EVALUATION OF THE CENTRAL REGION OF MARICÁ FROM THE PERSPECTIVE OF DEVELOPMENT ORIENTED TO PUBLIC TRANSPORT – DOT

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ABSTRACT

This article aims to evaluate the central region of the municipality of Maricá - RJ, from the perspective of Public Transport-Oriented Development - DOT (ITDP, 2024). A territorial cut in the Municipality of Maricá will be presented from the perspective of the five characteristics of the DOT (VTPI, 2019). It is expected to survey the advances in urban mobility, which this city can offer as an example to other Brazilian cities, as well as identify the weak points to be mitigated. The article concludes that the five characteristics of the DOT are partially met in Maricá. It is recommended that future studies evaluate the contrast present in the central region with the other neighborhoods, which have lower population density and less urban attractions. It is expected that this research will encourage the application of the DOT concept in cities, increasing traffic quality and sustainability.

Keywords: Land Use and Transport. Urban Planning.

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INTRODUCTION

In urban environments, the proper functioning of road infrastructures is essential to promote connectivity, accessibility and quality of life for the population. In the Brazilian context, road axes, such as railways and highways, were major inducers of accelerated occupation and development of urban centers, given the possibility of facilitating commuting between housing and work (ABREU, 2022; VILLAÇA, 2001). Later, according to Borsagli (2016), the strengthening of the modern movement during the 1920s made the automobile the "symbol of progress, of *status* and of social distinction" of Brazilian metropolises, generating reflections on the planning and sectorization of cities, and sometimes neglecting the human scale. As a response to the fragilities that are reproduced at the global level, the United Nations Sustainable Development Goal 11, which deals with the adaptation of cities and communities to become more inclusive, safe, and resilient, suggests that, by 2030, increased access to transport systems should be provided, while also increasing sustainable urbanization (UN, 2023). In view of the relevance of the theme, concepts related to the sustainability of urban mobility and the favoring of pedestrian scale have gained worldwide recognition, which includes the strengthening of measures and projects that address such issues (GILLIS; SEMANJSKI; LAUWERS, 2016).

Among the concepts of sustainable urban mobility, DOT - Public Transport-Oriented Development, is an approach that uses the principles of compact and sustainable city planning, promoting more "walkable" neighborhoods and their integration with public transport (FANG et al., 2023; REDZUAN et al., 2022; VTPI, 2019). The understanding of ODT is also directly related to the favoring of high population densities and mixed land use, that is, regions that offer wide availability of housing, shops, jobs and services located short distances, encouraging populations to reduce their dependence on automobiles or to prioritize the use of public transport (FANG *et al*., 2023; Papagiannakis; Yiannakku, 2022). Thus, it is necessary that the transit stations are located in centralities that allow walking distance, with radii from 400m to 800m, which represent 5 to 10 minutes of walking (REDZUAN *et al*., 2022). From the improvements in the infrastructures that support non-motorized transport, a greater contingent of trips can be made through walking or cycling, allowing the reduction of the total number of trips made by cars (VTPI, 2019). In addition, by creating friendlier and more attractive environments for pedestrians and cyclists, urban safety is consequently improved, due to the greater vitality of the streets; and community life, due to increased social interaction (Papagiannacis; Yiannakku, 2022).

According to (VTPI, 2019), the concept of DOT can be described through five main characteristics, namely: (1) the neighborhood is designed for cycling and walking, with

adequate facilities and attractive street conditions; (2) the streets have good connectivity and speed reducing features (*traffic calming*) to control vehicular traffic; (3) mixed-use development includes shops, schools, and other public services, as well as a variety of housing types and prices in each neighborhood; (4) parking lot management should encourage a reduction in the amount of land destined for this use, associating cost savings with reduced car use; and (5) transit stops and stations must be convenient, comfortable, and safe, with features such as comfortable waiting areas, merchants, public restrooms, signage, and multimodal navigation tools. Thus, it is understood that the investigation of these five characteristics allows us to understand the quality of city planning from the point of view of urban mobility, or even to predict how they can be adapted to meet the principles of DOT.

