schools, transforming face-to-face work positions into remote jobs, and causing people to leave home only for essential activities (PAULA, BRAIDA; 2021, ROCHA; COSTA; COLCHETE FILHO, 2021). Thus, it tends to be believed that the number of UPT passengers has been reduced to contain the advance of the disease (LIMA et al., 2020; G1, 2020).

OBJECTIVE

In this scenario, the goal of the article is to analyze the number of passengers using urban public transport (UPT) in Juiz de Fora, MG, Brazil, seeking to verify if there was, in fact, a decrease in demand for this means of transport and which factors influenced this event.

METHODOLOGY

The methodology used for the development of this work can be divided into four stages. The first phase consisted of a literature review in the "snowball" format (RIDLEY, 2012) to understand the panorama of urban public transport (UPT) in Juiz de Fora, MG, and its role in the domain of a medium city. The second stage dealt with data surveys on online platforms of the National Traffic Department (Denatran), the Brazilian Institute of Geography and Statistics (IBGE), and the Juiz de Fora City Council (PJF). The third phase addressed the data processing for elaborating the correlation graphs between variables, and the fourth and last one was concerned with the analysis of the results found in the graphs.

The object of study is the UPT sector in Juiz de Fora, MG, Brazil. Within this topic, the established variables were: (a) the number of UPT passengers, being the primary variable; and as secondary variables, (b) the UPT fare, (c) the private car fleet, and (d) the city population.

The time interval chosen for analysis was from 2013 to 2019 since the data source of the primary variable provides material starting from 2013. Coincidentally, this is the year that urban mobility becomes a frequent popular agenda, due to the June Days, as aforementioned. Despite the availability of data for 2020, it was decided not to include them in the analysis interval due to the effects caused by the COVID-19 pandemic in the transport sector. Given that one of the main strategies to contain virus contagion is social distancing, and therefore the non-

use of UPT (LIMA et al., 2020), the inclusion of 2020 in the interval to be analyzed could influence the analysis, amplifying reduction or growth trends, leading to erroneous conclusions.

The first database consulted was the PJF Transparency Portal. The first collection sought data regarding the primary variable: (a) the number of UPT passengers in the city. This was accessed following the steps: Transparency Portal > Public Transport > Bus > Demand Report (PJF, 2020). It was possible to verify the demand per month and year and collect (b) the UPT fare data, the first secondary variable related to the primary. For (a), the total number of UPT users was adopted, including paying and exempt users.

The second database consulted was the Denatran Statistics. The second collection sought data from the second secondary variable: (c) the private car fleet. Data are provided for each month of a given year, so it was decided to adopt (b) as the value from December of the respective year. It was collected following the steps: Year > National fleet (December of the respective year) > Fleet by city and type > Sheet line "Juiz de Fora"> Sheet column "Automóvel" (Denatran, 2020).

The third consultation was conducted on the IBGE portal to collect the third secondary variable: (d) city population. Basing on population estimates in each year of the chosen interval, the estimated city population was obtained from 2013 to 2019, using the following steps: Homepage > Statistics > Social > Population > Population Estimates > Downloads > Year (IBGE, 2020).

The collected data were organized in tables to be converted into graphs, which explored the possible relations between the primary variable (a), represented in bars, and each of the three secondary variables (b), (c), and (d), represented in lines. After making the graphs, it was verified that the variables were indeed related to each other. In order to understand the degree of correlation among them, the Pearson's correlation method was used (FIGUEIREDO FILHO; SILVA JÚNIOR, 2009). A scatter plot was elaborated to assess each of the correlations: (a)–(b), (a)–(c) and (a)–(d). Each chart generated an "R²" value, which allowed the extraction of "r", also named the Pearson's coefficient. From "r," it was possible to measure the degree of correlation, which ranges from 0 to |1|, indicating negligible correlation when approaching 0 and a strong correlation when approaching 1. However, it is worth mentioning that statistical correlation does not imply causality between the variables. Therefore the analysis of the relation will be deepened in the analysis section.

