The Cycling Network Project in the Master Plan of the Municipality of Oeiras:

Its role in the mobility of the school population

Instituto Superior Técnico, Lisbon, Portugal

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ABSTRACT

Society needs to fight climate change. Knowing that the transport sector is one of the biggest contributors to environmental pressure, it is necessary to adopt more sustainable mobility, shifting away from pollutant modes. Although the advantages of cycling are recognized, it is not used by everyone, and its promotion among the youngest is necessary.

The present research aims to evaluate the cycling potential of the road network surrounding the schools in the municipality of Oeiras, through a set of elements for planning the cycling network and the decision of route choice by users; and to assess the coverage of the current, projected, and potential cycling network based on the students' Home-School route.

GIS analysis methods were used to do this analysis, and the *network analyst tool* was used. Different datasets were used: road network and school data from the Municipality of Oeiras, mobility survey and census data from the national statistics, and a survey data collection.

With both the cycling network planed for the municipality and the proposal presented in the present study, it is concluded that more than 41% of students' commuting trips are covered by the cycling network and, since 95.9% of the actual potential population would be willing to use this transport mode, it can be concluded that the school population is already aware and conscientious to uptake cycling.

Keywords: Active Mobility, Cycling Mobility, Cycling Network, School Population, Network Analysis.

1. INTRODUCTION

To fight climate change, it is imperative to intervene in the transport sector, as this is one of the most significant contributors to environmental pressure. Thus, it is necessary to change mobility patterns to more sustainable modes. Although the advantages cycling are recognized, it is not used by everyone, since it is not a practice instilled in society, it is necessary to promote a new culture of means of travel among the youngest (Mobilizar, 2020).

Oeiras is currently a municipality of low cycling maturity, since there is 22.27 km of cycling network and only 0.2% of trips are made by bicycle (INE, 2018). However, the municipality's willingness to change this paradigm is clear. That said, the present study intends to critically analyse this same network to understand what its coverage will be for the home-school movements of students residing in the municipality. The choice fell on this population, given that in a municipality of low cycling maturity, it is necessary to start educating the youngest to create habits so that travel in these modes of transport is natural.

The present study aims to: evaluate the cycling potential of the road network surrounding the schools in the municipality through GIS spatial analysis methods (ArcGIS Network Analyst), more specifically, the areas of influence, also using the factors slope, continuity, distance, time and security; assess what percentage of the school population residing in the municipality will be covered by the current, projected and potential cycling network; and, through a sample of the population, to understand what the potential displacements will be in this mode of transport.

2. THEORETICAL FRAMEWORK

The creation of a cycling network is central to the use of bicycles, since the existence of infrastructure is the most important decision factor, as it offers safety and comfort. To guarantee a correct planning of the cycling network, it is required to guarantee five functional criteria: cohesion (connection to points of interest with the fewest possible breaks); direction (route closest to straight-line distance); safety (cyclable infrastructure and avoiding conflicts with other users of the public space); comfort (avoiding physical demands, dangers, and discontinuity); and the attractiveness, although it depends on each user, is related to the support infrastructure, lighting, landscape, etc. (IMTT, 2011).

In addition to these principles, it is necessary to understand the factors that influence people to use this mode of transport or not and that influence the decision of the route choice.

Table 1 – Factors that influence bicycle use and route choice decision

Author/Year	Location	Factors
Road Directorate **(2000)**	Copenhagen, Denmark	Cohesion; direction; logic; safety; comfort; attraction
Stinson & Baht **(2003)**	USA	Slope; time; cycling infrastructure; pavement
APA **(2010)**	Portugal	Car parking: avoid routes shared with pedestrian traffic; volume and speed of traffic; the presence of heavy vehicles; slopes
Menghini et. al. **(2010)**	Zurich, Switzerland	Distance; cycling infrastructure; slopes; points of conflict
Su et. al. **(2010)**	Vancouver, Canada	Air and noise pollution; landscape; segregated infrastructure; slopes; distance; direction
Winters et. al. **(2011)**	Vancouver, Canada	Safety; ease of walking; Meteorological conditions; interaction with other users
Ehrgott et. al. **(2012)**	-	Time; slope; volume and speed of traffic; pavement; cycling infrastructure
AASHTO **(2012)**	USA	Time; cohesion; landscape; cycling infrastructure; volume, speed, and interaction with traffic; direction; interceptions.
Vale **(2016)**	Portugal	Distance; slope; speed
Transport Scotland **(2021)**	Scotland UK	Safety; cohesion; direction; comfort; support infrastructure

Decision factors vary depending on the experience of the cyclist, so they must be comfortable and safe and the route simple and coherent (LTSA, 2004; Félix, 2012).

