

Research Article

Assessment of recreational and tourist cycling routes. Case study in the West Region of Portugal

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ABSTRACT

Recreational and tourist cycling routes in Portugal, namely in the west coast region, have been growing sharply in recent years. This trend can be generalized throughout the country, considering the importance of the strategy outlined by the Portuguese Cycling Federation, to reach more people, to offer better practice conditions, and contributing to the sustainability of the regions. In order to ensure a quality offer in terms of cycling related products, 13 routes were assessed in the territory of Caldas da Rainha municipality, as part of its Cycling Center project. An innovative methodological approach was used based on the regulations for the approval of Portuguese cycling routes, which involved different stakeholders, focus group, data triangulation, with different points of assessment, techniques and emerging technological instruments, facilitating greater depth in data collection. The results allowed for the assessment of a balanced distribution of routes and existing resources, in terms of technical difficulty, level of physical effort and touristic and landscape interest. The quality of conditions for sports and recreation can contribute to the promotion of active lifestyles, safety, comfort, the attraction of tourists and the promotion of the heritage and sustainability of the territory.

Management implications:

- Cycling Routes can contribute to the deseasonalisation of outdoor-based tourism demand.
- The participation of stakeholders (e.g. cyclists, clubs, companies, municipality) can contribute to the development of a cycling tourism destination.
- Planners should identify the specific needs of this segment to design and manage the offer.
- Specialized services are needed to support recreational cycling and tourism.
- Cycling tourism products should value the points of interest of the territory, and the satisfaction of cyclists, also considering, the level of difficulty of each route
- The cycling industry can help improve destination positioning.
- Climate, safety and the quality of natural resources are key to enhancing a cycling tourism destination.

1. Introduction

The feeling of freedom associated with outdoor practices and the contact with nature, in the contexts of sport, recreation and tourism, can be experienced through multiple forms of expression (Silva, et al.,

2021). One of the most emerging in current times, both internationally and nationally, is through the use of the bicycle, in its various forms of cycling, Mountain Biking (MTB), Road Cycling (RC) and Cyclotourism or Gravel (CT/G). Vlogger and Demetz (2011), highlighted the existence of a Cycling Tourism Tribe and reports from the Adventure Travel Trade

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Association (ATTA, 2020, p. 62) provide evidence of the growth and reputation of cycling as a recreational and tourist product. The relevance of cycling in the European context is also highlighted by Pröbstl-Haider et al. (2017).

This development is accompanied by changes in the profile of practitioners, tourists, or consumers of these types of activities. Despite the presence of motivating factors that are related to the general adventure tourism profile, there are aspects related to the implementation of strategic networks, quality and safety, as well as convenience services, that are considered attractive factors to choose a bicycle trip. The knowledge about the needs, motivations and expectations of the “Cycling Tourism Tribe” is crucial for policy makers and DMOs in order to improve recreational and tourist cycling and to create the most attractive products. Considering this reality, in the context of nature and adventure sports, some assessment studies have also been carried out on sport, recreational and tourism infrastructures, namely in Walking, Cycling and Outdoor Sport Tourism-Related Activities (Carvalhinho, et al., 2015; Mata et al., 2021; Silva et al., 2021). The systematic study of sport and recreational spaces can help improve the quality of products and destinations where they are located, safeguarding the issues of safety, consumer expectations and local sustainability.

It was upon these initial considerations that we conducted the present study within the context of territorial planning for the development of sports, recreational, and tourist infrastructures. The objective of this paper was to create and test an innovative and participative methodological approach to evaluate cycling routes, which allowed planning, designing and assessing cycling routes, based on parameters and criteria of national reference and technical quality, aiming a quality offer in relation to cycling practices, in sporting, recreational and touristic contexts, in the west region of Portugal, specifically, in the municipality of Caldas da Rainha. This can be an important contribution to improve the conditions of practice of the different practitioners, to promote enriching experiences, with high levels of comfort and safety, and for the sustainability of this particular region (Gajdosik, 2015).

The methodological approach used was mainly qualitative and based on the regulations for the approval of Portuguese cycling routes. It involved different stakeholders, focus groups, data triangulation, with different points of assessment, techniques and emerging technological instruments, facilitating greater depth in data collection.

This paper is divided into seven sections. In the following section, dedicated to the literature review, we highlight the growth of these practices and their relevance within the current landscape of recreational and tourist activities, both internationally and nationally. We also emphasize their significance in the context of sustainable destination development. The section concludes with a set of important insights regarding the user profile of these types of facilities and their connection with the technical characteristics of cycling networks. Subsequently, we present the methodological aspects employed, the results, and their respective discussion. The article concludes with limitations, the key findings of the study and their contribution to the development of tourism and the region under study.

2. Literature review

2.1. The growth of recreational and tourist cycling

In Portugal, as in Europe, it has been observed a notorious increase in cycling activities, with multiple benefits for society in terms of environment, health and economy. Events such as MTB “Marathons”, “Raids” and “Challenges”, RC “Granfondos”, and the products associated with “Great Crossings” and Cycling Routes, and “Cyclin’n Portugal Centers”, have been determining factors for the growth of the sport, in recent years, moving thousands of participants and contributing to the economic impact of these territories. However, it is important to ensure that this growth is accompanied by constant assessment, with quality criteria, preferably uniform throughout the national territory and

international cycling communities. In Portugal, according to the Portuguese Cycling Federation FPC (2022), there are currently more than 35 homologated Cycling Centers, more than 10 Great Cycling Crossings, and three road route networks, totaling more than 12,000 km of registered routes.

According to WTO (2019) and ATTA (2017), the available data point out a strengthening of this trend in the coming years, which is articulated with the increase in demand for recreational activities favoring direct contact with natural and cultural heritage. The so-called “bicycle industry” already represents a huge economic value in Europe, as identified by the European Parliament. In this sense, the FPC (2022) considers that a coordinated approach of this field is fundamental to ensure the best use of the experience of the entities involved, namely the activation of the networks of economic agents (at a local, national and international level), with the aim of maximizing the return on investments, creating the conditions for the increase of sports and recreational practice in an environmentally responsible and economically viable way. The Portuguese Cycling Federation, as the institution that promotes, regulates and manages cycling in all its specialties and aspects, recognizes that a strategy for the sustained development of cycling is also based on the diversification and increase of the number of practitioners, as well as on the existence of more and better conditions for sport, recreational or daily practice, in comfortable and safe conditions (FPC, 2022).