RESULTS

Based on the data obtained and to facilitate their analysis and understanding, it was decided to represent them in the form of graphs that will be presented throughout this section. The charts are the result of the correlation between the primary variable – (a) number of UPT passengers – and each one of the three secondary variables – (b) UPT fare, (c) private car fleet, and (d) city population.

Chart 1 presents the data collected from 2013 to 2019 for the aforementioned variables. The data were correlated in Graphs 1-6, which will be presented after the chart.

Chart 1: Data used to produce graphs 1- 6. Annual data listing for the city of Juiz de Fora: (a) number of urban public transport passengers, (b) UPT fare, (c) private car fleet, and (d) city population.

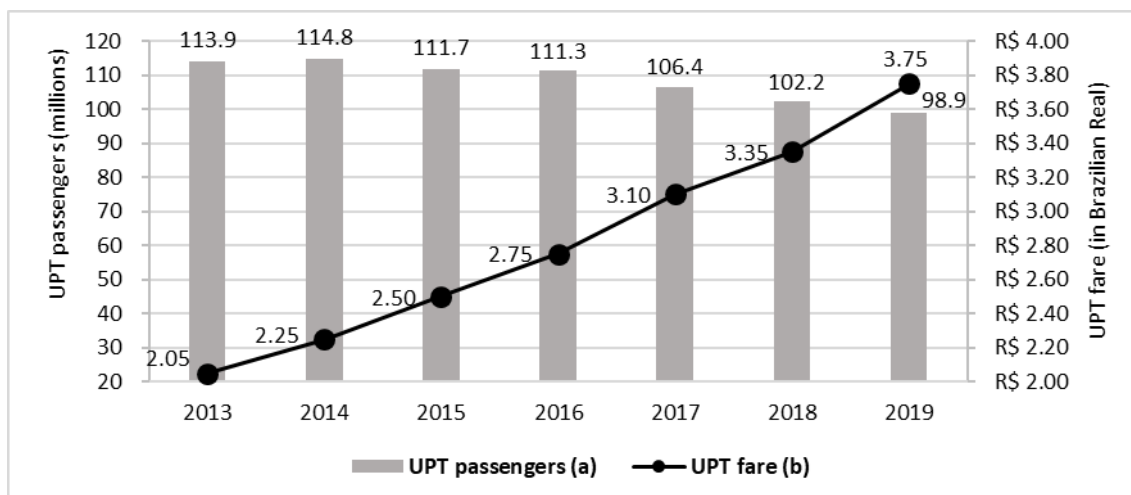
Year	Number of UPT passengers	UPT fare	Private car fleet	City population
2013	113,986,584	R\$ 2.05	150,951	545,942
2014	114,828,731	R\$ 2.25	158,131	550,710
2015	111,782,632	R\$ 2.50	163,820	555,284
2016	111,327,943	R\$ 2.75	168,653	559,636
2017	106,429,848	R\$ 3.10	174,057	563,769
2018	102,202,866	R\$ 3.35	178,978	564,310
2019	98,976,094	R\$ 3.75	183,178	568,873

Source: Organized by the authors (2021). Sources: Denatran (2020), IBGE (2020) and PJF (2020).

The first analysis observed through the data was between the pair of variables (a)–(b), which refers to (a) the number of UPT passengers and (b) the UPT fare in Juiz de Fora, represented in Graphs 1 and 2.

Graph 1 shows that in 2013, (a) the number of passengers was 113.9 million, and in 2019, it was 98.9 million, recording a reduction of 13.2% over seven years. The (b) UPT fare, on the other hand, started the year 2013 at the price of R\$ 2.05 and ended the year 2019 at R\$ 3.75, indicating an increase of 82.9%.