Next, methodologies for the evaluation of decision factors that will be considered in and for this study.

Slopes

The slope is one of the main parameters to consider in the design of a cycling network, as the high slopes cannot be cycled by everyone.

AASHTO (2012) considers that slopes greater than 5% are considered unsuitable for cycling, and also states that the ideal is even to have a maximum of 3% slope. This assessment is also adopted by other manuals.

For the APA (2010) the criteria are a little more conservative, since slopes up to 3% are desirable on a slope up to 145m and acceptable up to 205m, up to 5% between 75m and 110m, up to 7% between 35m and 60m and finally, up to 12% between 5m and 15m.

For the UK Cycling Infrastructure Design Manual (2020), only routes with a maximum slope of 5% are acceptable, for 2%, the maximum is 150m, for 2.5%, 100m, 3% 80m, 3 .5% 60m, 4% 50m, 4.5% 40m, and 5% 30m.

Distance and Time

When traveling by bicycle, distance and time are directly associated with the speed at which the movement is made, since this distance is covered at different times by other users. Speed must enter the equation for calculating the efficiency of this mode of travel. In this way, it is important to understand from some studies, how the speed can vary.

There are several studies that point to different speed values when traveling by bicycle (European Commission, 2000; Road Directorate, 2000; LTSA, 2004; AASHTO, 2012; Propensity to Cycle Tool, 2020; Moura & Félix, 2019). The values considered for the speeds are between 6 km/h and 30 km/h for non-electric bicycles.

Safety

Security can be assessed in several ways. There is no general rule that determines the choice of the best typology when designing a cycling infrastructure, however, there are two essential factors to consider, the volume and speed of traffic.

The guide to good practices from Belgium (2009) and the French manual “Les bandes cyclables” (2009), suggest that coexistence routes should be implemented when the speed does not exceed 30km/h and does not exceed the 7000 vehicles/day. Cycling lanes should be implemented when the road speed is between 30 km/h and 60 km/h, and between 7000 and 12000 vehicles/day or at speeds >60 km/h if they do not exceed 1000 vehicles/day. Cycling Tracks should be considered for the remaining values. IMTT (2011) presents a decision method with some variations **(Figure 1).**

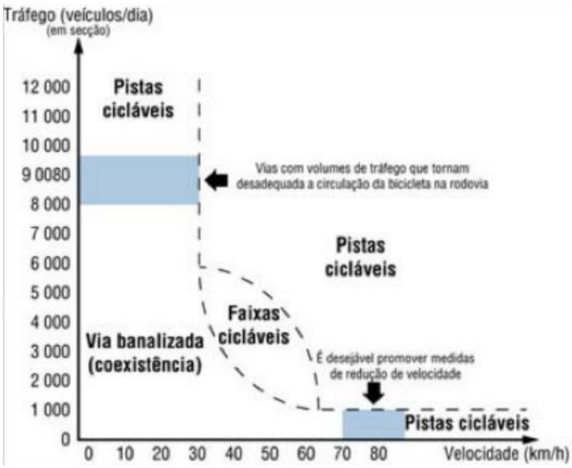

Figure 1 - Criteria for the implementation of different types of cycling infrastructure

For the EC (2000) an integrated circulation should be privileged as it offers greater safety. It also states that a segregated cycling lane should only be considered when the intensity and volume of traffic are incredibly high.

The cycling manual of Ireland (2011) points out that roads which have problems with the volume and speed of traffic should not be segregated from cycling infrastructures, but instead implement a set of calming traffic measures.

AASHTO (2012) in addition to advocating integration, also adds that besides the speed and volume of traffic, the presence of buses or heavy vehicles should be considered.

