

Analysis of the urban mobility of a medium-sized city in northern Rio Grande do Sul

Júlia Brum Campestrini

Master's student of the Graduate Program in Architecture and Urbanism (PPGARQ), ATITUS, Brasil.
jliabrumcampestrini@gmail.com

Alcindo Neckel

Professor Doutor, ATITUS, Brasil.
alcindo.neckel@atitus.edu.br

Tháisa Leal da Silva

Professora Doutora, ATITUS, Brasil.
thaisa.silva@atitus.edu.br

RESUMO

The lack of urban planning can cause several consequences for cities, especially in the face of accelerated population growth, resulting in obstacles to urban infrastructure and its services, especially in terms of mobility, making it necessary to think of strategies aimed at accessible development, and efficient and sustainable cities. In this context, the general objective of this study is to analyze the active mobility of the city of Passo Fundo/RS (Brazil), in particular, the bike paths and public transport in the city. Thus, initially, bibliographic research was carried out on the subject addressed, then data collection was carried out on the main points of public transport and cycle paths in the analyzed city. From the data collection, an analysis was carried out through maps and it was possible to perceive the importance of analyzing the urban mobility of the municipalities, which helps in the understanding of the current scenario, collaborating both in the management and in the municipal planning, as in the development of guidelines that adapt to the place in the search for a better quality of life for citizens.

PALAVRAS-CHAVE: Town planning. Urban mobility. Remote Sensing.

INTRODUCTION

The growth of cities without proper planning can lead to several problems in urban infrastructure (ZHENG; KHAN; ABBAS, 2022). The United Nations (2019) estimates that the world population could reach 8.5 billion inhabitants by 2030, raising concerns about how today's cities can deal with the consequences of this accelerated population growth.

The early definitions of urbanization began in mid-1867 when it was stipulated that urbanization is characterized as the process of densification of the rural population in urban centers or villages (YAO; XU; HUANG, 2021). In general, it is understood that urbanization is a consequence of economic transformations, technological, scientific, and administrative advances, as well as social transformations involving the culture and daily habits of the population (ZHENG; KHAN; ABBAS, 2022). Urban growth and expansion, without planning space and services, bring several dangers and threats to the environmental quality of urban ecosystems (MARANDOLA JR et al., 2013).

Thus, concerns arise in relation to urban infrastructure and public services offered. However, for new strategies to be adopted in the urban planning of cities, benefiting the environment, economy, and social factors, urban policies must guarantee access to infrastructure and social services for all, including housing, education, health, work, and safety. (LOFHAGEN, 2020).

From these perspectives, issues related to urban mobility also need attention. Such issues are a priority in urban planning, provided for in Law 12,587/12 - Urban Mobility Law, which determines that municipalities with more than 20 thousand inhabitants must plan and implement urban mobility policy (BRASIL, 2012). The lack of planning in relation to urban mobility adds to problems, such as atmospheric and noise pollution, high levels of congestion and especially a lack of integration between available transport modal points (ANDRADE et al., 2016).

In Brazil, demographic growth has increased distances between certain places within the city, so as there is low investment in public transport systems, the mobility of most Brazilian cities is dependent on private vehicles (CHINELLI, et al., 2021). In addition, the lack of efficient mobility also contributes to the decline in employment, study, health and leisure opportunities, causing an environmental imbalance in the urban space (CARVALHO, 2016).

In this way, even though Law 12.587/12 becomes a reference, questions still arise as to how urban space without expansion capacity will seek viable solutions to improve infrastructure (CHINELLI, et al., 2021). Thus, active mobility becomes a significant bias to mitigate some problems found in urban infrastructure, as active transport is considered one of the most sustainable urban mobility methods (PRADO, 2019). This mobility model has a significant impact on reducing congestion and accidents, as well as on the perspective of the population in relation to the city (SILVA et al., 2018).

The municipality of Passo Fundo has about 145,569 vehicles in circulation, of which 422 are public transport vehicles (IBGE, 2021). However, since 2014, the city has had the Passo Fundo Mobility Plan, which aims to provide guidance on the subject, and also deals with the process of consolidation, reiteration, and control of urban expansion (PASSO FUNDO, 2014a). Through the mobility plan, the city seeks to encourage the use of bicycles for leisure and as a means of transport for its citizens (SARAIVA, 2018). In view of this, in 2016 the Passo Fundo Vai de Bici program was created, which aims to share bicycles free of charge for the population, allowing users to move easily around the city. From the knowledge of these perspectives, the questions that guided this research emerged. One questions the current scenario of urban mobility in the city of Passo Fundo. In this scenario, the query is whether cycle lanes and public transport points are sufficient to meet the mobility of the city. What other initiatives can be incorporated to improve active mobility in Passo Fundo?

