

Transport Research Arena (TRA) Conference

How equal is accessibility to cycling infrastructure? A ranking to compare territories in Lisbon, Portugal

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Abstract

This study develops a set of indicators regarding the accessibility of Lisbon's cycling network throughout time, considering the significant changes concerning infrastructure development that have occurred since 2008. We measured the access to cycling infrastructure and equipment in 24 Lisbon districts with open data and GIS methods to calculate accessibility metrics in four time periods (2008, 2016, 2018, and 2021). From the estimated indicators, it was possible not only to provide an overview of the implementation of the cycling network over time and in various aspects, but also to simulate and evaluate the impact of the expansion of the cycling network planned in a systematic way, also ensuring that the performance of the cycling network between the regions of the city occurs in an equitable manner.

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1. Introduction

The accessibility to cycling infrastructure and equipment is not equally distributed among territories and populations of the same city. This study aims to assess how the population and the territory of Lisbon have equal access to cycling infrastructure. Lisbon is a European city that has been investing in cycling, with major improvements in the last decade, including the cycling network expansion and the implementation of a bike-sharing system. Consequently, the cycling modal share has leapfrogged from 0.2% to an estimated 2%, in 10 years.

This study seeks to develop a set of indicators regarding the accessibility of Lisbon's cycling network throughout time, considering the significant changes that have occurred since 2008. The indicators developed seek to monitor the evolution of the cycling infrastructure and verify whether the network is meeting the guidelines set forth by the Lisbon Municipality, i.e., a continuous, effective and safe cycling network that promotes the daily use of the bicycle on home-work/school routes by people of all ages. These indicators therefore seek to fill the gap concerning the aspects that seem to have conditioned the evolution of Lisbon's cycling network from a multivariate point of view, including data on population, urban mobility data and information on some relevant public equipment (schools, public transportation, green spaces, among others).

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2. Methodology

We measured the access to cycling infrastructure and equipment in 24 Lisbon districts with open data and GIS methods to calculate accessibility metrics, including population, public transport facilities, schools, and the spatial distribution of work and education-related trips in the cycling network. These indicators are measured in four time periods (2008, 2016, 2018, and 2021), before and after major policy interventions mentioned above. Using mesh widths of 400m, 500m, and 600m from the cycling network, it was possible to observe how the territory and population were incrementally being covered by the implemented infrastructure and to identify the areas where such improvements were not reached, contributing to generating asymmetries in the access to cycling infrastructure.

Most of the data stems from open-source databases, as specified in Table 1. The georeferenced database containing Lisbon's cycling network over the years is a product of previous research projects, except for the most recent cycling network (May 2021), obtained from a collaborative map of cycling routes in and around Lisbon¹. Data from *Lisboa Aberta* can be accessed online², and trip related data was obtained from Instituto Nacional de Estatística (2018).

Table 1: Indicators for the evaluation of the accessibility of the cycling network and respective data sources.

Indicator (description)	Data source
Share of resident population covered	Lisboa Aberta
Access to public transportation stations	Lisboa Aberta
Share of school population covered	Lisboa Aberta + Ministry of Education
Access to green spaces	Lisboa Aberta
Share of museums covered	Lisboa Aberta
Share of tourist sites covered	Lisboa Aberta
Coverage of short-duration work trips using the cycling network	Instituto Nacional de Estatística
Coverage of short-duration school trips using the cycling network	Instituto Nacional de Estatística
Access to urban area	Lisboa Aberta

For each indicator, the performance of the cycling network is calculated (e.g., share of resident population covered by the cycling network), as well as for each of the 24 Lisbon districts. In this manner, it is possible to detect possible territorial disparities related to each variable analyzed.

This methodology is used on a number of previous research studies from governmental agencies, social organizations, and development financial institutions. We followed the one carried out by Vasconcellos and Mendonça (2017), within the framework of the Urban Mobility Observatory, which aggregates indicators related to the different dimensions of the transportation systems in Latin American cities. Nonetheless, it is possible to highlight some limitations of the methods adopted, such as the disregard of local characteristics that could weight the assembled variables in a non-uniform manner, and the non-establishment of optimal ranges or thresholds above or below which the transportation systems could be considered adequate or not.