According to Lyon's "Guide pour la conception des aménagements cyclables" (2019), additionally to speed and traffic volume, there are other factors that must be considered: the presence of public transport; trees and street furniture; the complexity of the intercessions; and the traffic direction.

In addition to understanding the type of cycling infrastructure to be implemented, it is also important to understand the dimensions to be applied **(Table 2).**

Table 2 - Summary of measures considered in national and international planning and design guides for cycling networks

Entity	Country	City / State / Region	Year	Unidirectional Cycling Lane	Bidirectional Cycling Lanes	Cyclable Range	Distance from Fixed Objects	Distance to Vehicles (parking)
Road Directorate	Denmark	Copenhagen	2000	1,7 a 2,2	2,5	1,7	0,3	-
Generalitat de Catalunya	Spain	Catalonia	2008	1,5 a 1,75	2,0 a 2,5	1,5 a 2,0	-	--
SPW	Belgium	Wallonia	2009	1,5	2,5	1,25	0,5	-
APA	Portugal	-	2010	1,5 a 2,0	2,5 a 3,0	1,25 a 1,5	-	-
IMTT	Portugal	-	2011	1,3	2,20 a 2,60	1,5	0,25 a 1,0	0,8
The National Transport Authority	Ireland	-	2011	2,0	3,5 a 4,0	2,0	0,25	-
ENFYS	Wales	Cardiff	2011	1,5	2,0 a 3,0	1,5 a 1,8	-	-
AASHTO	USA	Washington D.C.	2012	1,8 a 2,4	4,3 a 4,6*	1,2 a 2,4*	-	0,5
Sustrans	UK	-	2014	2,5	4,0	1,5 a 2,0	0,2 a 0,5	-
SENAC	-	-	2016	2,0	2,4 a 3,6	1,8 a 2,8	-	1
Direction de la Voirie	France	Lyon	2019	1,6 a 2,5	2,5 a 4,0	1,2 a 2,0	-	0,5
Department of Transportation	USA	Minnesota	2020	1,5 a 3,0	3,0 a 4,5	1,2 a 2,0	<1,5	0,5
NSW	Australia	-	2020	2,0 a 3,0	3,0 a 4,0	1,5 a 2,0	-	0,4
TSO	UK	-	2020	2,0 a 2,25	3,0 a 4,0	1,2 a 2,0	0,25 a 1,0	0,5 a 1,0
Transport Scotland	Scotland	-	2021	1,5 a 2,5	2,0 a 4,0	1,5 a 2,5	-	-

* Space to overtake

In this table, the values vary in the same field, as it is necessary to foresee several situations, such as the speed and volume of traffic, the type of vehicles that circulate, the presence of parking, contact with the sidewalk, and the available space.

In addition to the type of infrastructure and its width, there are other ways to assess safety, more specifically the level of stress to which the cyclist is exposed when traveling. This stress level varies depending on volume, speed, type of road hierarchy, number of lanes, frequency of parking rotation, number of intersections, and street width. Thus, the greater the stress one should opt for segregation and the lower for integration (Furth, 2012; 2017).

3. METHODOLOGY

There is no perfect model of cycling network planning, as the factors to be considered depend on the experience of the cyclist. That said, it is up to planners to create a solution that covers all types of cyclists, and for that, it is necessary to unite as many factors as possible. Next, the methodology for each of the factors used in the present study will be deepened.

Distance and Time

The average intra-municipal travel in Oeiras is 2.9 km (INE, 2018). As for time, travel within the municipality takes an average of 14 minutes (INE, 2018). That said and considering that one of the objectives is to show that this is an alternative mode, its efficiency must be ensured, for this, we will consider these 14 minutes as the maximum travel time.

To arrive at the distance that can be covered in this period, it is necessary to know the speed at which cyclists travel, as mentioned above, these values are not linear. In this way, lower speeds were considered for 1st and 2nd cycle students and higher speeds for 3rd and secondary students. For the former, reference was made to the manual “Collection of cycle concepts” from Copenhagen (2000). The choice fell on this manual as it was the only document that referred to speeds practiced by children. Thus, it was considered that 1st and 2nd cycle students reach a travel speed of 7 km/h, already considering the start-stop movements. For the 3rd cycle and secondary school students, the average speed values of the GIRA (Lisbon bike sharing system) were used as a reference, where data from the average between the speeds of frequent and occasional cyclists (11.95 km/h) were used.).