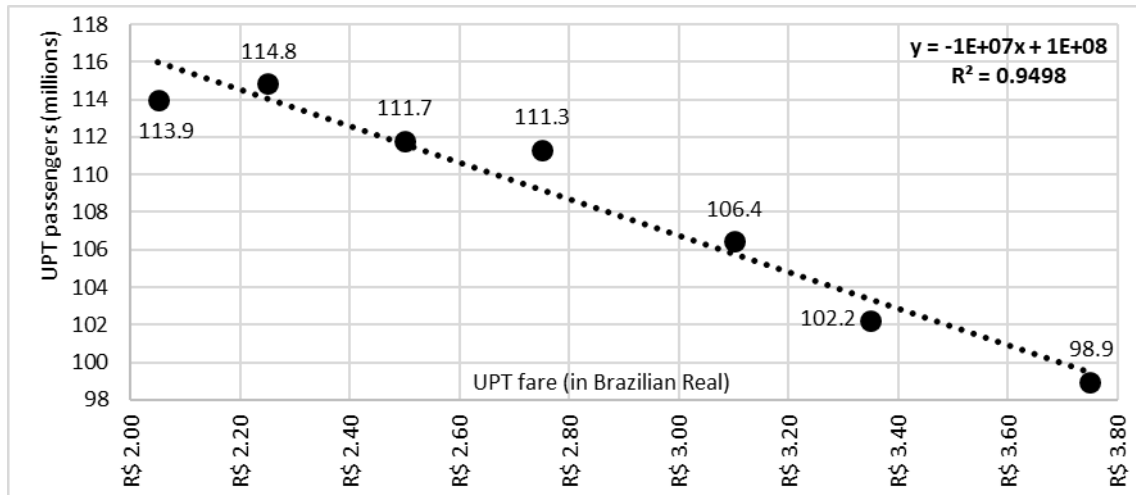
Graph 1: Relation between the (a) number of UPT passengers and the (b) UPT fare between 2013 and 2019.



Source: Organized by the authors (2021). Data source: PJF (2020).

In Graph 2, configured as a scatter plot, the goal was to understand how the secondary variable (b) UPT fare influences the primary variable (a) number of UPT passengers. Thus, (a) was established as a dependent variable, being located on the x-axis, while (b) was established as an independent variable, being located on the y-axis.

Graph 2: Data correlation graph, between the (a) number of UPT passengers and the (b) UPT fare, with decreasing trend line and R² value.



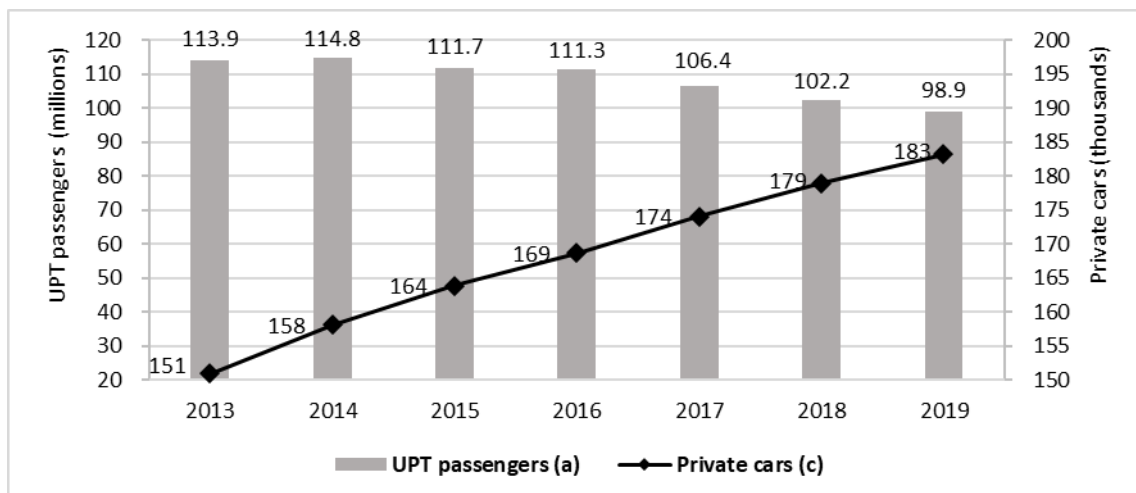
Source: Organized by the authors (2021). Data source: PJF (2020).