According to Fang *et al.* (2023), DOT strategies have been increasingly used around the world as a response to addressing social, economic, and environmental challenges. From a social and environmental point of view, Redzuan *et al*. (2022) studied the possibilities of integrating the DOT with the seafronts, demonstrating that aspects such as "legibility" and "connectivity" are fundamental concepts to improve access and the relationship of pedestrians with the water landscape. On the other hand, considering economic aspects, ODT can also be considered a tool for social equity, since it is capable of improving travel options and accessibility for low-income families, through public or non-motorized transport (VTPI, 2019). In this context, it is noteworthy that the Zero Fare is a national policy that aims to implement free public transport, facilitating the population's access to goods and services. In Brazil, at least 67 cities adopt the Zero Fare policy throughout their transport system (CARRANÇA, 2023), among them, the Municipality of Maricá, located in the State of Rio de Janeiro, Brazil. Based on the contextualization presented, it is necessary to study urban mobility strategies that can be integrated into the sustainable planning of cities, aiming at the valorization of natural resources, accessibility and improvement of quality of life.

OBJECTIVE

Among the municipalities located in the State of Rio de Janeiro, Maricá stands out as a positive example of sustainable urban mobility due to the offer of buses and bicycles that have been traveling with Zero Fare since 2014, benefiting approximately 170 thousand inhabitants. Thus, it is understood that its central neighborhoods of the municipality, which have greater consolidation of the road network and greater availability of public services and equipment, were adequate to improve the integration of mobility with the urban space,

which indicates the relevance of the study of the area. Therefore, the objective is to evaluate a territorial area in the Municipality of Maricá from the perspective of the five main characteristics of the DOT described by (VTPI, 2019). From this evaluation, it is expected to raise the lessons of urban mobility that the territory can offer to other Brazilian cities, as well as to raise the weaknesses that must be mitigated, helping in their sustainable development.

METHOD

The method of this study is classified into four stages. In the first, we sought to understand the five main characteristics of the DOT concept, based on the definition found in the Online Encyclopedia of Transportation Demand Management (TDM), one of the most comprehensive information resources in the world about mobility management strategies, and maintained by the *Victoria Transport Policy Institute*, or Victoria's Transport Policy Institute, in Portuguese (VTPI, 2019). After understanding the five characteristics, stage two consisted of choosing a territorial area located in the municipality of Maricá, Rio de Janeiro, as well as its characterization. To this end, historical, demographic and socioeconomic information in the area was collected, which supported the diagnosis. Thus, step three deals with the diagnosis of the region with a focus on the characteristics of DOT.

For the survey of the first characteristic, "*the neighborhood is designed for cycling and walking, with adequate facilities and attractive street conditions*", the Geographic Information Systems (GIS) and the analysis through satellite images were used as a tool to understand the current design of bike lanes and bicycle stations, as well as the assets that support the attractiveness of the streets. On the other hand, for the survey of the second characteristic "*the streets have good connectivity and traffic calming resources to control vehicle traffic*", the strategy used was the analysis of the road network and its hierarchy, in order to understand the local speed patterns. For feature three, "*mixed-use development includes shops, schools, and other public services, as well as a variety of housing types and prices in each neighborhood*," the strategy consisted of surveying various facilities, such as health clinics, schools, and squares, in order to assess their attendance within a radius of 500m (comfortable walking distance). For feature four "*parking lot management should encourage a reduction in the amount of land allocated to this use, associating cost savings with reduced car use*", the analysis considered the survey of the total number of local private parking lots. Finally, in feature five "*stops and transit stations must be convenient, comfortable and safe, with features such as comfortable waiting areas, merchants, public restrooms, signage and multimodal navigation tools*", the transit stations and their quality in

meeting the listed aspects were surveyed, considering their service within a radius of 400 meters.

Finally, in the fourth stage, located in the final considerations, the lessons that the case study can offer to Brazilian cities that seek to implement policies such as the Zero Tariff are listed, as well as the guidelines that can mitigate local weaknesses and guide the sustainable development of the region.