2.2. Cycling, tourism and sustainability: environment, economy and education

The outlines about sustainability and its direct relationship with destination competitiveness are on the agenda of Destination Management Organizations (DMOs) and the agenda of policy makers as the tourism growth has been continuously observed (WTO, 2019; WTO, 2020). It can now be assumed that tourism competitiveness issues are closely related to sustainable development approach in tourism destinations, providing new products and services with less impact on the environment and society (Streimikiene et al., 2021). A particular phenomenon of tourism growth, closely connected to sustainable principles, has been adventure tourism. Along with continued growth and prospects to continue, Cheng et al. (2018) and Janowski et al. (2021), it has also been changing in terms of participant profile (ATTA, 2017). These changes in consumption patterns pose major challenges in the adventure sports and tourism industry.

Cycling (MTB, RC and CT/G), seen as a particular facet of adventure sports and tourism, has evolved into a global sporting and recreational activity. Non-professional cyclists now travel to experience destinations in a more active, experiential and sustainable way (Buning & Lamont, 2021). A niche tourism market where the concepts of sustainability and rural and mountain territories clearly intersect is that of cycling tourism. This product aims to increase the competitiveness and sustainability of establishing partnerships between private and public organizations (Gazzola, et al., 2018). According to Bakogiannis et al. (2020) and Privitera (2011), the bicycle is one of the most energy efficient and wellbeing enhancing vehicles, which in turn makes it an environmentally friendly way to explore territories. It contributes to low energy consumption, reduces the inhalation of pollutants, generates environmental benefits, and improves physical well-being. It can also contribute to local, regional and national economies, considering the need for infrastructure, networks, services and marketing activities. These characteristics make cycling tourism, an important part of sustainable tourism initiatives, which contradict mass tourism and allow tourists to experience territories, landscapes and traditions in a form of slow tourism (Gazzola et al., 2018). Cycling and tourism activity is becoming increasingly popular as it allows for in-depth communication with nature and people (Bakogiannis et al., 2020). Data from the Adventure Travel Trade Association (ATTA, 2020, p. 62), showed electric bike itineraries as one of the most in-demand trips. It also showed e-bikes and

cycling (both road and mountain) as some of the most on-trend activities.

Considering the European example, according to [Pröbstl-Haider et al. \(2017\)](#), MTB plays an important role in the portfolio of leisure and tourism activities in the European Alps, and in many other rural destinations. The authors also point out that some tourism destinations have now developed a customized offer of facilities and packages aimed at this target market group. In this context, tourism competitiveness issues are closely linked to addressing the sustainable development goals of tourism destinations and providing green tourism services that have no negative impact on the environment, ensure resource savings, protection of the natural environment, and are based on innovations in green service development, and recreational and tourism cycling can be an important factor in tourism sustainability and competitiveness ([Streimikiene et al., 2021](#)).

Considering education and environmental responsibility through outdoor education, several studies have left clues about the effectiveness of this approach in changing the environmental awareness of children and young people ([Light, 2006](#); [Rosa & Carvalhinho, 2012](#); [Tahara & Filho, 2009](#)). More recently, a study of [Zafeiroudi \(2020\)](#) in Greece, also found the positive impact of outdoor activities (including mountain biking) on attributes associated with environmental responsibility in adolescents participating in a previous organized intervention program.

Considering the specificity of Mountain Biking, a study developed by [Wang and Wang \(2022\)](#), with the objective of studying and understanding the specific case of the Trans Canada Trail, highlights the importance of this route to build Canada as a healthy nation. The author emphasizes that this type of structures is especially important in promoting contact with nature, especially for children, but that they need the right technologies and structures for their effectiveness.

2.3. The cycling tourist profile and the parameters for route development

According to the Adventure Travel Trade Association (2017) report on the adventure tourism market, the profile of adventure tourists is changing from an “adrenaline” seeker (e.g. risk; excitement) to a more introspective character considering learning, being in nature and personal transformation as new motivators. Some studies show that the main motivations for bicycle tourism are related to health, adventure, enjoying destinations or being away from the crowd, enjoying nature and relaxing from everyday life ([Bloy, 2001](#); [European Parliament, 2012](#)). [Watthanaklang et al. \(2016\)](#), also found contemplation has the most important factor on Thai tourist motivation to ride bikes, both for mountain or sea tourist attractions.

In addition, the presence of local, national and international bicycle networks, the activities of their communities, bicycle races, festivals, activities and their outreach to the masses thanks to social media have contributed to the increase in the number of cycling tourists and their turn to international travel ([Duran, et al., 2018](#)).

A study by [Rejón-Guardia et al. \(2018\)](#) in the Balearic Islands shows that motivations such as personal knowledge of the Balearic Islands, having friends or family there, or a recommendation from friends or acquaintances, followed by prestige-related motivations were predicted expenditure variables. But despite evidence of more general motivators (i.e. common to other adventure activities and contexts), the authors found that specific aspects related to cycling routes or networks were also found to be extremely important in tourist decisions. They found that sensory and physiological motivations, such as the attractiveness of the scenery, appropriateness of routes, weather and signage, and those related to a sense of ownership clearly distinguish tourists who spend more than three days at the destination from others. [Bakogiannis et al. \(2020\)](#) explored the motivators for cycling tourism in Greece and found four main categories: road network characteristics, physical environment, social environment, and built environment. Their results showed that the attractiveness of a route is mainly influenced by the characteristics of the road network. Natural environment features scored the

second highest, but only half the weight compared to road network features the policies most able to foster and attract bicycle tourism in Greece are those that improve road safety conditions and information along cycleways. Signage of safe and accessible cycleways with good road surface conditions, construction of dedicated cycling infrastructure where cycleways follow main roads or narrow roads where cyclists feel safe, information along the route about places of interests and maintenance of cycleways, are policies that can foster bicycle tourism. A study by [Bakogiannis et al. \(2020\)](#) provide a short but comprehensive review of studies looking at the quality of cycling networks that point to aspects such as traffic volume, speed levels, the proportion of large bus lorries on the roads, the existence of slopes, intersections, road information and signage. Infrastructure was also considered as one of the most important factors considering the safety of cyclists. [Parkin et al. \(2007\)](#) also argue that cyclists feel safer in cases of cycleways and exclusive cycleways. A study by [Mundet et al. \(2022\)](#) focused on the Girona case (Spain) identified, among other variables, the main motivations of cyclists and the most important conditions and factors relating cycling routes. The more mentioned factors were the condition of the roads, the climate, nature and landscape, gastronomy and the quality of the local restaurants whereas the presence of specific services for cycling tourism and prices were less important factors.