3. Results

Once the variables are computed at the specified levels of analysis (400m, 500m, and 600m), it is possible to visualize the performance of the cycling network in the analyzed periods, as presented in a non-exhaustive way in the following figures, using as an example the results for the share of resident population covered (Fig. 1) and the coverage of work-related short-duration trips through the cycling network (Fig. 2).

In order to further investigate the analysis in a more synthetic way, the level of analysis of 500m was considered the most appropriate, considering not only the distance to access the cycling network by nondedicated roads (roughly 2 minutes by bike, 10 minutes on foot), as well as for presenting results with a degree of heterogeneity that allows for meaningful rankings in terms of prioritization of public policies. A summary of the observed results for the collected variables is presented in Fig. 3.

¹ <https://ciclovias.pt/dados.html>

² <https://lisboaaberta.cm-lisboa.pt>

The visualization of the districts’ performance allows not only to highlight the isolation of the parishes of Ajuda, Campo de Ourique, and Alcântara, regarding the accessibility to the cycling network, but also to identify that the general performance of a district may not be accompanied by one or another variable (e.g., Areeiro has high general accessibility, but the percentage of green spaces covered is below the average for Lisbon; Beato shows a low general accessibility, but has good accessibility to its tourist attractions).

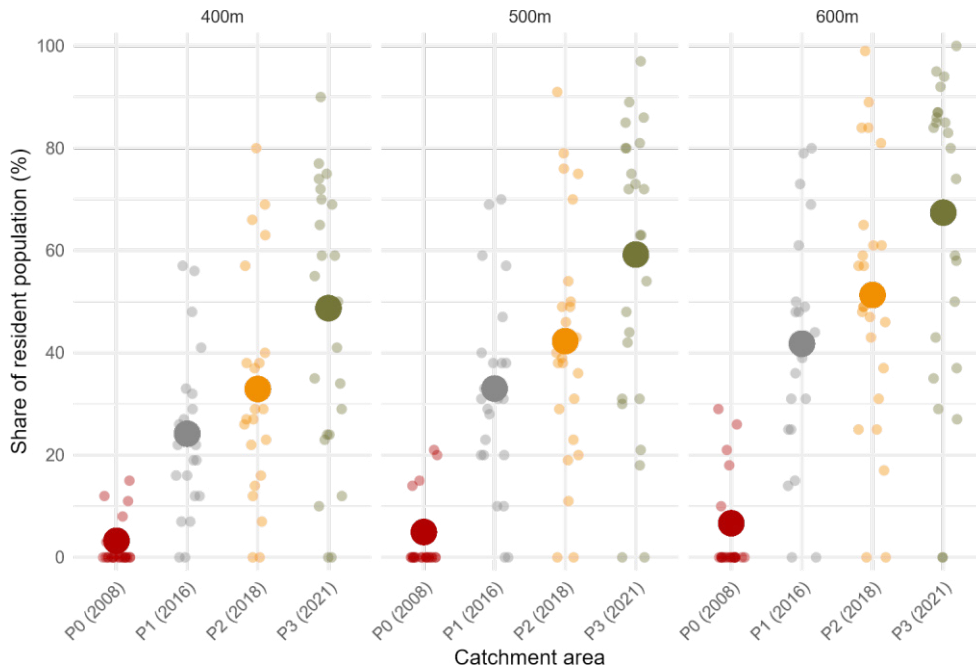


Fig. 1. Share of resident population residing near the cycling network in each district, for different levels of analysis and time periods. Averages for the city of Lisbon are represented in the circles with larger size and opacity.