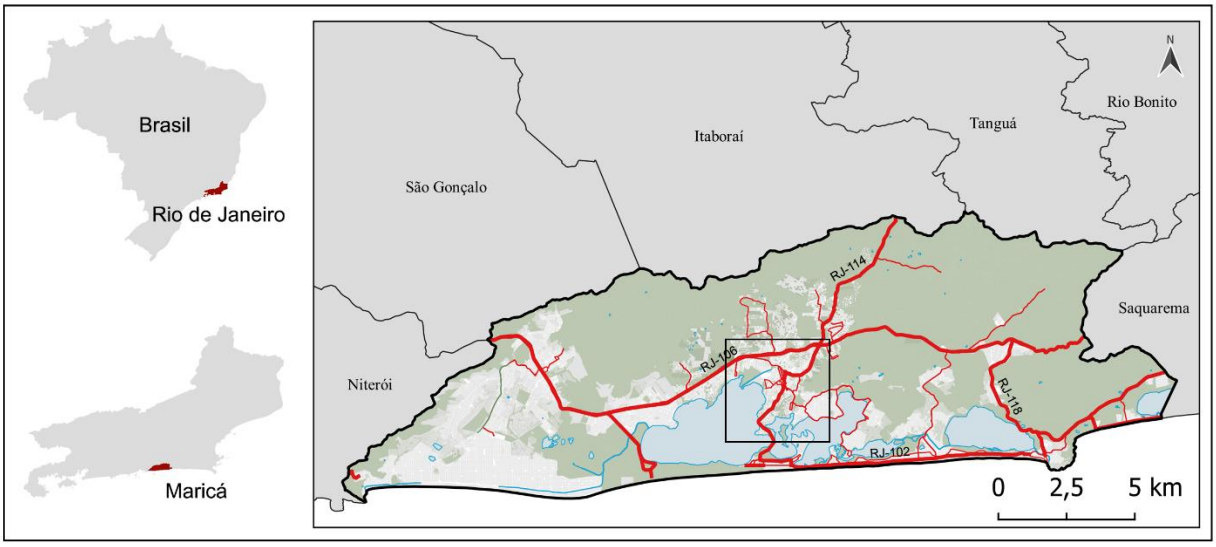
CASE STUDY

Maricá is a municipality of approximately 362 km², located on the coastal strip of the Metropolitan Region of Rio de Janeiro, Brazil (Figure 1). It is noteworthy that factors such as geomorphology, hydrography and proximity to road axes can be considered as the main inducers of its urban development. In this sense, one of the first settlements established in the area took place after the inauguration of the first stretch of the Maricá Railroad, in 1888, connecting the territory to the Rio do Ouro to enable local accessibility and food exports (SOCHACZEWSKI, 2004). Later, after processes of expansion of the Road, it allowed the migration of residents of Niterói and Rio de Janeiro, interested in the agricultural activity performed in Maricá (COYUNJI, 2009). The commercial importance of the Railroad elevated Maricá to the category of city in 1889 (SOCHACZEWSKI, 2004), transforming it into a Municipality in 1911. Later, the road is transformed into the RJ-106, the Amaral Peixoto Highway. After its doubling between the years 1990 and 2000, it was possible to establish greater accessibility in relation to the other adjacent municipalities, such as Niterói, São Gonçalo, Itaboraí and Saquarema, which also marked the beginning of a real estate boom, characterized mainly by the construction of summer houses (SOCHACZEWSKI, 2004).

Currently, only 19.85% of the region is classified as an urban area, where a medium-density occupation can be observed, mainly along the highways and the lagoon complex. In addition to the Amaral Peixoto Highway (RJ-106), which crosses the entire length of the municipality, its road system is also composed of other structuring axes, such as the Governador Paulo Torres Road (RJ-102), the Prefeito Alcebíades Mendes Avenue (RJ-110), the Vereador Oldemar Guedes Figueiredo Highway (RJ-114) and the Sampaio Corrêa-Jaconé Road (RJ-118). According to IDR (2022), the total number of registered vehicles has increased significantly over the last decade, from 35,223 in July 2010 to 76,001 in October 2021. According to the Maricá Urban Mobility Plan (MARICÁ, 2022), the urban public transport system has been operated, since 2014, by the Public Transport Company (ETP), the municipality's state-owned company. The public transport lines under ETP's responsibility have Zero Fare, that is, the user is exempt from paying for the provision of

services. Later, the same company was responsible for the implementation of a municipal bicycle sharing system, popularly known as "Vermelhinhas" (MARICÁ, 2022), which also have free service. The system has 20 bicycle stations located in the most populous neighborhoods of the region, such as Parque Nanci, Centro, São José do Imbassaí, Itaipuaçu and Ponta Negra.