In sum, despite the existence of motivators that are fixed in the general adventure tourism profile, there are aspects related to the implementation of strategic networks, quality and safety, as well as convenience services, that are considered attractive factors to choose a bicycle trip. This information is crucial for policy makers and DMOs in order to improve recreational and tourist cycling and to create the most attractive products. The quality of the landscape, cuisine, agriculture, local culture and traditions, and sustainability are the competitive advantages of recreational and tourist cycling, and these are the elements that participants seek and for which they are willing to pay a premium price ([Gazzola, et al., 2018](#)).

3. Research context and methodology

3.1. Objectives and methodological approach

Taking into consideration the previous assumptions presented in the last section, namely: i) the growth of recreational and tourist cycling; ii) the importance of cycling products as vehicle for regions and tourism destinations sustainability; iii) the necessity for a rigorous approach to route assessment and creation, given that its features greatly influence user satisfaction, the objective of this study is to create and test an innovative and participative methodological approach to evaluate cycling routes. This approach will enable the planning, designing, and assessment of cycling routes based on parameters and criteria of national reference and technical quality, with the aim of offering high-quality experiences in relation to cycling practices within sporting, recreational, and touristic contexts. The focus of this study is on the west region of Portugal, specifically in the municipality of Caldas da Rainha.

A qualitative analysis approach was utilized, involving the collection of documents, conducting focus group sessions, and undertaking field observations ([Creswell, 2009](#); [Ellram, 1996](#); [Yin, 2009](#)). The methodological approach is illustrated in [Fig. 1](#), which outlines the different phases of the process, each stage, and the variables studied. The variables in the figure are presented in italics font.

The overall methodological approach is divided in two main phases. The first phase consists of territory characterization, including geography, human capital and existing/in-project infrastructures directly related with cycling activities. This initial phase is crucial for understanding the entirety of the existing resources.

The second phase of the process involves gathering and organizing all the necessary data. It consists of 4 stages that are interconnected and commence with a consultation moment with the main stakeholders (Stage 1). With the information collected in this initial stage, Stage 2

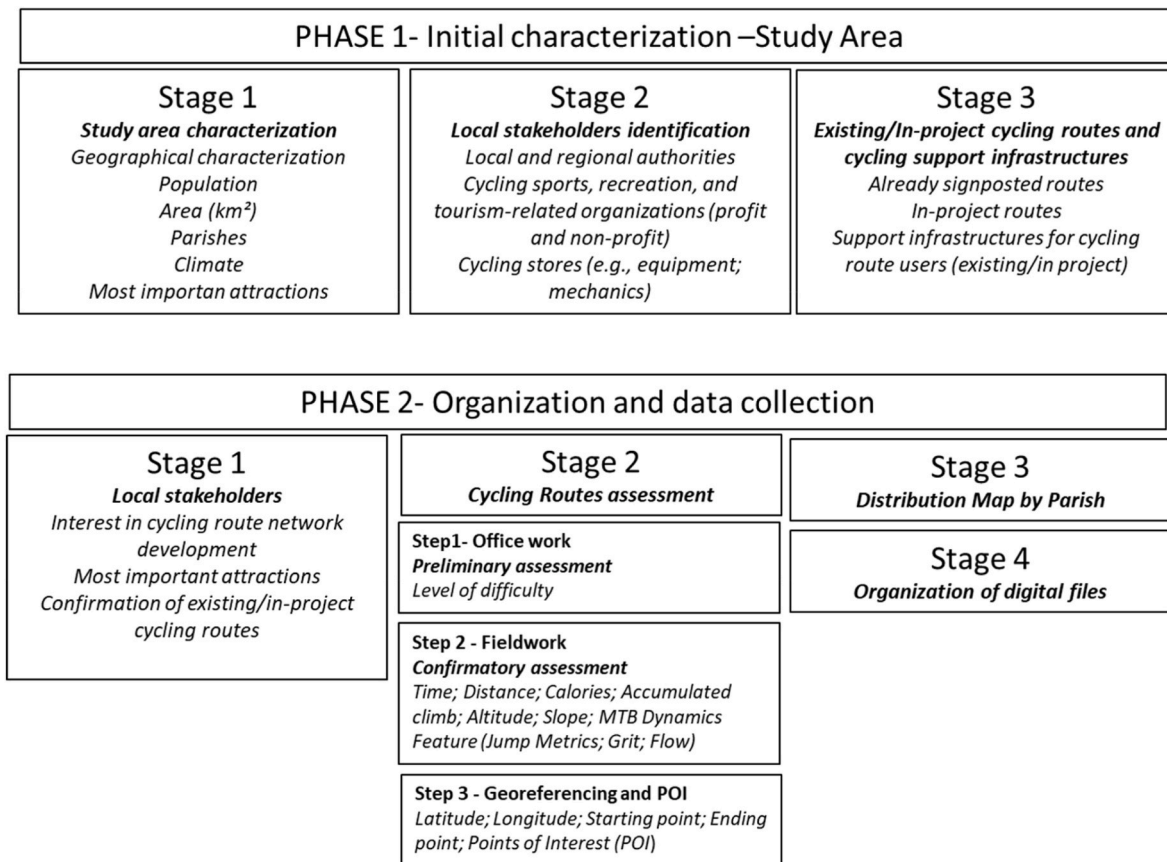


Fig. 1. Methodological approach (own production).

begins, where the assessment of cycling routes is effectively conducted. Stages 3 and 4 focus on compiling and organizing this information. Each phase of the process is explained in detail in the next subsections.

3.2. Phase 1- initial characterization

3.2.1. Stage 1- study area

In this first phase, a diagnostic assessment of the reality was carried out, within the scope of the territory characterization. The Municipality of Caldas da Rainha is located in the West Coast Region of Portugal, belongs to the District of Leiria, and is at a distance of 90 km (North) from Lisbon. It has an area of 255.69 km² and 50.898 inhabitants, being divided into 12 parishes (A. dos Francos, Alvorinha, Carvalhal Benfeito, Foz do Arelho, Landal, Nadadouro, Nossa Senhora Pópulo Coto e São Gregório, Salir de Matos, Santa Catarina, Santo Onofre e Serra do Bouro, Tornada e Salir do Porto, Vidais). Three of these parishes are near the Atlantic Coast, and one is near the Óbidos Lagoon, and it is possible to cover more than 20 km of routes by water (Sea and Lagoon) (Municipality of Caldas da Rainha, 2022). The climate in this territory is temperate Mediterranean with Atlantic influence, characterized by mild winters with some precipitation. Summers are usually cool, sometimes humid, and there may be persistent northerly winds, as well as some morning fog. Throughout the year, in general, the temperature range can vary between 8° and 26 °C and is rarely below 4 °C or above 32 °C. The Municipality of Caldas da Rainha and its Parishes are represented in Fig. 2 (identified in a darker shade of gray).