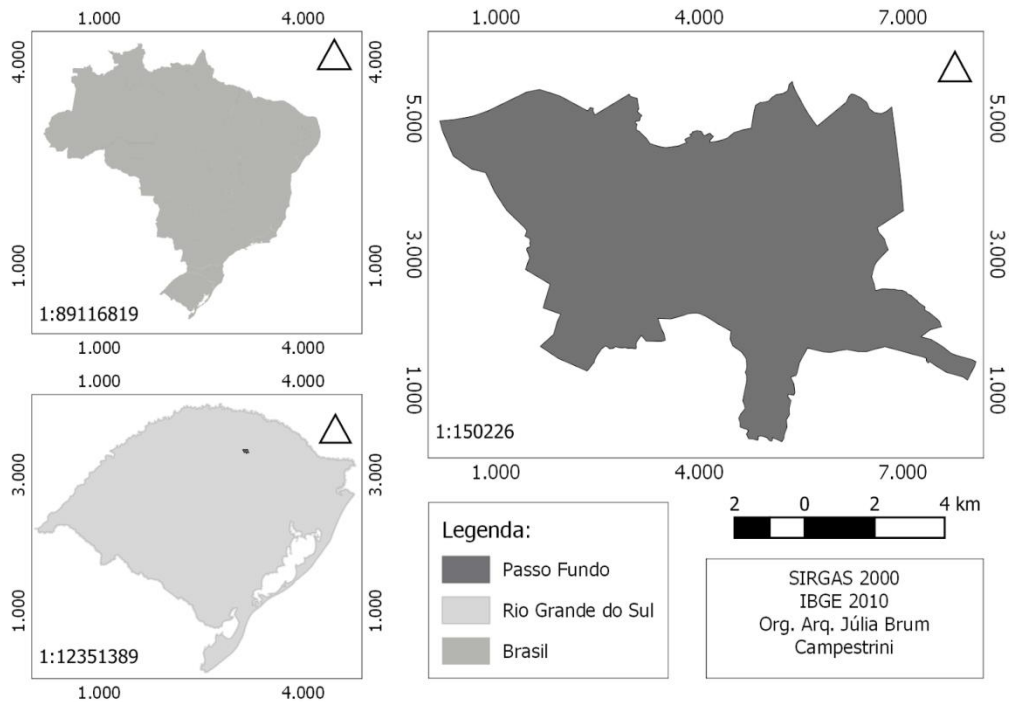
The general objective of this study is to analyze the urban mobility of the municipality of Passo Fundo/RS, in particular the cycling and public transport points of the city and, from the analyzes carried out through maps, identify positive points and points to be improved within the scope of of urban mobility in the city.

METHODOLOGY

2.1 Characterization of the object of study

The city of Passo Fundo is located in the north of the state of Rio Grande do Sul, approximately 289 km from the state capital, Porto Alegre (Figure 1). It has a population density of 235.92 inhab/km² (IBGE, 2010), and an estimated population of 206,103 people (IBGE, 2021). Furthermore, according to the latest IBGE 2010 census, about 180,120 people live in urban areas, while 4,706 people live in rural areas.

Figura 1: Location Map of Passo Fundo/RS.