The regression generated by the two variables (a) and (b) leads to an excellent correlation verified through $r=0.97$. For Figueiredo Filho e Silva Júnior (2009), the observed value corresponds to a "strong correlation".

The second relation analyzed was between the pair of variables (a)–(c): the (a) number of UPT passengers and the (c) fleet of private cars in Juiz de Fora, represented in Graphs 3 and 4.

Graph 3 shows that in 2013 the city had a fleet of 150,951 private cars, while in 2019, it reached 183,178, registering an increase of 21.3%. Again, the secondary variable increased (21.3%) while the primary variable decreased (13.2%).

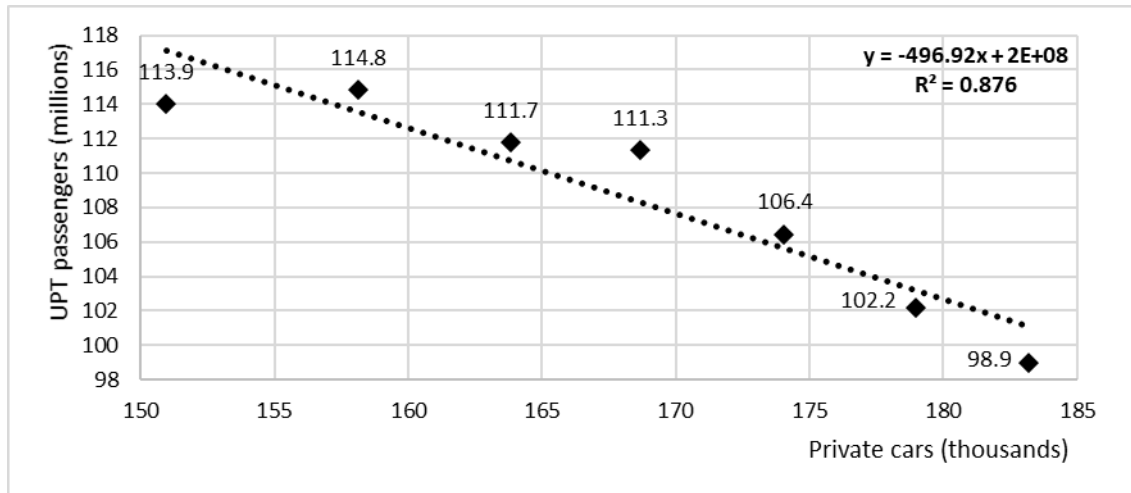
Graph 3: Relation between the (a) number of UPT passengers and the (c) private car fleet between 2013 and 2019.



Source: Organized by the authors (2021). Data source: Denatran (2020), PJF (2020).

Graph 4 follows the same analysis structure as Graph 2, but in this case, it establishes the (c) fleet of private cars as an independent variable, located on the y-axis.

Graph 4: Data correlation graph between the (a) number of UPT passengers and the (c) private car fleet, with decreasing trend line and R² value.