3.2.2. Stage 2 - local stakeholders identification

Regarding the identification of local operators, in the field of sports products and services related to cycling, we proceeded to cross data, considering the following sources: i) Entities registration on the Municipality of Caldas da Rainha databases (Local Administration, for

Clubs and Sports and Recreational Associations); ii) National Tourism Recreation Agents Register (Tourism Recreation Companies and Maritime-Tourism Operators); iii) Internet search. This characterization allowed us to identify 66 organizations in total (33 clubs, 25 Tourism Recreation Companies, 8 Maritime-tourism Operators), public and private, with work developed in the field of sports, recreation and active tourism. Out of this total, only 3 organizations were selected (1 Club, 1 Association, 1 Tourism Recreation Company), considering their relation with recreation and tourism cycling.

As support services to cycling activities, there were 5 cycling stores, for the sale of material and equipment, maintenance and repair of bicycles, and only 1 company with availability to rent bicycles.

3.2.3. Stage 3- existing/in-project cycling routes and cycling support infrastructures

We did not identify any signposted Cycling Routes in the Municipality of Caldas da Rainha. However, there is 1 segment of Route with about 20 km, the “EuroVelo” Atlantic Coast Route (European Cycle Route Network) available on the Internet, but not signaled on the ground.

In terms of Cycling Sport Facilities, it was possible to identify 1 Cycling Center (ongoing project), with the following characteristics: i) 10 Cycling Routes (MTB = 4, RC = 6); ii) Support services: WC, Showers, Electrical outlet, Bike Station (washing and bike maintenance), Information panel with useful information about the cycling routes, QR Code, useful and emergency contacts.

3.3. Phase 2- organization and data collection

3.3.1. Stage 1- local stakeholders meetings

Consultation meetings were held (*focus group*), in order to collect the opinion of various stakeholders (Municipality of Caldas da Rainha,

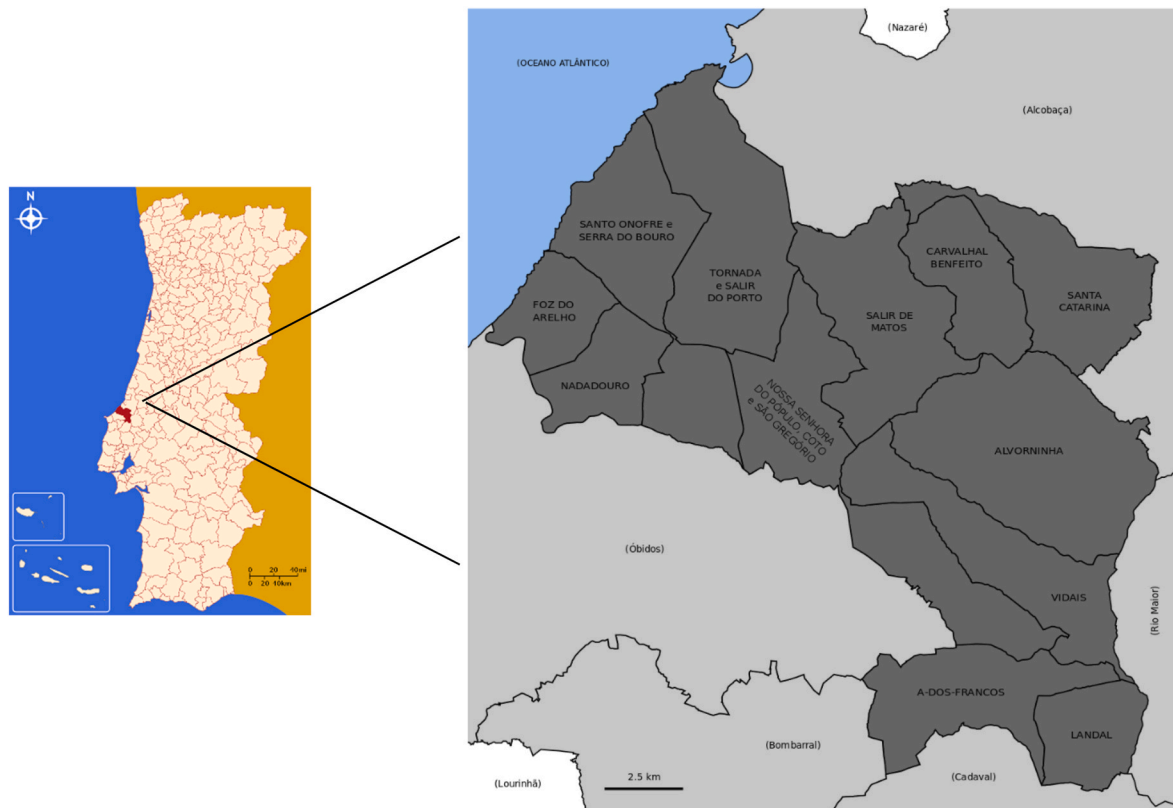


Fig. 2. Study area- Municipality of Caldas da Rainha. Source: Wikipedia (left image) and Gazillion (right image), from https://commons.wikimedia.org/wiki/File:Caldas_da_Rainha_freguesias_2013.svg.

Parish Councils, Portuguese Cycling Federation - FPC, Portuguese Camping and Mountaineering Federation - FCMP, Associations, Clubs, Tourism Promotion Companies) and reference individuals in the sector (experts, teachers, and other with experience in sports). The questions addressed were related to the knowledge and use of registered routes, identification of Points of Interest (POI) to visit in the territory of the Municipality of Caldas da Rainha and ascertaining the development potential of this sector. A total of 10 meetings were realized and results were recorded on field notes. In this stage it was also carried the analysis of the available information regarding the ongoing project of the “Cycling Center of Caldas da Rainha - Cyclin’ Portugal”.

In terms of the data collected, it was possible to identify the potential of this territory and the interest of different stakeholders, in developing products and services associated with the various aspects of cycling (Aschauer, 2021). Thus, in addition to the 10 circular routes designed in the “Cycling Center of Caldas da Rainha”, and 1 International “Euro-Velo” Route, designated further by “Cyclotourism/Gravel - Eurovelo (CT/G -Eurovelo)”, it was also identified the possibility to evaluate 2 more linear routes in a National and International context. These, originally created as pedestrian routes, can be easily adapted to the practice of recreational cycling and tourism. These are the “Grand Route - Atlantic (GR 11/E9)”, and the “Grand Route - Caminho do Mar (GR CMar)”, with connection to “Fátima” and “Santiago de Compostela”: In cycling variants these can be called “Cyclotourism/Gravel - Atlantic (CT/G - Atlantic)” and “Cyclotourism/Gravel - Caminho do Mar (CT/G - CMar)”.