Figure 1. Case study location. Source: Authorial elaboration, 2023.



Based on the historical character of the central region of Maricá, which has a greater number of tourist attractions, a wide variety of public facilities and a greater concentration of bicycle stations compared to the other neighborhoods (11 stations out of a total of 20), this was selected as a case study for the evaluation of the five main characteristics of DOT (VTPI, 2019). The territorial cut includes the neighborhoods of Parque Nanci, Mumbuca, Itapeba, Centro, Flamengo and Araçatiba, in the vicinity of the RJ-106 and RJ-114 highways.

RESULTS

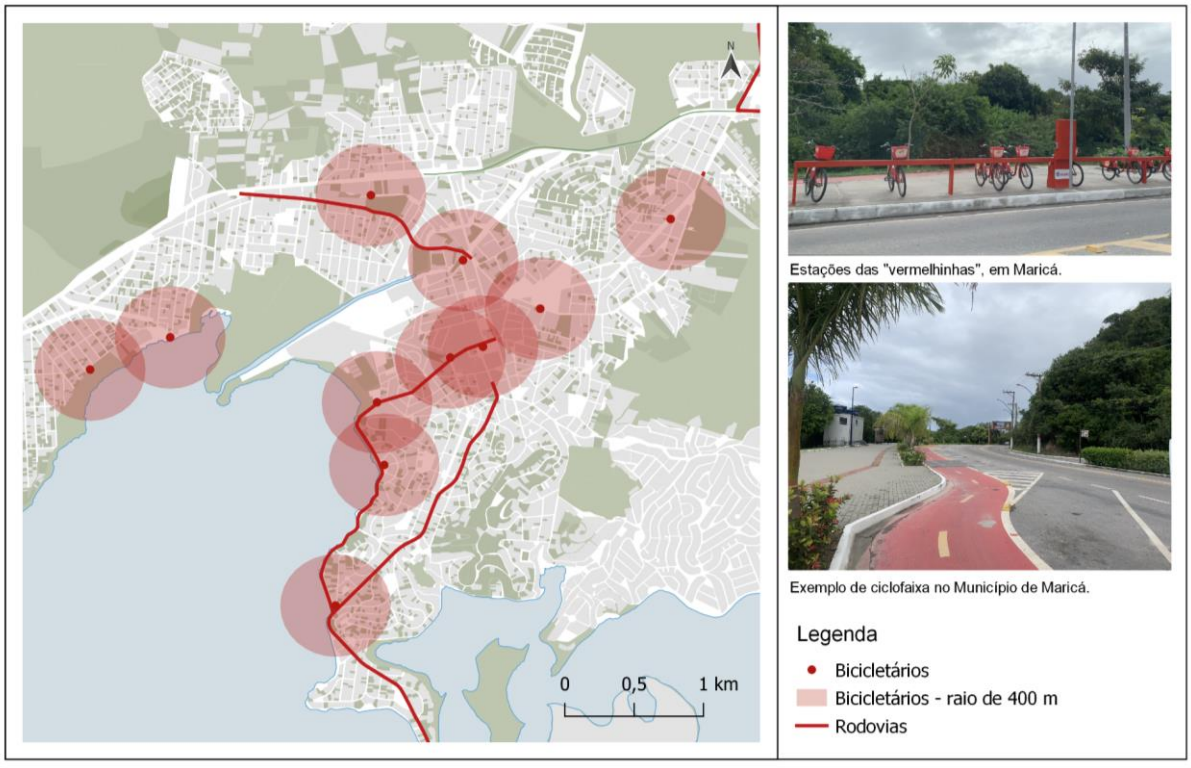
The following items aim to discuss the five items that characterize a city adequately developed for traffic; using the central region of Maricá as a case study.