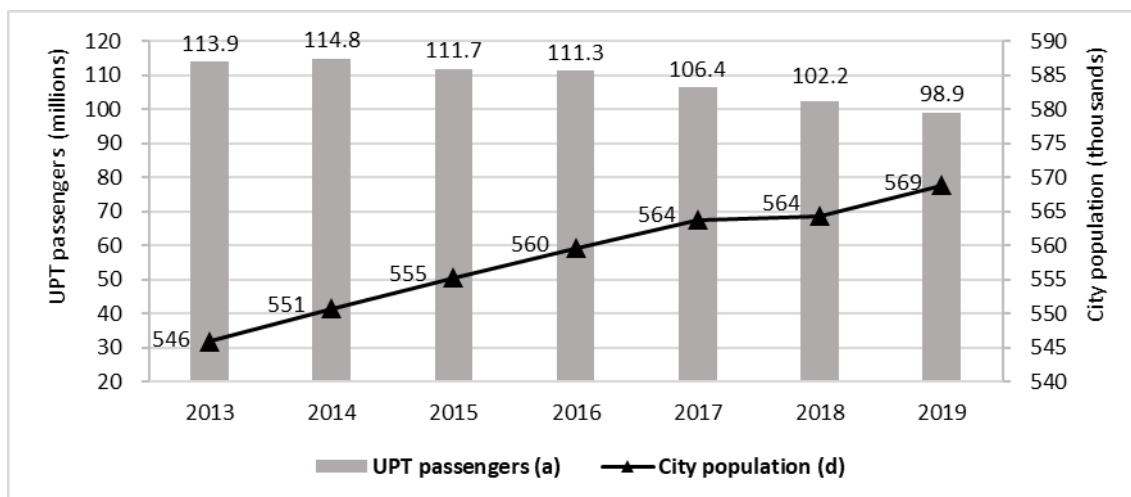


Source: Organized by the authors (2021). Data source: Denatran (2020), PJF (2020).

Finally, the third and final analysis observed was between the pair of variables (a)–(d): the (a) number of UPT passengers and the (d) population in Juiz de Fora (Graphs 5 and 6).

The data behavior in Graph 5 is similar to Graphs 1 and 3, being differentiated by the secondary y-axis, which, in this case, presents the (d) city population, represented by the line. In 2013, the estimated (d) city population was 545,942 inhabitants, reaching 568,873 in 2019, growing 4.2%, while the (a) number of UPT passengers decreased by 13.2% in the same period.

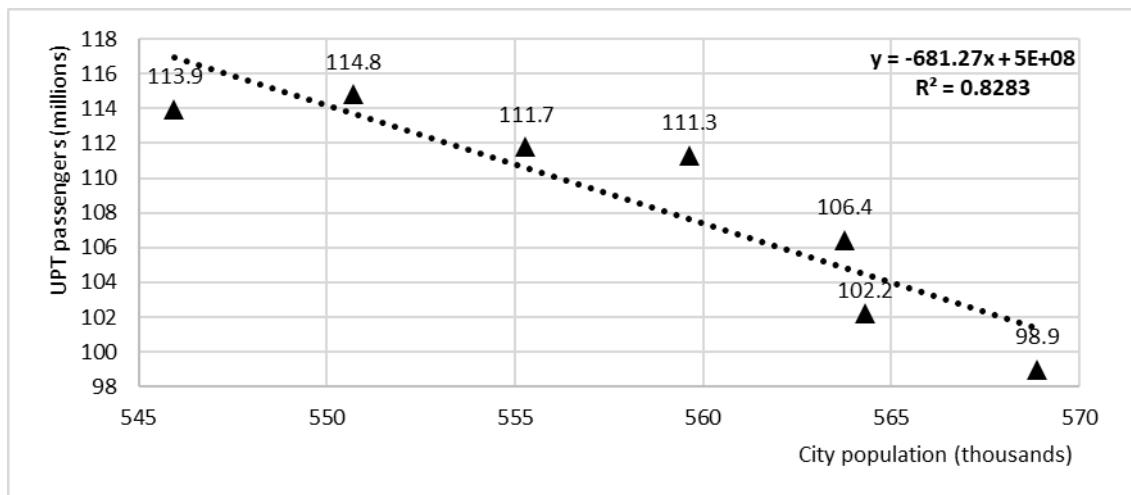
Graph 5: Relation between the (a) number of UPT passengers and the (d) city population between 2013 and 2019.



Source: Organized by the authors (2021). Data source: IBGE (2020), PJF (2020).

In Graph 6, the analysis is made between the (d) municipal population and (a) UPT passengers. Again, the Person Correlation ($r=0.91$) indicates a negative "strong correlation" (FIGUEIREDO FILHO; SILVA JÚNIOR, 2009).

Graph 6: Graph of correlation of data between the number of passengers and the municipal population, with the decreasing trend line and the value of R^2 .