In conclusion, after this phase, it was possible to verify that there are no cycling routes signposted and implemented on the ground. However, it was possible to identify a total of 13 projected routes (MTB = 4, RC = 6, CT/G = 3), on which the respective assessment was carried out in the next stage of the process.

3.3.2. Stage 2 - cycling routes assessment

The cycling routes assessment was carried in three steps.

Step 1: The first was a preliminary assessment, in the office, and therefore served as a provisional assessment. Tracks in GPX format were used, to be analyzed in the Software “ibp index”. This analysis intended to measure the human effort, through the effort index (theoretical), considering that this can also depend on other factors such as, the physical condition and the rhythm used by each practitioner, and the weather conditions. For this purpose, we considered 3 reference tables according to FPC (2020), for MTB, RC and CT/G, using the following parameters and assessment criteria: Distance, Accumulated Climb and Slope, Terrain Type, Technical Characteristics, Difficulty level.

Tables 1–3, are the reference for the assessment of Routes, allowing to classify each Route individually, assigning scores from 1 to 4, in each indicator (eg. Distance). The sum of these partial points resulted in a final Score, which corresponded to the level of difficulty of each Route (e.g. Easy).

Step 2: In a second step, a confirmatory and complementary assessment was carried out in the field. The Tracks were recorded in “GPS Garmin Edge 830” and “Smartwatch Garmin Forerunner 935” devices, and downloaded in “Garmin Connect” and “Strava” applications. The crossing of all the data collected allowed us to confirm and complement the initial data, making the final assessment more complete, with greater accuracy and quality. In this situation, and to evaluate each of the Routes, the indicators “Time, Distance, Calories, Accumulated Climb, Altitude (minium and maxium), Slope and MTB Dynamics Feature” were used.

The MTB Dynamics Feature includes 3 types of data (Garmin, 2022), namely, Jump Metrics, Grit and Flow, that are automatically enabled when you are using the MTB Activity Profile on a compatible Edge device: i) Jump Metrics - Includes jump count, jump distance, hangtime, and jump speed. An alert will appear during a ride when a jump is detected. The locations of the jumps and a Jump Score (combination of

Table 1
Reference for MOUNTAIN BIKING (MTB) routes assessment.

Practitioner	Dist.	Accumulated Climb/Slope	Terrain Type	Technical Characteristics	Score	Diff. Level
Beginners with no experience and little physical resistance	Under 15 km	Under 200 m max. slope = 7%.	Stable dirt terrain more than 1.5 m wide	Unobstructed progression in the lane	4 to 6	Easy
Little experience, and technique, and medium physical resistance	15 km–30 km	201–400 m max. slope = 10%	Dirt floor, less than 1.5 m wide	Very irregular path, in dirt or stone, less than 0.75 m wide	7 to 9	Moderate
Experienced, good technical ability and physical endurance	31 km–50 km	401 m–750 m max. slope = 15%	Uneven dirt terrain, less than 1.5 m wide	Progression needs normal riding levels, with many obstacles (roots, wetlands, rocks)	10 to 12	Difficult
Only for practitioners with a lot of experience and high physical resistance	Over 50 km	Over 751 m	Very irregular path, in dirt or stone, less than 0.75 m wide	Progression that requires perfect mastery of all riding techniques. Very demanding course with assessment zones in many sectors, steep descents and climbs	13 to 16	Very difficult

Source: Adapted from [FPC \(2020\)](#).

Table 2
Reference for ROAD CYCLING (RC) routes assessment.

Practitioner	Dist.	Accumulated Climb/Slope	Terrain Type	Technical Characteristics	Score	Diff. Level
Beginners with no experience and little physical resistance	Under 30 km	Under 200 m max. slope = 7%.	100% asphalt pavement, stable, and of excellent quality in more than 75% of the length/curves with internal angle +90° for accessible routes	Easy progression with open curves and gentle slopes	4 to 6	Easy
Little experience, and technique, and medium physical resistance	30 km–50 km	201–400 m max. slope = 10%	Somewhat uneven pavement, with cobblestone areas and enough width for two cars to pass.	Progression needs a basic level of piloting, presence of curves and slopes in some places	7 to 9	Moderate
Experienced, good technical ability and physical endurance	51 km–75 km	401 m–750 m max. slope = 15%	Uneven pavement, with potholes, cobble areas, and sections less than 3 m wide.	Progression needs normal riding levels, with consecutive sharp turns and steep slopes	10 to 12	Difficult
Only for practitioners with a lot of experience and high physical resistance	Over 75 km	Over 751 m	Very uneven pavement, with potholes, cobblestone areas, unpaved areas, and stretches less than 3 m wide	Progression requiring perfect mastery of all riding techniques with very sharp consecutive turns and very steep slopes	13 to 16	Very difficult

Source: Adapted from [FPC \(2020\)](#).

Table 3
Reference for CYCLOTOURISM or GRAVEL (CT/G) routes assessment.

Practitioner	Dist.	Accumulated Climb/Slope	Terrain Type	Technical Characteristics	Score	Diff. Level
Beginners with no experience and little physical resistance	Under 25 km	Under 200 m max. slope = 7%.	Stable ground, paved or asphalt terrain with a width of more than 1.5 m	Progression without visible obstacles in the lane	4 to 5	Easy
Little experience, and technique, and medium physical resistance	25 km–40 km	201–400 m max. slope = 10%	A dirt, cobblestone, or asphalt terrain that is wide enough for a vehicle to pass	Progression needs a basic level of attention, presence of sandy areas and some small stones	6 to 8	Moderate
Experienced, good technical ability and physical endurance	41 km–60 km	401 m–750 m max. slope = 15%	Uneven terrain on dirt, cobblestone or asphalt, with a width of less than 1.5 m	Progression needs a good level of attention, with many obstacles in the lane (potholes, stones, sand)	9 to 12	Difficult
Only for practitioners with a lot of experience and high physical resistance	Over 60 km	Over 751 m	Very irregular terrain, in dirt, cobblestone or sidewalk, with a width of less than 0.75 m	Progression that requires a lot of attention, with many obstacles on the track (holes, stones, sand), very variable consistency of the floor and small drops in some places	13 to 16	Very difficult

Source: Adapted from [FPC \(2020\)](#).

distance, hangtime, and speed of the jump) are available in Garmin Connect once the device has been synced; ii) Grit – measures the overall difficulty of a mountain bike ride based on factors such as the speed of the ascent and descent and the angle of turns throughout the ride. Rating scale: Easy (0–20); Moderate (20–40); Hard (40+); iii) Flow - measures the overall difficulty of a mountain bike ride based on factors such as the speed of the ascent and descent and the angle of turns throughout the ride. Rating scale: Easy (0–20); Moderate (20–40); Rough (40+).