THE NEIGHBORHOOD IS DESIGNED FOR CYCLING AND WALKING, WITH ADEQUATE FACILITIES AND ATTRACTIVE STREET CONDITIONS

To evaluate this characteristic, three main aspects were considered with the support of the GIS: the location of the shared bicycle stations; the availability of bike lanes or bike lanes; and the location of tourist assets that represent important destinations for the resident population, justifying their locomotion on foot (Figure 2). As explained, the territorial cut has

11 of the 20 bicycle stations available in the Municipality, serving most of the resident population, when considering a radius of 400 m. Although the bike lanes connect a significant portion of the stations, it is noteworthy that some of them have low or no connectivity between the system, which prevents greater opportunities for safe travel through the territory. This situation is highlighted mainly in the neighborhoods of Parque Nanci and Itapeba, which have, respectively, two waterfronts that could be integrated into the system; in the neighborhood of Flamengo, where the lack of integration with the bike lanes located on the RJ-106 and RJ-114 highways is observed; and in the entire western portion of the Maricá Lagoon, which does not have any access element for pedestrians and cyclists. On the other hand, the layout of the stations is observed as positive points, since they are located in the vicinity of historical and cultural elements, configuring the attractiveness of the routes.

Figure 2. Bike lanes and shared stations in the central region of Maricá. Source: Authorial elaboration and authorial photographs, 2023.



STREETS HAVE GOOD CONNECTIVITY AND TRAFFIC CALMING FEATURES TO MODERATE VEHICULAR TRAFFIC

The evaluation of this characteristic took into account the analysis of the road design, as well as its hierarchy, in order to understand the connectivity between the roads and the speed patterns. Considering that the central region was one of the first to suffer from urbanization processes, resulting from the proximity to the Railroad and the lagoon system,

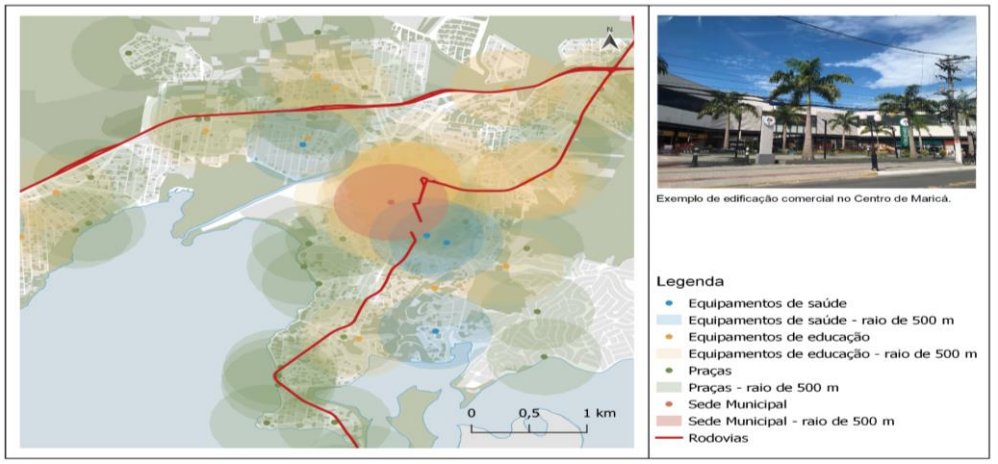
the road system presents a mixed network, predominantly organic in old regions, and orthogonal in recently subdivided blocks. Consequently, there is a system of low connectivity between roads, which impacts the fluidity of vehicles and the lower possibilities of access to neighborhoods. In addition, when evaluating the hierarchy of the road system, it is noted that the territory is mostly composed of local roads, that is, those that allow a maximum speed of 30 km/h. A smaller portion of roads is characterized as arterial, which allows a speed of 60km/h; in addition to the RJ-106 and RJ-114 highways, which allow speeds of up to 110km/h.

When evaluating the speed reducing elements (*traffic calming*), especially on roads that have a sudden transition between slow and fast traffic, it is noted that only a few adopt such resources, through the use of crosswalks or the indication of intersections and mandatory stops, for example. Thus, the adoption of strategies that increase pedestrian safety is identified as an opportunity.