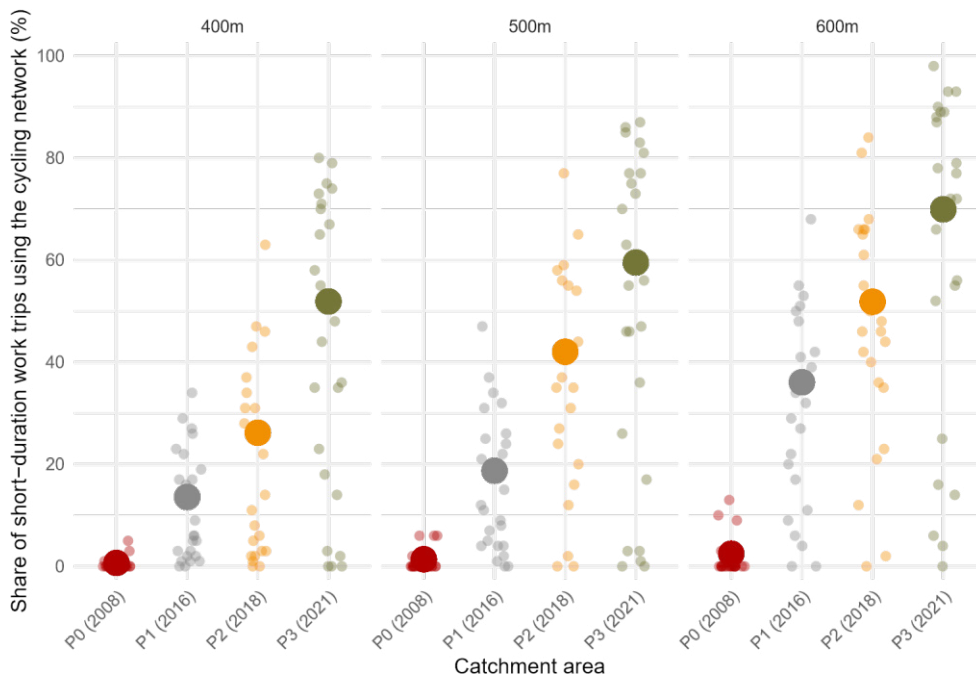


Fig. 2. Share of work-related short-duration trips covered by the cycling network in each district, for different levels of analysis and time periods. Averages for the city of Lisbon are represented in the circles with larger size and opacity.