Step 3: In this last step, georeferencing of the routes was carried out, as well as the identification of POI (Points of Interest). As mentioned earlier, it was possible to identify 13 cycling routes for the assessment process. Thus, for each one, geographic coordinates were recorded with latitude and longitude, identifying the starting point and end point. The

POIS of landscape, historical, cultural and touristic, of passage and visitation, also integrated each of the routes, being these provided by the parishes of the Municipality of Caldas da Rainha.

3.3.3. Stage 3: distribution map of cycling routes by parish

Table 8 is presented in the results section, identifying the number of kms of routes allocated to each of the Parishes of Caldas da Rainha Municipality.

3.3.4. Stage 4: organization of digital files

The information provided by the Caldas da Rainha Municipality, referring to the cycling routes (tracks) was organized in GPX and KML format, to be viewed on computer, smartphone and GPS devices (N =

26). Digital maps, in PDF format, of all the routes under study will also be organized (N = 13), making a total of 39 digital files.

3.4. Technological requirements and procedures

To perform this study the following equipment and technologies were used: i) Cycling routes (tracks) available in GPX format; ii) Garmin Edge 830 GPS (or similar) for cycling, in order to record the data during the execution of each route; iii) Garmin Connect App (or similar), to record the physiological data; iv) List of POI, of each route; v) Maps of the territory (Municipality and Parishes of Caldas da Rainha).

4. Results

4.1. Cycling routes assessment

In a 1st moment (office assessment), the “Tracks” files in GPX format were used, to be downloaded from the software “ibp index” (IBP index, 2022). The results can be seen in Tables 4–6, through the indicators “Distance, Accumulated Climb, Altitude (minium and maxium), Slope, Difficult Level by ibp index (BYC). The Field assessment was a 2nd moment performed with the devices “GPS Edge 830” and “Smartwatch Garmin Forerunner 935” were used, to record the “Tracks”, and be downloaded in the applications “Garmin Connect” and “Strava”. The FPC (2020) were also considered.

The results in this phase are presented in Figs. 3–5 (maps with routes) and Tables 4–6, through the indicators, “Dynamics Feature (Jumps/Grind/Flow), Time, Calories, Terrain Type, Technical Characteristics and Difficulty level by FPC.

In order to facilitate the results display, they will be presented separately for each cycling route.

Table 4 shows that there is a balanced distribution of 4 routes, by the different levels of difficulty provided in the FPC regulation, i.e. 1 “easy” route (green), 1 “moderate” route (blue), 1 “difficult” route (red) and 1 “very difficult” route (Purple). This means that the MTB variant offers products for all levels of riders and can reach as many riders as possible. The number of kms, the positive accumulated gradient, the duration and the average caloric expenditure of each route, as well as the type of road surface, present an increasing difficulty along the 4 routes.

The assessment done through the “MTB dynamics feature” also proves that there is a progression of the technical level, corresponding to the requirements of each difficulty level. The importance of the technical level of piloting and high physical condition is emphasized, to accomplish MTB 4 successfully and safely.

The final score obtained in the assessment of all items, establishes the final difficulty level of each route with an assigned color (eg. Score = 4 = Easy = Green).

Table 4
Cycling routes assessment – Mountain Biking (MTB).

Route	Dist. (km)	Acc.Climb /Altitude/ Slope	Dynam. Feature (J/ G/F)	Time/ Cal.	Terrain type	Technical Characteristics	Difficulty (FPC) (ibp index)
MTB 1 Green	14,0	67 m 21–55 m Under 5%	J = 0 G = 12,8 F = 2,6	0h42 294 c	Stable dirt terrain, more than 1.5 m wide	unobstructed progression in the lane	Easy (score = 4) (8 BYC)
MTB 2 Blue	27,0	200 m 5–88 m 7% (547 m)	J = 1 G = 29,8 F = 2,7	1h29 775 c	Stable dirt terrain, more than 1.5 m wide	Very irregular path, in dirt or stone, less than 0.75 m wide	Moderate (score = 7) (19 BYC)
MTB 3 Red	45,0	399 m 1–156 m 12% (288 m)	J = 2 G = 53 F = 2,7	2h27 1238 c	Uneven dirt terrain, less than 1.5 m wide	Progression needs normal riding levels, with many obstacles (roots, wetlands, rocks)	Difficult (score = 11) Very Difficult (31 BYC)
MTB 4 Purple	69,7	1139 m 4–158 m 22% (231 m)	J = 3 G = 68 F = 3,5	3h55 2105 c	Very irregular path, in dirt or stone, less than 0.75 m wide	Progression that requires perfect mastery of all riding techniques. Very demanding course with assessment zones in many sectors, steep descents and climbs	Very difficult (score = 16) (83 BYC)

Source: own elaboration

In Table 5, referring to the 6 RC routes, it can be seen that the difficulty level of each route is also progressive and increasing, ranging from 24 k (RC 1) to 94 k (RC 6). Here, the intermediate levels were valued with a greater supply of routes, namely, 2 “moderate” routes (blue) and 2 “difficult” routes (red), leaving only 1 “easy” route (green) and 1 “very difficult” route (purple).

The average duration of the routes, varies between 1 h (RC 1) and 4 h (RC 6), considering a “moderate” intensity of effort, providing routes for different levels of cyclists, with leisure or sport objectives. In general, the type of road surface does not present problems, reinforcing the importance of the physical condition of the riders to respond to the level of effort caused by the altimetry and the duration of the more difficult routes.

The difficulty levels attributed by the “ibp index” platform (5 levels), present an acceptable concordance with the FPC (2020). These previously evaluated results were verified and confirmed through the assessment carried out in the field. To homologate a “Cyclin” Portugal Center” is necessary that, at least one of the network routes has 6 routes. In this case, this assumption is verified because there is an offer of 6 properly structured RC routes.