That said, students from the 1st and 2nd cycles, when circulating at an average speed of 7 km/h, can cover 1.63 km in 14 minutes. On the other hand, students in the 3rd cycle and secondary school at a speed of 11.95 km/h can travel 2.78 km/h in the same period

After knowing the distance that could be covered by each level of schooling, the objective is to understand the area of influence of each educational establishment. *A priori*, two possible analysis methodologies were identified, both from ArcGIS. The first was to measure distances through buffers, and the second was to use the network analyst tool (network analysis). The choice fell on the second one, because it evaluates the distance with the road network and not in a straight line

Firstly, for the application of the network analyst tool, it was necessary to prepare the data, in this way, the shapefile of the Oeiras road network was used, which is in the vector model, of the line type.

Second, the Network Dataset present in ESRI's ArcCatalog was used, which aims to build a GIS network, and use to create the Service Areas.

Road Network Hierarchy

In this factor, it will be seen if all levels are suitable for the use of the bicycle. For this, it was based on the characterization of the road network present in the PDMO.

That said, it was considered that the 1st level road network, due to its functionality, was not able to use bicycles, since there is a high volume and speed of traffic on these roads, in addition to the fact that in the PMUS these roads are prohibited. the implementation of cycling infrastructures. As for the remaining levels, these will all be considered for the potential analysis.

Slopes

The study chosen for evaluation in the present study was from APA (2010). The choice fell on this study since they are the norms practiced in Portugal and it is by these values that the municipality of Oeiras is governed. However, it has more comfortable standards for cyclists than the IMTT (2011). To calculate the slopes, two shapefiles were needed, the road network of the municipality of Oeiras, in vector format, and the digital raster model of the terrain. The second was made available by COPERNICUS, having a resolution of 25 and a vertical altimetry error of 7m. These were calculated with the “road slope calculator” tool from Qgis, where the slopes were obtained in percentage. Finally, they were classified into different classes according to the percentage of the slope and difficulty of cycling (0-3 Flat; 3-5 mild; 5-8 medium; 8-10 demanding; 10-20 Terrible; >20 impossible).

Continuity

This factor must be ensured throughout the entire circulation, with as few failures as possible. Faults are defined as roads that do not have the potential for cycling or infrastructure implementation. For the present study, any type of failure was not considered, since it is a municipality of low cycling maturity and in the creation of a cycling network for a target population such as the school, whose focus is the capture of new users. and the creation of a new culture of mobility, for which it is necessary to have infrastructure throughout the route so that safety and comfort are ensured.

In this way, only the roads that had a direct connection to the educational establishments were considered. This analysis was carried out by superimposing the shapefiles of the potential road network and the network of educational establishments on the orthophoto map.

Safety

This factor was divided into two moments of analysis. The first is to understand what type of cycling infrastructure to implement, and the second is whether the roads that have so far been seen as potential are of sufficient size for the implementation of cycling infrastructures. For the type of cycling infrastructure to be implemented, the IMTT methodology (2011) was considered. The choice fell on this study because it is the methodology that is planned for Portugal.

It uses two factors to define the type of cycling infrastructure to implement, the speed and volume of traffic. For the first factor, there was no type of information in the municipality of Oeiras, only the signalling plummets were geo-referenced. In this way, it was necessary to survey by superimposing the layers of the signalling plummets referring to speed (point-type vector) and the potential road network (line-type vector) with Google Earth, and from the latter, the meter in street mode view to identifying the values present in the signal plummets. Second, the volume of traffic, and the value of the vehicle counts available in the PMUS were used, these only have values up to the 4th hierarchical level. For the 5th level roads, it is foreseen, in the PMUS, that they are coexistence roads, in this way, they were also not considered in the width of the roads, making their exclusion for the potential depends only on the discontinuity.