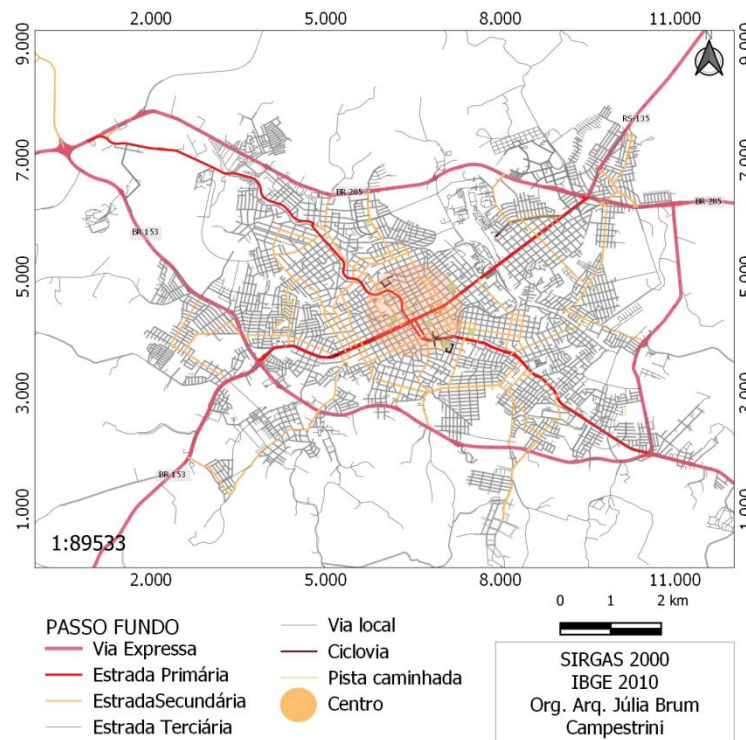


Fonte: Prepared by the authors (2022).

Figure 1 demonstrates the location of the city of Passo Fundo, which is characterized by being an educational, medical, and economic center in the north of Rio Grande do Sul. Its location has an urban network of small municipalities, becoming a reference in the socioeconomic and population dynamics of nearby cities (FERRETO, 2012; MULLER, 2021). There are six municipalities that surround the object of study, namely Pontão, Coqueiros do Sul, Carazinho, Santo Antônio do Planalto, Ernestina, Marau, and Coxilha, having as connections the RS-135 and RS-324, the BR 153 and BR 285.

Still, in relation to the road axis, the configuration of the municipality occurred from two main axes (Figure 2), namely Avenida Brasil and Avenida Presidente Vargas, on which the railroad that brought great development to the area was implemented (FERRETO, 2012).

Figura 2: Road Map of Passo Fundo/RS



Fonte: Prepared by the authors (2022).

Figure 2 shows the road axes of Passo Fundo, in which the two avenues responsible for the city's structure are located in red. It is also noted in the city center, where both avenues meet, that the blocks form a checkered layout. According to Zampieri and Andrade (2019), this urban design, called positivist, is developed as the premise of representing order and balance. From this central area, the city developed and followed other forms.

Currently, the city has 22 sectors, divided into neighborhoods, subdivisions, and villages. Among these sectors, it was noted that three neighborhoods formed sub-centers according to the structure of the city, namely Boqueirão, Vera Cruz, São Cristóvão and Petrópolis. Thus, as the city grows, urban planning must be revised in order to improve the quality of life of its citizens.

Therefore, the city of Passo Fundo, together with the current municipal laws, prepared in 2014 the Municipal Mobility Plan of Passo Fundo, which aims to present guidelines for planning and restructuring urban mobility. The plan, in addition to presenting the guidelines and objectives, also analyzes the municipality, based on 5 main axes, namely regional circulation, intra-urban circulation, collective transport, bicycle transport and pedestrian circulation (PASSO FUNDO, 2014).). Thus, presenting the current scenario and future proposals for the development of these axes.

In addition, thinking about active mobility, the municipality created the Passo Fundo *Vai de Bici* Program, this initiative aims to encourage the use of active transport, health, and sustainability (SARAIVA, 2018). Currently, approximately 30 bicycles are available at the 10 bike-sharing points in the city (PASSO FUNDO, 2022). The City Hall installed sharing stations at points

on Avenida Brasil and Avenida Presidente Vargas, from these stations users can use a bicycle for free for a certain time, requiring only registration.

The project has been active since 2016, being interrupted only during the first year of the COVID-19 pandemic, due to security concerns. The new Coronavirus pandemic influenced daily habits and urban mobility in the city, depending on security measures and protocols (DA FONSECA ERLACHER; BASTOS, 2022). A study carried out by NZN Intelligence, in partnership with Estadão Summit Mobilidade Urbana (NZN INTELLIGENCE, 2021), presented a series of data regarding changes in citizens' habits with the COVID-19 pandemic, and from questionnaires carried out with more than 2,200 people in the five Brazilian regions, about 10.6% of respondents started using bicycles, seeking to avoid crowds in mass public transport (NZN INTELLIGENCE, 2021), demonstrating once again the importance of active transport for physical and mental health.