Table 6 shows that, besides the Circular Routes circumscribed in the Municipality of Caldas da Rainha, there is a good opportunity to register and signalize 3 segments, of national and international routes. Usually, this type of routes is preferred by practitioners of Cyclotourism or Gravel, having as objectives, to cross the country on a trip of several days.

These routes are characterized as “easy” and “moderate”, and usually have strong leisure and active tourism components associated with cycling. From a technical point of view, they are not very demanding and allow beginner cyclists with reduced physical condition to ride them, and with the use of simpler and multipurpose bicycles.

4.2. Georeferencing cycling routes and points of interest (POI)

The 13 cycling routes were georeferenced, considering the starting points (N = 13) and ending points (N = 13). In these routes the Points of Interest (POI) to visit in each of them were also georeferenced, given their distribution in the territory of the Parishes that are part of the Municipality of Caldas da Rainha. In total, 26 georeferenced points and additionally 66 POI allocated to cycling routes were added. In total 88 georeferenced points were obtained.

In Table 7 it is possible to see that all routes have POI to visit, and that all parishes also have POI as a visitation offer. However, the routes that have the greatest number of kilometers and the greatest number of POI (MTB 4 and RC 6) stand out. On the other hand, although the Route GC-Atlantic has few kilometers (n = 24), it presents a high number of POI (n = 17), since this route runs through a lagoon and a sea coastal

Table 5
Cycling routes assessment – Road Cycling (RC).

Route	Dist. (km)	Acc. Climb/Altitude/Slope	Time/Cal.	Terrain type	Technical Characteristics	Difficulty (FPC) (tbp index)
RC 1 Green	24,1	148 m 6–65 m 6% (167 m)	0h57 450 c	100% asphalt pavement, stable, and of excellent quality in more than 75% of the length/curves with internal angle +90° for accessible routes	Easy progression with open curves and gentle slopes	Easy (score = 4) (10 BYC)
RC 2 Blue	33,7	292 m 9–123 m 10% (112 m)	1h22 738 c	100% asphalt pavement, stable, and of excellent quality in more than 75% of the length/curves with internal angle +90° for accessible routes	Progression needs a basic level of piloting, presence of curves and slopes in some places	Moderate (score = 7) (18 BYC)
RC 3 Blue	37,0	305 m 9–154 m 10% (112 m)	1h26 1157 c	Somewhat uneven pavement, with cobblestone areas and enough width for two cars to pass.	Progression needs a basic level of piloting, presence of curves and slopes in some places	Moderate (score = 8) (18 BYC)
RC 4 Red	60,3	716 m 9–164 m 15% (149 m)	2h27 2014 c	Somewhat uneven pavement, with cobblestone areas and enough width for two cars to pass.	Progression needs normal riding levels, with consecutive sharp turns and steep slopes	Difficult (20 BYC) (score = 11)
RC 5 Red	66,2	792 m 9–211 m 15% (274 m)	2h40 2035 c	Somewhat uneven pavement, with cobblestone areas and enough width for two cars to pass.	Progression needs normal riding levels, with consecutive sharp turns and steep slopes	Very Difficult (39 BYC) (score = 12)
RC 6 Purple	94,2	1150 m 7–228 m 17% (296 m)	4h10 2467 c	Somewhat uneven pavement, with cobblestone areas and enough width for two cars to pass.	Progression requiring perfect mastery of all riding techniques with very sharp consecutive turns and very steep slopes	Very Difficult (52 BYC) (score = 14) (85 BYC)

Source: own elaboration

line, allocating numerous landscape POI with strong tourist attraction (eg. POI “Picnic Park”, Georeference: 39.476008, -9.191162).

4.3. Distribution map of cycling routes

Table 8 allows us to identify, the number of kms allocated to each of the Parishes.

In Table 8 we can observe the distribution of 528.8 km of routes by the 3 cycling networks. The RC routes have the largest number of kilometers, since from a logistical point of view and the allocation of resources, namely, the physical signage on the ground and the maintenance of the trails, is much more complex and expensive.

The “OSB” parish covers a significant part of the municipality’s territory, having important attributes in its favor, from part of the coastal area to the historical hull of the city, where the headquarters of the “Cycling Center of Caldas da Rainha” is located. For this reason, the circular routes all start and end in this location, contributing for a higher concentration of kilometers in this area.

The routes of the CT/G variant, especially the “CT/G-Atlantic”, being characterized for crossing the Council, uses preferentially the territories of the more coastal parishes (FA, N, OSB and TSP).

4.4. Digital files

All routes presented detailed information, “Tracks”, in GPX and KML format, to be viewed on computer, smartphone and GPS devices (N = 26).

From the navigation point of view, it was also possible to use the “Tracks” in GPX format, in several GPS devices (Garmin eTrex touch GPS, Garmin Edge 830). Digitized maps in PDF format (AllTrails Pro software) were made available for the 13 routes under study, plus 3 maps for each of the networks (MTB, RC and CT/G), and 1 general map of all the routes studied, for a total of 17 maps. These include geographic coordinates, road and trail network, topographic scale, distance, altimetry graph, positive and negative accumulated gradient, and QR Code for connectivity to the various devices.

5. Discussion

This case report aimed to test a new methodology to evaluate cycling routes, namely in the Municipality of Caldas da Rainha, located in the West Region of Portugal, composed by the 10 routes of the Cycling Center of Caldas da Rainha and 3 more CT/G bike segments that cross this territory. The development model assumed in this sports and recreational cycling area, was based on cooperation and participative management with several stakeholders, namely, with Higher Education Institutions (Sports and Tourism areas), with National Sports Federations, with recreational and sports associations and clubs, with local operators and companies, and also, with the collaboration of some invited experts. The involvement of the community in this type of projects is a fundamental strategy to support the political decisions and for the sustainability of the activities to be developed (Capriello & Rotherrham, 2009; Gajdosik, 2015). However, the participation of local clubs and companies is still very low (4,5%), considering the potential of this territory for sports and recreational practices in contact with nature. On the other hand, events like the “MTB Marathons”, the “Volta a Portugal em Bicicleta - RC” and thematic cycling tours in the Region, can be important strategic actions to involve the community. According to Mundet et al. (2022) these initiatives must be carried out on the basis of a solid governance which articulates the work of the public sector, the private sector and the national and international bodies linked to road cycling tourism. These types of proposals can be used to influence social change and political action, bringing benefits to cities and the people who live and participate in them (Misener & Mason, 2006; Perić et al., 2016).

In relation to the effective assessment of the cycling routes, it was

Table 6
Cycling routes assessment – Cyclotourism/Gravel (CT/G).