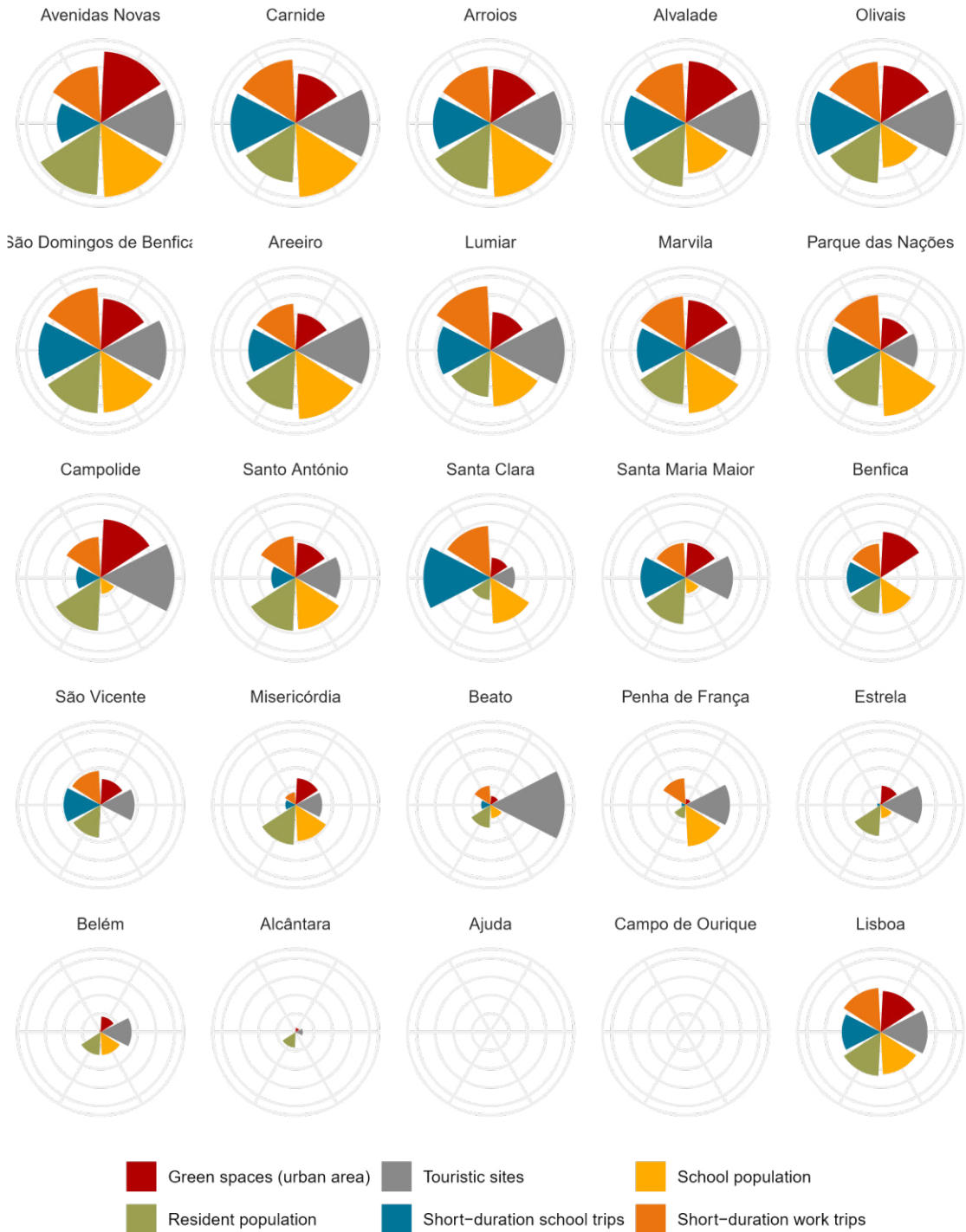


Fig. 3. Comparison of the performance of the districts, and the average of the city of Lisbon, in the set of the obtained indicators.

Thus, once the analysis level of 500m has been defined, it is possible to present the districts in ascending order relative to the variable analyzed for each of the obtained indicators, that is, from the districts with the lowest performance to the districts with the highest performance.