2.2 Methodological procedures

The development of the work was carried out through qualitative, exploratory research, based on a case study of analysis of Mobility indicators in the city of Passo Fundo/RS. This research has an applied nature, which aims to seek knowledge so that it can be used to mitigate real problems. According to Bardin (2016), scientific research becomes better understood from its division into methodological steps (Figure 3):

-Step 01: Conducting bibliographic research, in order to understand the concepts of the urban infrastructure of Passo Fundo and its planning, as well as the idea of active mobility, based on studies already carried out, through books, theses, dissertations, as well as publications from the Scopus Science and Google Scholar databases.

-Step 02: A case study about the city of Passo Fundo, as well as an analysis of the mobility planning guidelines provided through the current Municipal Mobility Plan and the Passo Fundo *Vai de Bici* Municipal Program. In addition, the works of Saraiva (2018) and Morigi (2020) were used as the theoretical basis, which addressed the cycle and public transport of the object of study, respectively.

-Step 03: Survey and collection of data on the city's road profile, bus routes, cycle lane points, and bicycle sharing stations, using as reference the geographic data provided through IBGE (2020) and the SIRGAS Coordinate Reference System 2000 (2021).

-Step 04: From the analysis, the data were tabulated and mapped using a remote sensing platform, QGIS, for the development of an analysis of the indexes presented from maps to better demonstrate these results.

Figure 3 presents the stages of development of the study mentioned above, aiming at a better understanding of the methodological process.

Figura 3: Methodological Process



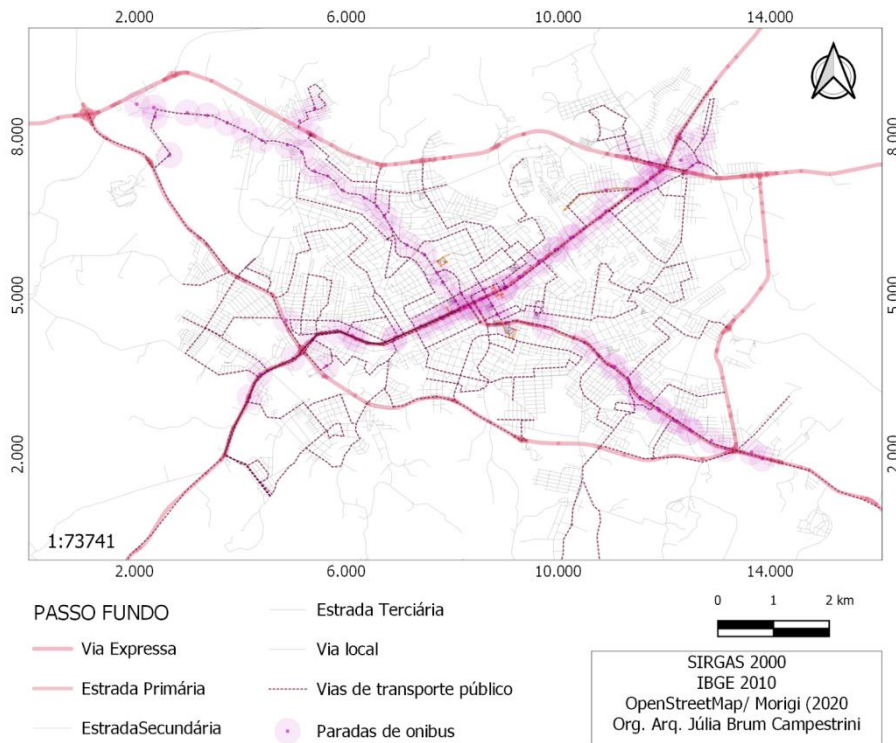
Fonte: Prepared by the authors (2022).

RESULTS AND DISCUSSIONS

The method proposed for the evaluation of this study consists of the elaboration of maps from the QGIS program (2010), using the SIRGAS 2000 Coordinate Reference System and the geographic data of the IBGE 2020 as a reference, thus enabling the elaboration of the analysis of the urban mobility of Passo Fundo, considering its public transport and cycling.