After defining the type of cycling infrastructure to be implemented, it will be checked whether the roads in question have a dimension for their implementation. Google Earth was used to measure the streets, as it allows for measurements at various scales of the territory. For the final calculations, a margin of error of up to 1m was considered.

Simultaneously with these calculations, all the elements that were already in the streets were identified (separators; parking; green corridor, and/or sidewalk), so that they enter the calculations, since their removal will not be considered to the detriment of the infrastructures. In addition to these elements, the bus routes were also considered, as they will influence the sizing of the route, regardless of the reference value for that hierarchical level in the case of implementing a cycling lane.

However, as it is a consolidated territory in most cases, it is necessary to adjust to having space for the implementation of cycling infrastructures, in this way the following points will be considered in case of need:

- Consider the number of minimum recommended routes in the PMUS.
- Eliminate central dividers, as they are only mandatory on 1st-level roads. If it is necessary to suppress it, traffic calming measures must be implemented.
- Parking will be considered in parallel, as this is the one that needs the least space.

The reference parameters for the calculation of the streets were those of the PMUS, having also been complemented by the values of the IMTT, by which the municipality is governed.

3.1. Potential Population

To calculate the potential of students, the resident population in the subsection by age group will be used. This statistical level was used, as it is crucial to have cycling infrastructure throughout the route to attract new cyclists and promote safe and comfortable travel. With the data in the subsection, the proximity to a potential infrastructure is quite high**.**

Data on the resident population by age group in the subsection are not yet available for the 2021 census, and therefore it was necessary to make a proxy projection. It also happens that the number of subsections reduced between census periods, so the first step was to understand how the new subsections were designed. In the case of these being united, the resident population by age group was only added, if they were subdivided, the calculation was done through density, that is, the projection for the “ceded” area.

After this survey, the population projection was, then, made through the variation of the total resident population between 2011 and 2021, in each subsection for the age groups, that is, the value of the variation of the total resident population by subsection was applied to the different age groups.

Although the age groups corresponding to the schooling cycles do not coincide with the age groups of the BGRI, age groups were considered by proximity, as can be seen below:

- 1st cycle students are between 6 and 10 years old, however, the age group from 5 to 9 was considered to calculate the potential.
- Students in the 2nd cycle are between 11 and 12 years old, and the age group from 10 to 13 years old was considered.
- 3rd cycle and secondary students will be considered in the same age group since there is only the age group from 14 to 19 years old.

4. RESULTS

In this chapter, the results of the calculations of the potential population will be presented, based on the different stages of the cycling network in the municipality of Oeiras, the results of the surveys, and the proposals.

4.1. Potential Population

The stages presented will be the existing cycling network; the designed cycling network; the school cycling network, which was presented in this study; and the maximum potential of the municipality.

Existing Cyclable Network

As already mentioned, Oeiras is still at an embryonic stage in terms of cycling mobility, so it was to be expected that the existing cycling network would not be able to cover a large part of the Home-School movements of students in the municipality. That said, there is only one educational establishment that coincides with the existing cycling network, which means that it can only cover 1.59% of the total number of students in the municipality. More specifically, this covers 2.81% of 2nd cycle students, 2.25% of 3rd cycle students, and 2.51% of total housing in the municipality of Oeiras, which is quite relevant in the present analysis, since it is of a target population that is in constant rotation.

Designed Cyclable Network

As for the cycling network designed for the municipality, there was a substantial increase in the level of coverage of educational establishments compared to the existing network. In this way, the projected cycling network covers 17 of the 42 teaching establishments in the municipality, also increasing the potential of students who can travel in this mode of transport. This network can cover up to 27.8% of students in the municipality and 39.29% of the accommodation. In terms of schooling cycles, this network covers 25.54% of 1st cycle students, 22.47% of 2nd cycle, and 33.81% of 3rd cycle and secondary.

School cycling network

The school cycling network was the network defined in the present study. This has a very wide coverage of the municipality's educational establishments, as it covers 30 of the 42 schools. This network also covers 26.99% of the municipality's students and 46.26% of the municipality's accommodation. In terms of school cycles, this network covers 34.91% of 1st cycle students, 18.85% of 2nd cycle and 25.19% of 3rd cycle and secondary.