Source: Organized by the authors (2021). Data source: IBGE (2020), PJF (2020).

DISCUSSION OF THE RESULTS

In general, the results obtained make it possible to observe strong relations between the decrease in (a) the number of passengers of urban public transport in Juiz de Fora with the increase in (b) UPT fare and in the (c) private car fleet. Even with a 4.2% rate of (d) population growth accumulated over seven years, the UPT records a steady decline in passenger access to public transportation.

As noted, since 2013, the sector has been going through a crisis. The 2020 data were not included in the analysis; however, it is worth mentioning that the COVID-19 pandemic that began in 2020 aggravated the crisis in the sector, according to Salles (2020). However, other factors should be considered.

One of these factors is the increasing support for on-demand ride services (ODRS). Initially treated as an alternative to more consolidated means of public transport such as buses and taxis, this modality offers a competitive price, primarily when used in a shared way.

An example is taken to move from Rua Halfeld, in the city center, to the Universidade Federal de Juiz de Fora campus. If performed by UPT, the individual expense is R\$ 3.75 (PJF, 2021), the price of a ticket. However, if it is performed using ODRS in the shared modality, with the capacity of four passengers, the trip's total price varies between R\$ 10.00 and R\$ 15.00 (UBER, 2021), which counts from R\$ 2.50 to R\$ 3.75 per person.

Thus, the price of ODRS is equivalent to the UPT. However, the ODRS presents more benefits to the passengers in relation to the UPT, such as the shorter travel time, the fact that it is a door-to-door service, the guarantee of seats for all passengers, and greater flexibility of schedules (CASSEL, 2018).

Another factor that may be linked to the reduction in the number of UPT passengers

is the change of the consortium of companies providing the service. The implementation of the new consortium took place in the second half of 2016 (G1, 2016) and proposed an adaptation to the current demands of urban transport, with newer buses, a more accessible fleet, and the implementation of free internet.

However, the change in the visual identity of the buses considerably hindered the recognition of the lines, affecting mainly illiterate people (VALENTE, 2017). The old bus identification system was defined by color, which each color corresponded to an area of the city, allowing users to intuitively know where they were going. In the current system, colors play the unique role of identifying which company that specific vehicle belongs to. These changes directly impact the user experience when using the service and may hamper the use of UPT.

CONCLUSION

Because of the facts presented, it was possible to verify a significant decrease of 13.2% in the (a) number of urban public transport (UPT) passengers in Juiz de Fora in the period from 2013 to 2019, although the (d) population increased 4.2%.

Among the reasons for this decrease in the use of UPT, it is possible to highlight the 83% increase in the (b) UPT fare and the growth of 21.3% of the (c) private car fleet in the city.

The crisis in the sector had already been punctuated by public protests and frequent general dissatisfaction, with a considerable reduction of 18.3% in the number of passengers by 2019. This crisis was further aggravated by the COVID-19 pandemic that began in 2020, which discouraged the use of this means of transport as a way to contain the disease's progress.

It is believed that the change in the buses' visual identity has influenced the UPT user's experience. However, it is necessary to conduct further studies on the user's perception of this modification to measure the possible impacts arising from this exchange. This study did not address this theme because it concerns concepts about human perception, which is not the focus of the work.

External factors such as the arrival of on-demand ride services (ODRS) in the city were not quantitatively addressed. Therefore, it is necessary to conduct studies that measure the effects of this means of transport insertion concerning UPT adherence in the city.

Another factor that may interfere with the use of UPT is the change in daily life in Post-pandemic life, since many people have adopted the practice of remote work, began to study more remotely and perform more activities at home and/or by digital means. If this happens, people will stay longer at home and probably depend less on UPT, so this impact should also be studied.

Since the transport network plays a fundamental role in the structuring of cities, especially concerning contemporary Brazilian medium cities, it is believed that the public transport system should undergo a remodeling of its services, seeking to adequate under the influence of intrinsic and external factors, meet the new demands of use and adapt to new social and economic standards.

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