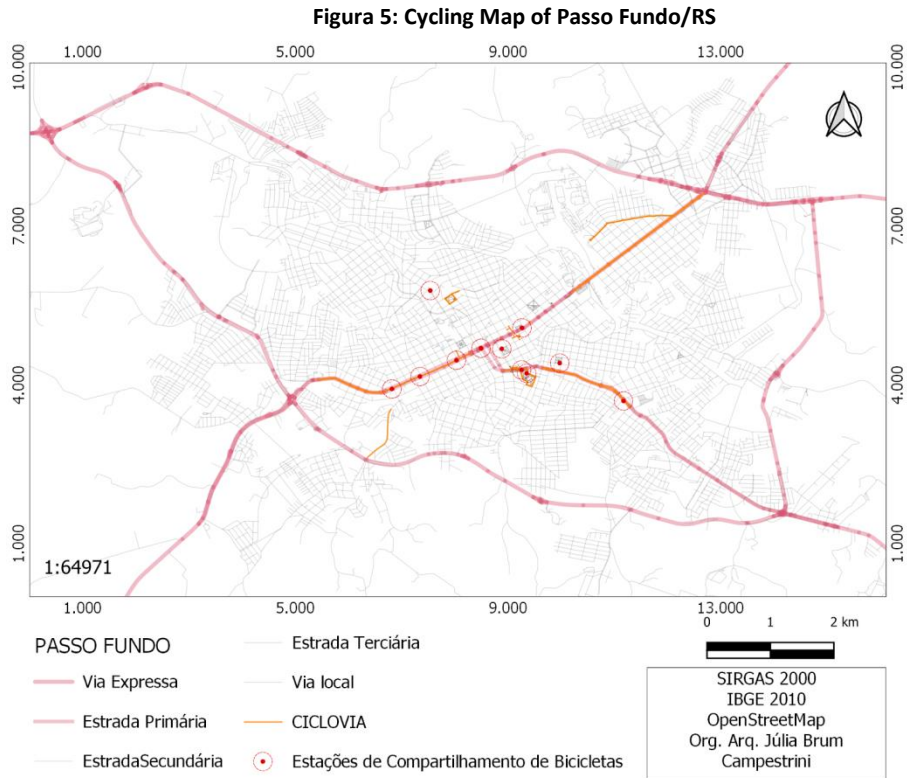
Figure 4 shows the public transport map of Passo Fundo, which has as a reference the research by Morigi (2020), which identified all public transport stops and routes in the city. The present research focused on the stops located in the structuring axes of the city. From the analysis of the map in Figure 5, it is possible to see that Passo Fundo has a large number of bus stops that run along the main axes of the city. In this way, the city's public transport serves all 22 sectors of the city, promoting ease of locomotion and access to the city's neighborhoods.

Figura 4: Public Transport Map of Passo Fundo/RS



Fonte: Prepared by the authors (2022).

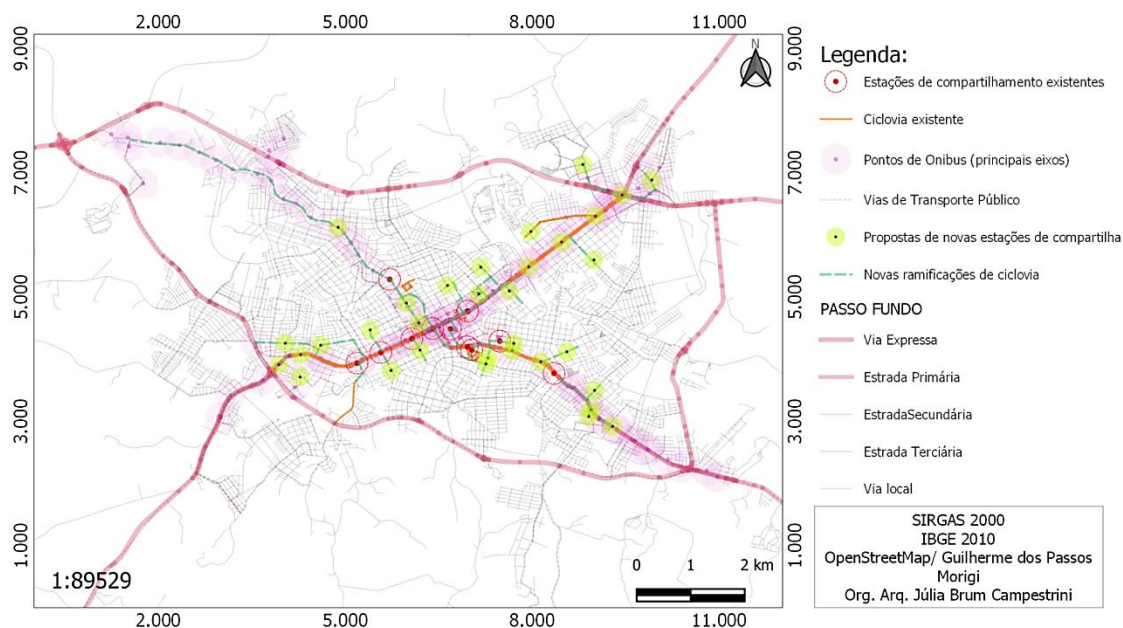
Figure 5 shows the Cycle Road Map of Passo Fundo, highlighting the 11 points of Bicycle Sharing Stations in the city, through red circles. It is noted that most of the points are located in the central axis of the city, more specifically on Avenida Brasil Oeste and Avenida Presidente Vargas, which connect the central region with the Boqueirão and São Cristóvão neighborhoods, and the main leisure axes of the city. It can be observed that the locations of these points of sharing stations have topography with few levels, which tends to facilitate the locomotion of users. The same is seen in the orange layout, which shows the available bike lane routes in the city, that is, the current model of tactical transport is located in areas that facilitate locomotion and that make connections with the inducing axes of Passo Fundo. However, the lack of integration of these points with Avenida Brasil Leste, where Bairro Petrópolis is located, and Avenida Sete de Setembro, where Bairro Vera Cruz is located, is notorious.