Maximum Cyclable Potential

The maximum cycling potential is related to the junction of all the network stages analyzed above, to obtain the maximum potential of students who will be able to make their trips from home to school by bike. From the outset, it is legitimate to think that the school cycling network should be the network of maximum potential since it was based on the potential of the entire road network in the municipality. It turns out that the projected network, as it did not coincide on certain roads, used a different methodology from the one used in the present study, and, in addition, it made proposals outside the road network, that is, in green and expectant spaces. This last projection was not possible in the present study, as there is no information in shapefile format on the lands which belong to the municipality, nor on possible green corridors, urban parks and/or other green spaces that are planned to be executed.

After joining the three networks, it was concluded that 35 of the 42 educational establishments may have cycling infrastructures in their surroundings. This translates into coverage of 41.45% of students and 63.21% of the accommodation. In terms of schooling cycles, this network covers 48.76%, 32.09% of the 2nd cycle, and 41.13% of the 3rd cycle and secondary.

4.2. Survey

The survey aimed primary and secondary school students in Oeiras. More specifically, the parents of 1st and 2nd cycle students, for being the decision-makers/responsible for their children's travel, and 3rd and secondary students, for having the autonomy to travel independently.

The survey's objectives were to understand: the current mobility patterns; barriers and motivations for cycling; in the case of non-users, what will have to be done to make them change their minds; and the real potential of cycling. The sample consisted of 731 students.

The most used mode of transport in home-school trips is the car (55%). The bicycle is only used by 3.2% of the students, and a third mentioned this mode as a second option, that is, although they use this mode, it is not what they often use.

As for school-home travel, the patterns observed point to some differences, namely in students who use the car as a mode of transport. This difference is justified by the fact that the school leaving time does not coincide with the parents' working hours.

The main motivations given to bicycle users were: the pleasure of riding a bicycle (100%); maintaining physical shape (87.5%); travel time (58.33%); economic issues (25%); the absence/frequency of public transport (16.66%); and the ease of parking (4.1%).

On the other hand, the barriers pointed out for those who do not use the bicycle were: the absence of infrastructure (44.1%); traffic safety (38.5%); the home-school distance (37.06%); the slope of the roads (16.8%); not having a bicycle (14.4%); lack of support equipment at the destination (9.5%); not knowing how to ride a bicycle (9.3%); meteorological conditions (8.3%); maintenance costs (1.1%); air and noise pollution (0.8%); and security in terms of crime (0.6%).

In addition to these reasons, others were also occasionally identified: being on the way on the parents' route; the high number of children; the age; and the weight of the backpack.

Next, the objective was to understand if, if the reasons that prevent respondents from using the bicycle were suppressed, they would be willing to use this mode of transport on their journeys, where 82.6% of respondents answered in the affirmative.

The insertion of the respondents' postal codes was also part of the survey. The purpose of collecting this information is related to the calculation of the real cycling potential. Real cycling potential is understood to mean respondents whose postal code (point of origin) and educational establishment (point of destination) were covered by the maximum potential network identified above.

For the calculation of the real cycling potential, a specific methodology was defined, which will be presented below:

1. Eliminate surveys in which respondents did not reside in the municipality of Oeiras;
2. The shapefile of the postal codes (dot-type vector model) was superimposed with the shapefile of the subsections of the maximum cycling potential (polygon vector model), to eliminate the postal codes that were outside the subsections;
3. Eliminate surveys whose educational establishment was not in the aforementioned cycling network;
4. Eliminate the surveys in which the respondent already uses the bicycle as a means of transport when traveling from home to school;
5. Through the analysis of responses to barriers to the use of this mode of transport, surveys that identified barriers that were difficult to remove were eliminated. These barriers are the distance between home and school, since if you live too far away, cycling is not as efficient when compared to other modes, and if you live too close, the distance is more efficient if you walk; the slope of the roads, this is a natural cause that is difficult to eliminate and expensive, as Oeiras is a municipality of low cycling maturity, it is more important in the short and medium term to implement cycling infrastructure to create a cohesive network, than spending funds higher in small interventions; handy on the parents' routes, as parents would not send their children to school by bicycle and would return home to pick up the car; meteorological conditions, as they are also a natural cause; air and noise pollution; and security in terms of crime.