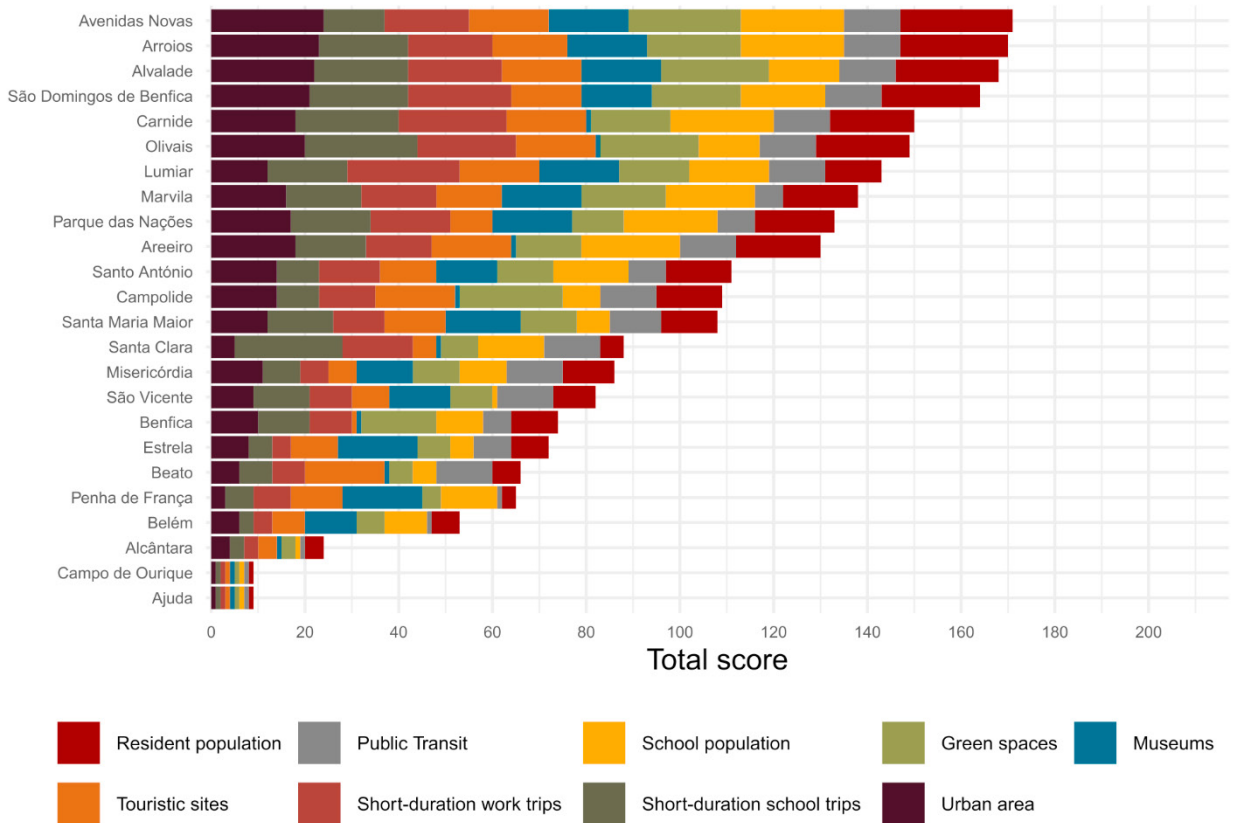


Fig. 4. Comparison of the performance of Lisbon's districts through the evaluated indicators.

From the relative positions of each district in each indicator in ascending order (i.e., from the district with the lowest performance - position 1 - to the district with the highest performance - position 24), it is possible to draw up a cumulative index of these relative positions in each indicator (i.e., adding up the position of all the indicators selected) for each district. In this manner, the total score ranges from 9 to 216 which corresponds to the 9 variables selected times position 1 or 24 in the ranking of the districts, respectively.

This ranking provides a compound indicator through the aggregation of the obtained indicators, in a way to denote the priority for eventual interventions in favor of the expansion of the cycling network according to the variables adopted, as presented in Fig. 4.

In this way it is possible to identify not only the set of districts whose positions are quite unfavorable in all the variables analyzed (Ajuda, Campo de Ourique, and Alcântara), but also the districts that usually appear among the most privileged positions in almost all the indicators presented (especially Avenidas Novas, Arroios, Alvalade, and São Domingos de Benfica). In the districts in the first positions, the sum of the positions is above 160, that is, 74% of the maximum possible score.

4. Discussion and conclusion

In this study, it is possible to portray the evolution of the cycling network implemented in the Municipality of Lisbon from a multivariate point of view, employing nine indicators relating to the accessibility of the cycling network. From the estimated indicators, it is possible to claim that there has been notable progress in the cycling network

deployed in a significant part of the themes analyzed, which has occurred continuously since 2008. However, there are significant disparities between the indicators considering the most recent version of the cycling network (May 2021) and the level of analysis of 500m.

As shown in Fig. 5, most of the indicators have estimated average coverage values of 62%, with a notable exception concerning the coverage of subway and train stations (86%), which has a smaller spatial distribution than the other variables analyzed. The indicators for education-related short trips (52%), green spaces (55%), school population (57%) and resident population covered (59%) that can be accessed from the cycling network are the ones with the lowest values among the calculated indicators.