Fonte: Prepared by the authors (2022).

In view of the perspectives analyzed, Figure 6 presents a map of Passo Fundo with areas to be considered for the new integration of the city's cycling ramifications, using Saraiva's research (2018) as a reference to carry out these premises. Thus, in Figure 6, the points in "light green" demonstrate the proposed coverage areas for future bike-sharing stations, while the dotted line in "dark green" shows cycle lane connections between the existing points. For the proposition of these connections, the areas of the city where there was a lack of sharing stations and which have better accessibility with the different sectors of the city were taken as a criterion, since they are used to assist in the daily locomotion of citizens.

Figura 6: Map of Proposals for Active Mobility in Passo Fundo/RS



Fonte: Prepared by the authors (2022).

Thus, based on the analyzes carried out, it appears that the importance of creating new points of bicycle sharing station that serve the region of Bairro Vera Cruz and Bairro Petrópolis, since they are considered sub-centers of Passo Fundo, and active transport tends to improve the quality of life not only for local residents, but also for workers and students from other parts of the city, allowing them to move quickly and safely in the region. In addition, even though there are bike lanes in Bairro Boqueirão and Bairro São Cristóvão, it is still important to expand them, ensuring greater mobility and covering more areas of the city. For these expansions to take place, it is necessary that the implementation planning provided for in the Municipal Mobility Plan be followed, and that the cycleway points can connect with public transport, improving mobility and accessibility in the urban environment.

FINAL CONSIDERATIONS

This article presented a study on urban mobility in the city of Passo Fundo, specifically on the city's cycling and public transport axes.

From this research, it was noticed that Passo Fundo/RS has a higher proportion of points of bicycle-sharing stations and cycle lanes in the central region of the city, which are located in areas with smoother topography and that connect to the main axes of transport. leisure activities in the city, such as Bella Città Shopping Center, Praça Tochetto, as well as Praça Marechal Floriano, and Parque da Gare. Regarding public transport, Passo Fundo presented satisfactory data, since most of the stops and bus lines serve all 22 sectors of the city.

Thus, in relation to new proposals for active transport, it would be interesting to increase the number of bike-sharing stations for the areas that add to Bairro Petrópolis and Bairro Vera Cruz, since they have few stations and bike lane connections, making it difficult for users in these regions to use more of this transport. In addition, even though Bairro Boqueirão

and Bairro São Cristóvão have most of the axes, it is necessary to encourage their increase, so that they continue to integrate other sectors of the city.

Although Passo Fundo presents positive results, it is necessary that the mobility planning of the municipality continues to be revised, so that the development of infrastructure and urban services in the municipality can offer safety, accessibility, well-being, and sustainability to its citizens. For these aspects, analyzing the current scenario of the municipalities becomes essential, since such analyzes help in urban planning, providing quality of life for the population and promoting the efficient urban development of the municipality.

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