After applying this methodology, only 49 surveys met all these requirements. Of these 49 respondents, only 2 would not consider using the bicycle if the reasons mentioned were suppressed, due to the weight of the backpack and the fact that it is too young. This means that the real potential for cycling is 95.9%.

Since the two respondents who would not consider using this mode make their journeys on foot, with the use of bicycles by the others, 27 journeys by car on the way home to school would be suppressed. On the other hand, 25 trips would be deleted on the reverse route.

Although 95.9% is the representative value of a sample of the population, it is also believed, and in a sustained way in the remaining survey responses, that there is great potential for the use of this mode of transport by the school population (41.45 %) covered by the maximum potential cycling network.

4.3. Proposals

Throughout the study, the school cycling network was planned, whose objective is to see the cycling potential in the road network surrounding the schools. The result is shown in Figure 2, which, in addition to presenting this network, presents the proposal for the type of infrastructure to be implemented on each road.

As can be seen in Figure 2, besides the “traditional” cycling infrastructure (cycling tracks and bike lanes), the implementation of coexistence zones was also proposed, as these can lead to a considerable increase in the number of users. This is because a network composed only of cycling tracks and bike lanes will have users who start and end their journeys outside of them. In this way, the security felt when connecting to lanes and cycle paths can discourage the use of bicycles.

In addition to the proposal presented, it is also necessary to simultaneously adopt a set of measures to promote this way, as it is not enough to create cycling infrastructure. Having said that, a set of complementary proposals will be presented below for better promotion of this way in the municipality of Oeiras.

Although there are already sporadic actions in the municipality to promote active modes, such as the “car-free marginal”, it is proposed to use the bicycle on a specific day of the week for students to travel from home to school by bicycle.

Bicycle driving programs should also be implemented, not only to teach those who do not yet know how to ride, but also to improve the skills of those who already know how to ride a bicycle, namely learning to adopt defensive driving and being prepared to anticipate possible conflicts. The fact that they learn how to ride a bicycle will remove one more of the barriers pointed out in the survey for not using the bicycle.

It is proposed to the schools’ parents associations with cycling potential to create a “train of bicycles”, where the parents, in turn, were available to pick up a group of students from home and accompany them on their way to school. This proposed action helps to eliminate barriers pointed out in the surveys, such as the high number of children and/or the fear of being too young to move around alone without parental supervision.

A set of support infrastructures is proposed to be ensured along the cycling network. These relate to bicycle parking, which must be secure to prevent theft or vandalism; the presence of drinking fountains; and the availability of free maintenance and repair workshops in schools. The lack of support infrastructure was also one of the factors mentioned when analyzing the barriers to bicycle use pointed out by the respondents.

It is also proposed that the municipality of Oeiras allocate a bicycle bag to educational establishments that are within the maximum potential cycling network. This grant will aim to distribute bicycles to students who undertake to use this mode of transport when traveling from home to school. This measure will also contribute to those who pointed out “not having a bicycle” as a barrier to not using this mode of transport.

Finally, it is important to highlight the bike-sharing system. Although this is already planned by the municipality for its implementation, it is proposed that the maximum cycling potential of each educational establishment be considered when locating the stations. This action will help those who pointed out “do not own a bicycle”.