MIXED-USE DEVELOPMENT INCLUDES SHOPS, SCHOOLS, AND OTHER PUBLIC SERVICES, AS WELL AS A VARIETY OF HOUSING TYPES AND PRICES IN EACH NEIGHBORHOOD

The evaluation of mixed uses in the central region of Maricá consisted of a survey of various equipment, such as schools, squares, health centers and administrative buildings, in order to evaluate their service within a radius of 500 meters for the surrounding population. The results of this analysis indicated a wide availability of equipment located at short distances, especially squares, schools and shops, demonstrating the possibilities of carrying out activities that do not depend on automobiles. In turn, when analyzing the housing typologies, it is noted that the central region also has good diversity, which includes the presence of single-family and multi-family buildings, located on public roads or private condominiums. Mixed buildings (with commercial ground floor and other residential floors) are also found with greater predominance in the Centro neighborhood, contributing to the creation of living facades and public safety (JACOBS, 1961). Figure 3 shows the equipment lifted for the area. It is noteworthy that only a sample of the total equipment was highlighted in this analysis, so other essential services, such as banks, markets and various shops were not illustrated, although they also contribute to the vitality of the roads.

Figure 3. Public facilities that configure the mixed use of the central region of Maricá. Source: Authorial elaboration and authorial photographs, 2023.



PARKING LOT MANAGEMENT SHOULD ENCOURAGE A REDUCTION IN THE AMOUNT OF LAND ALLOCATED TO THIS USE, ASSOCIATING COST SAVINGS WITH REDUCED CAR USE

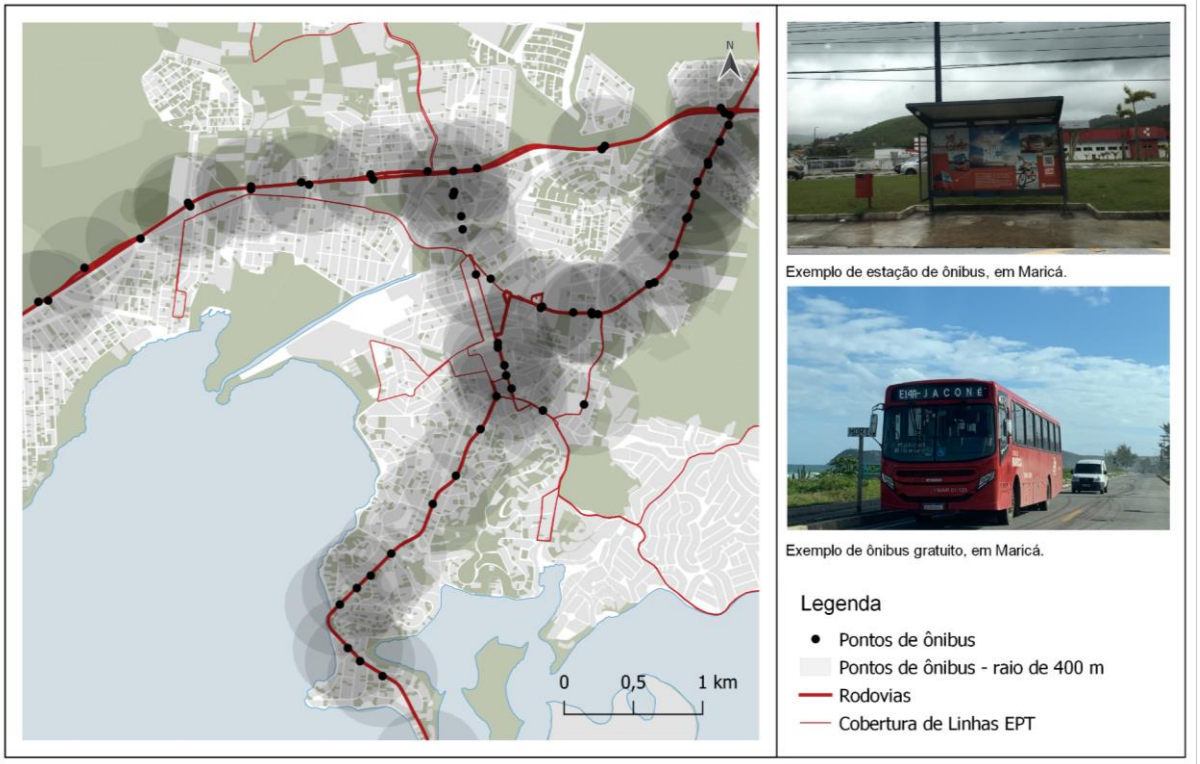
The evaluation of this criterion consisted of a survey of local private parking lots, in order to understand if the number of spaces made available is capable of impacting the use of the land, through the reduction of the contingent of vehicles parked on the roads. As a result, only four parking lots were identified in the territorial cut, all located in the Center, within a maximum radius of 1km. Although little information was found about these services, it was observed that these are small parking lots that charge, on average, R$ 8.00 per day. Considering that the case study is a region of medium population density, with high quality in terms of public transport, it is inferred that private parking lots are a strategy to accommodate the volume of vehicles present throughout the week in shopping centers, since the practice of parking on the road is uncommon in the region. Thus, although the total number of parking lots is considered sufficient for the demand, it is understood that they could be arranged in a dispersed way throughout the territory.