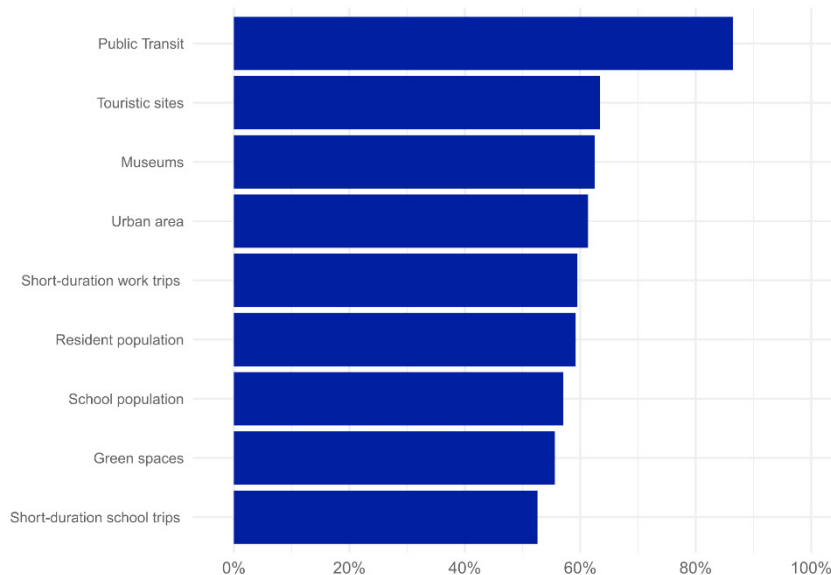


Fig. 5. Average coverage performance of the accessibility indicators.

However, the most significant disparities regarding the implemented cycling network are found at the district level, with regions of the city with good cycling coverage in several aspects (e.g., population, green spaces, tourist sites) contrasting with regions with non-existent or inappropriate cycling network. Districts like Avenidas Novas, Carnide and Arroios have a cycling structure that seems to serve most of the analyzed aspects. On the other hand, for a considerable number of districts (especially Alcântara, Belém, Estrela, Penha de França, Beato, Misericórdia, and São Vicente), the implemented cycling routes generally have unacceptable levels of accessibility in several indicators and still do not seem to be aligned with the guidelines aimed at constituting a cycling network for a continuous, effective and safe daily use of the bicycle by people of all ages. In the districts of Ajuda and Campo do Ourique, this cycling structure is still non-existent.

From the indicators surveyed for the cycling network in Lisbon, it is possible to notice that access to green spaces, the initial prerogative of the cycling network, does not seem to be the priority indicator among the surveys carried out in relation to the current cycling network (2021). In fact, the expansion of the cycling network undertaken since 2009 seems to have prioritized the implementation of cycling routes on urban roads, not exclusively based on the connection of parks through green corridors. This policy change in the implementation of bike lanes was fundamental to improve access to various facilities and services of public interest through the implemented bike lanes and bike paths. However, despite pointing to a cohesive network and presenting significant improvements regarding accessibility, the existing network still needs connections between groups of cycling routes implemented, especially between groups with greater length, in order to improve its connectivity and redundancy. In this way, it might promote greater attractiveness, safety and competitiveness against motorized modes.

The analysis performed in this report refers to the assessment of the accessibility conditions of the cycling network in Lisbon municipality, being complementary to accessibility analyses on a smaller scale, namely types of cycling crossings and maintenance conditions of the cycling network. In any case, it can point to possible connections between sections of the existing cycling network that would significantly increase levels of access. This could either be done

by laying out cycling routes seeking to meet the indicators established here (e.g., connecting locations with higher population density, with a concentration of schools, green spaces, and subway and train stations), with priority given to districts disadvantaged by cycling infrastructure.

From the indicators developed, it is possible not only to provide an overview of the implementation of the cycling network over time and in various aspects, but also to simulate and evaluate the impact of the expansion of the cycling network planned in a systematic way, also ensuring that the performance of the cycling network between the regions of the city occurs in an equitable manner.

Besides comparing the performance of Lisbon's districts and provide a clear overview of different cycling engagement levels, this ranking hopefully will also entice authorities to improve cycling conditions in their territories.

5. Acknowledgments

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