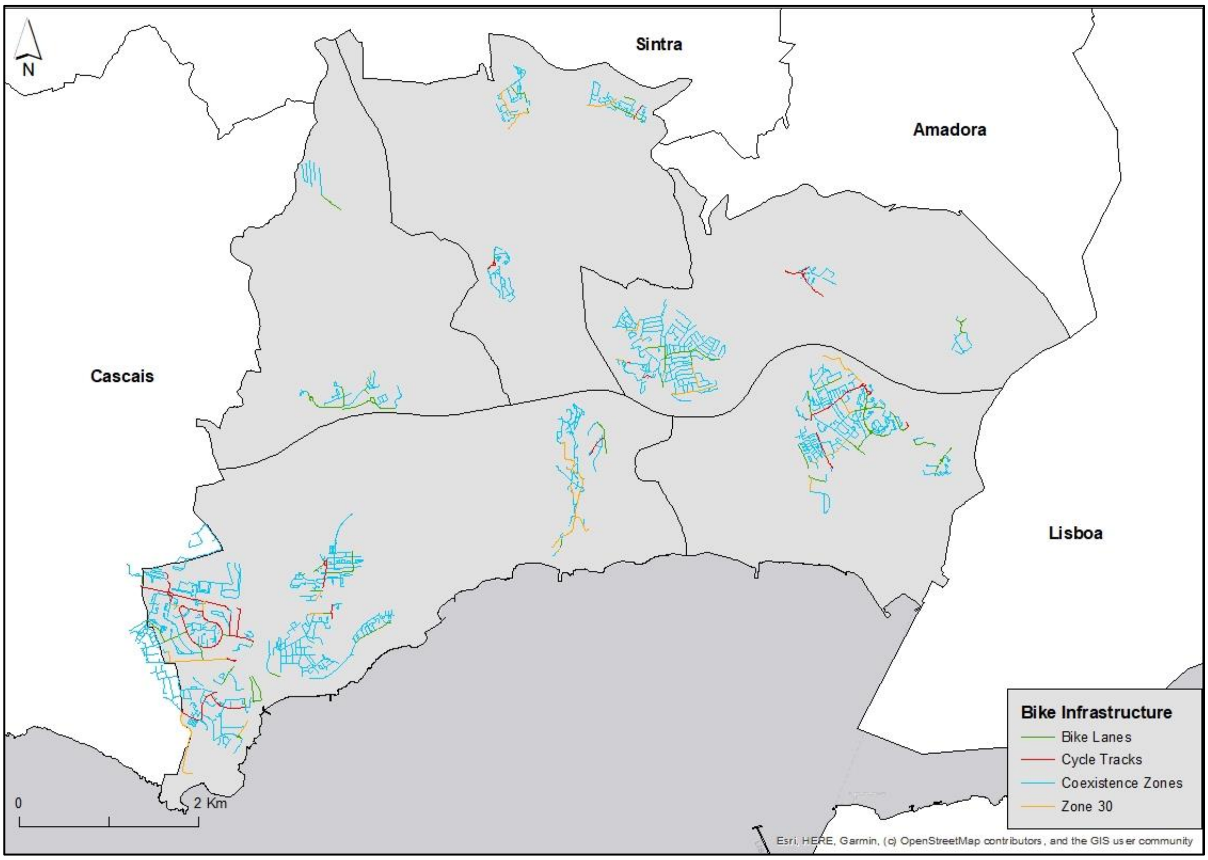

Figure 2 - Type of cycling infrastructure of the school cycling network

5. CONCLUSIONS

In the municipality of Oeiras, there is a clear desire to change mobility patterns, however, Oeiras is still at an embryonic stage in terms of cycling, but there are already projects to change this paradigm and consequently increase its cycling network. Thus, the present study focused on complementing the projected cycling network, through the creation of a school cycling network, to understand which school population had the potential to carry out home-school trips by bicycle.

That said, the objectives of the present study were achieved. Once the cycling potential of the road network surrounding the schools in the municipality was evaluated, giving rise to the School Cycling Network.

The percentage of the potential population for the different levels of the cycling network was also calculated. Thus, it can be concluded that the current cycling network had coverage of 1.59% of the students in the municipality, the projected network 27.8%, the school cycling network 26.99%, and the cycling network the maximum potential of 41, 45%.

It was also concluded that the real potential for cycling is 95.9%. Although 95.9% is the representative value of a sample of the population, it is also believed, and in a sustained way in the remaining survey responses, that there is great potential for the use of this mode of transport by the school population (41.45 %) covered by the maximum potential cycling network.

In short, the municipality of Oeiras is making efforts to increase the sustainability of mobility in the municipality. If the school cycling network is added to this planned effort, it can be concluded that more than 41% of students are covered by the cycling network. This value has the potential to create a culture of mobility and to develop a new habit of commuting because, at the same time, there is also an awareness of the school population for the adoption of this means since the real potential of displacement of the collected sample is 95.9%.

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