TRANSIT STOPS AND STATIONS SHOULD BE CONVENIENT, COMFORTABLE, AND SAFE, WITH FEATURES SUCH AS COMFORTABLE WAITING AREAS, MERCHANTS, PUBLIC RESTROOMS, SIGNAGE, AND MULTIMODAL NAVIGATION TOOLS

Finally, the evaluation of the last TOD characteristic consisted of the survey and evaluation of the current situation of the bus stations. In all, 64 stops were identified along the cut, demonstrating that the current distribution of lines serves all the neighborhoods analyzed. When considering a radius of 400m, it is noted that the access of the inhabitants is also facilitated due to the short distances. When the stations were evaluated, adopting as a parameter the furniture and the safety of the user, it was noted that most have waiting

benches, covering elements, trash cans, and information elements about the local public transport. However, it is not possible to say that all of them offer safety to the user, since the stations located on highways, for example, do not have local businesses or ample pedestrian movement. Figure 4 shows the bus stations, the lines covered by the ETP and the radius of 400m that allows the evaluation of accessibility to public transport.

Figure 4. Bus stations in the central region of Maricá. Source: Authorial elaboration and authorial photographs, 2023.



FINAL CONSIDERATIONS

In general terms, the study carried out in the central region of Maricá allowed us to verify that, among the five characteristics of DOT, only two are completely met, while three are partially met. It is considered that aspect one *"the neighborhood is designed for cycling and walking, with adequate facilities and attractive street conditions"* and aspect three "*mixed-use development includes shops, schools and other public services, as well as a variety of housing types and prices in each neighborhood*" are suitable for the case study, since the great diversity of activities developed in the region, on the pedestrian scale, are capable of activating the public space and generating greater opportunities for leisure and social interaction outdoors. On the other hand, when considering aspect two "*the streets have good connectivity and traffic calming resources to control vehicle traffic*", it is understood that the failures related to this aspect may be related not only to the organic layout, which results in low articulation between blocks, but also to the configuration of

private condominiums that hinder the creation of active routes along the edges of lagoons. In this sense, it is suggested that a study be carried out on the continuity of the bike paths and bike lanes along the lagoon, allowing the formation of a continuous system that improves the relationship of the inhabitants with the territory and with the water landscape. Additionally, the use of speed reducing elements, such as elevated roads and sound effects, is also suggested in regions that present abrupt speed transition between roads (such as places and highways), favoring pedestrian safety.

Characteristics four and five: "*Parking lot management should encourage a reduction in the amount of land allocated to this use, associating cost savings with reduced car use*", and *"Transit stops and stations must be convenient, comfortable, and safe, with features such as comfortable waiting areas, merchants, public restrooms, signage, and multimodal navigation tools"* obtained less prominence in the evaluation of the case study, due to the absence of complementary information for understanding. In the case of characteristic four, for example, the survey carried out on private parking lots was not able to inform the total number of vehicles that frequent the environment, making it difficult to understand the demand for necessary spaces. In aspect five, although the bus stations have elements compatible with those described by VTPI (2019), security is not guaranteed in remote regions, such as RJ-106. In this sense, the incentive to create small businesses and equipment for collective use would be able to improve the vitality of the streets, increasing safety.

Finally, it should be noted that the Center of Maricá presents a great incentive to the use of public and non-motorized transport, contributing to the sustainability and vitality of the region. From the point of view of DOT, the evaluation carried out allowed the observation of the efforts that have been made in one of the most important regions of Maricá, in order to adapt it and connect it to the free modes implemented from 2014 onwards. Thus, it is recommended that future studies evaluate the contrast present in the central region with the other neighborhoods present in the Headquarters District, since the neighborhoods north of the RJ-106 have lower population density and less urban attractions, resulting, consequently, in reduced accessibility. In addition, future studies could evaluate the quality of mixed streets through various aspects, such as: sidewalk width, existing afforestation or vegetation cover, safety, presence of active facades, among others. It is expected that the evaluation presented will allow the increase of discussions about the adaptation of the DOT concept in consolidated metropolitan regions, improving the quality of traffic and the sustainability of the areas involved.

REFERENCES

1. Abreu, M. (2022). *A evolução urbana do Rio de Janeiro* (5. ed.). Rio de Janeiro: Instituto Pereira Passos.

2. Borsagli, A. (2016). *Rios invisíveis da metrópole mineira* (1. ed.). São Paulo: Clube de Autores.

3. Carrança, T. (2023). Tarifa zero: as lições das 67 cidades do Brasil com ônibus de graça. BBC News Brasil. Disponível em https://www.bbc.com/portuguese/articles/cy65e4qnjjpo

4. Coyunji, M. (2009). *Paisagem e temporalidade: expressão natural e humana na Laguna de Maricá - RJ* (Tese de doutorado). Universidade Federal Fluminense.

5. Fang, Q., Inoue, T., Li, D., Liu, Q., & Ma, J. (2023). Transit-oriented development and sustainable cities: A visual analysis of the literature based on CiteSpace and VOSviewer. *Sustainability (Switzerland)*, 15(10), 8223. https://doi.org/10.3390/su15108223

6. Gillis, D., Semanski, I., & Lauwers, D. (2016). How to monitor sustainable mobility in cities? Literature review in the frame of creating a set of sustainable mobility indicators. *Sustainability (Switzerland)*, 8(1), 1–30. https://doi.org/10.3390/su8010029

7. IDR, Instituto Darcy Ribeiro. (2022). *Maricá em números - Volume 2*. Maricá. Disponível em https://idr.marica.rj.gov.br/wp-content/uploads/2022/12/Marica-em-Numeros-Volume-2-Digital-compactado.pdf

8. ITDP. (2024). TOD Standard. Disponível em https://brasil.un.org/pt-br/sdgs. Acesso em: 13 nov. 2024.

9. Jacobs, J. (1961). *The death and life of great American cities*. New York: Penguin Books.

10. Maricá. (2023). *Plano de Mobilidade de Maricá - Produto 3: Diagnóstico*. Maricá. Disponível em https://www.marica.rj.gov.br/wp-content/uploads/2023/01/Produto-3-Diagnostico-Versao-Final.pdf

11. ONU, Organização das Nações Unidas. (2023). *Objetivos de Desenvolvimento Sustentável*. Disponível em https://brasil.un.org/pt-br/sdgs. Acesso em: 15 jun. 2023.

12. Papagiannakis, A., & Yiannakou, A. (2022). Do citizens understand the benefits of transit-oriented development? Exploring and modeling community perceptions of a metro line under construction in Thessaloniki, Greece. *Sustainability (Switzerland)*, 14(12), 7043. https://doi.org/10.3390/su14127043

13. Redzuan, N., Latip, N. S. A., Ismail, N., & Ujang, N. (2022). Identifying urban design principles and its attributes for waterfront transit-oriented development (WTOD). *Planning Malaysia*, 20(2), 134–145. https://doi.org/10.21837/pm.v20i21.1098

14. Sochaczewski, J. (2004). *Contexto do desenvolvimento adotado pelo município de Maricá, RJ Niterói* (Tese de doutorado). Universidade Federal Fluminense.

15. Villaça, F. (2001). *Espaço intra-urbano no Brasil* (1. ed.). São Paulo: Studio Nobel.

16. VTPI, Victoria Transport Policy Institute. (2019). Transit Oriented Development. In *TDM Encyclopedia*.