Route	Dist. (km)	Acc. Climb/Altitude/Slope	Time/Cal.	Terrain type	Technical Characteristics	Difficulty (FPC) (ibp index)
CT/G CMar	9,6	32 m 12–58 m Under 5%	0h25 153 c	Stable ground, paved or asphalt terrain with a width of more than 1.5 m	Progression without visible obstacles in the lane	Easy (Score = 4) Very Easy (2 BYC)
CT/G EuroVeló	19,4	227 m 6–158 m 10% (278 m)	1h02 338 c	A dirt, cobblestone, or asphalt terrain that is wide enough for a vehicle to pass	Progression needs a basic level of attention, presence of sandy areas and some small stones	Moderate (Score = 7) (13 BYC)
CT/G Atlântica	23,1	210 m 6–156 m 11% (105 m)	1h25 652 c	Uneven terrain on dirt, cobblestone or asphalt, with a width of less than 1.5 m	Progression needs a basic level of attention, presence of sandy areas and some small stones	Moderate (score = 8) (19 BYC)

Source: own elaboration

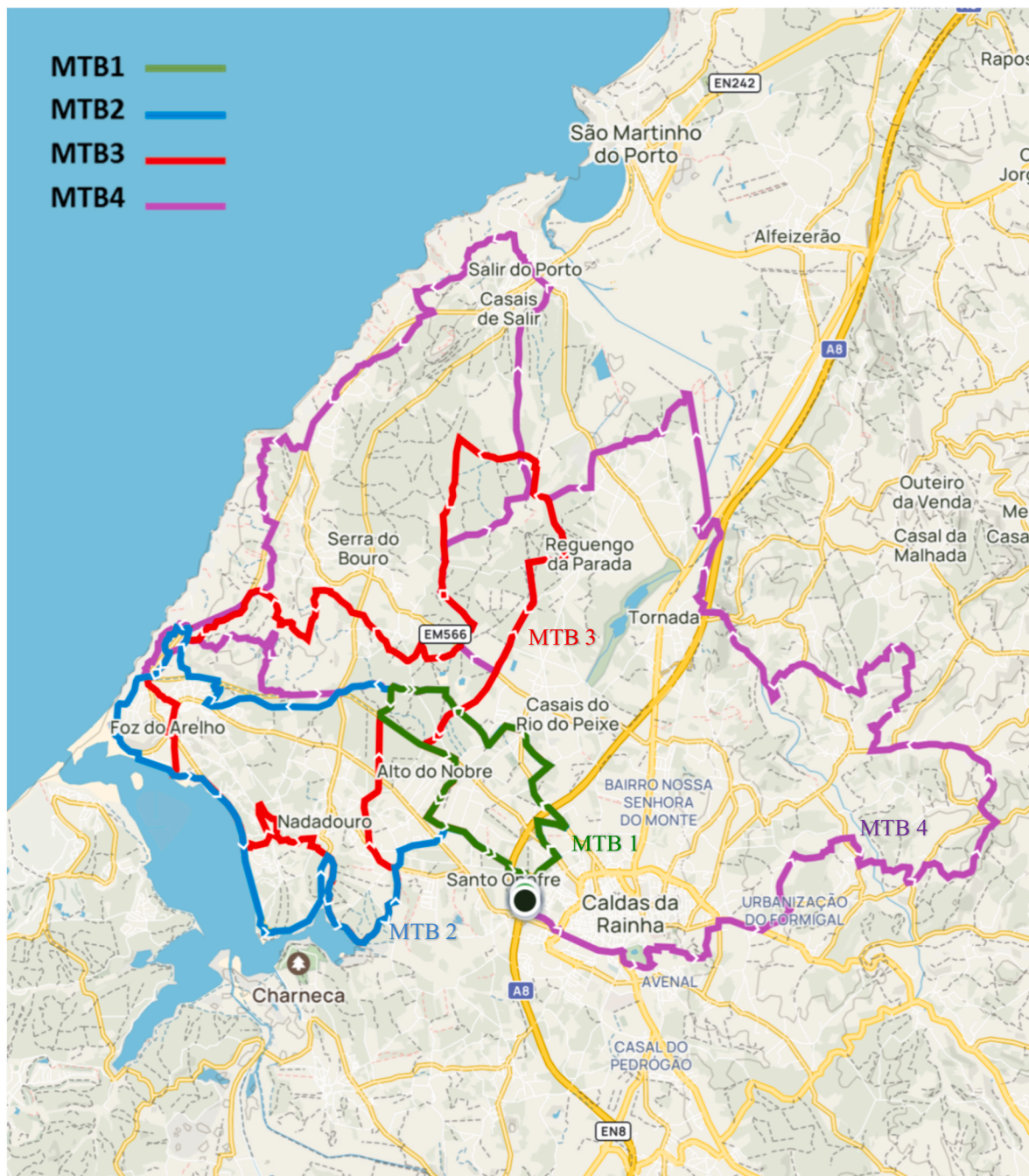


Fig. 3. Mountain Biking routes map. Source: Own production using AllTrails®.



Fig. 4. Road Cycling routes map. Source: Own production using AllTrails®.

verified that there is a diversified offer, translated by the 3 types of route networks, MTB, RC and CT/G, with adequate conditions to meet the purpose of the Cycling Center of Caldas da Rainha (FPC, 2020). The routes assigned to the Cycling Center are circular, considering that the starting point coincides with the ending point in all routes. This criterion facilitates the logistics of cycling practitioners and improves the support services to the activities, since a central support infrastructure is identified (Municipal Sports Stadium), with bathrooms, changing rooms, Bikestation (washing and workshop), electric current, internet, car parking, café-bar, and an employee permanently on site, between 9 h and 21 h and an information panel with all the necessary information for practitioners to do their activity in a comfortable and safe way. From a technical point of view, the cycling routes in their different aspects, present a diversified and adequate offer, as to the technical level of

riding, level of physical condition necessary and level of effort required. From a more accessible level, for beginners, to a more demanding level for experienced riders. However, if there is a possibility in the future, to expand the number of routes, it is recommended a greater bet of RC routes, in the levels of easy and moderate difficulty, in order to attract a greater number of practitioners and tourists cycling, as it happens in other parts of the country (FPC, 2022). As for the expansion of MTB routes, the intermediate level routes (moderate and difficult) should be valued, with greater investment in fun areas, with obstacles, trails, jumps, since the type of MTB practitioners value these aspects. However, according to the recommendations of IMBA (2022), it is necessary to plan this type of work well, in terms of construction, improvement and preservation of trails, in order to find the best solutions.

The cross-referencing of the data collected, through the various

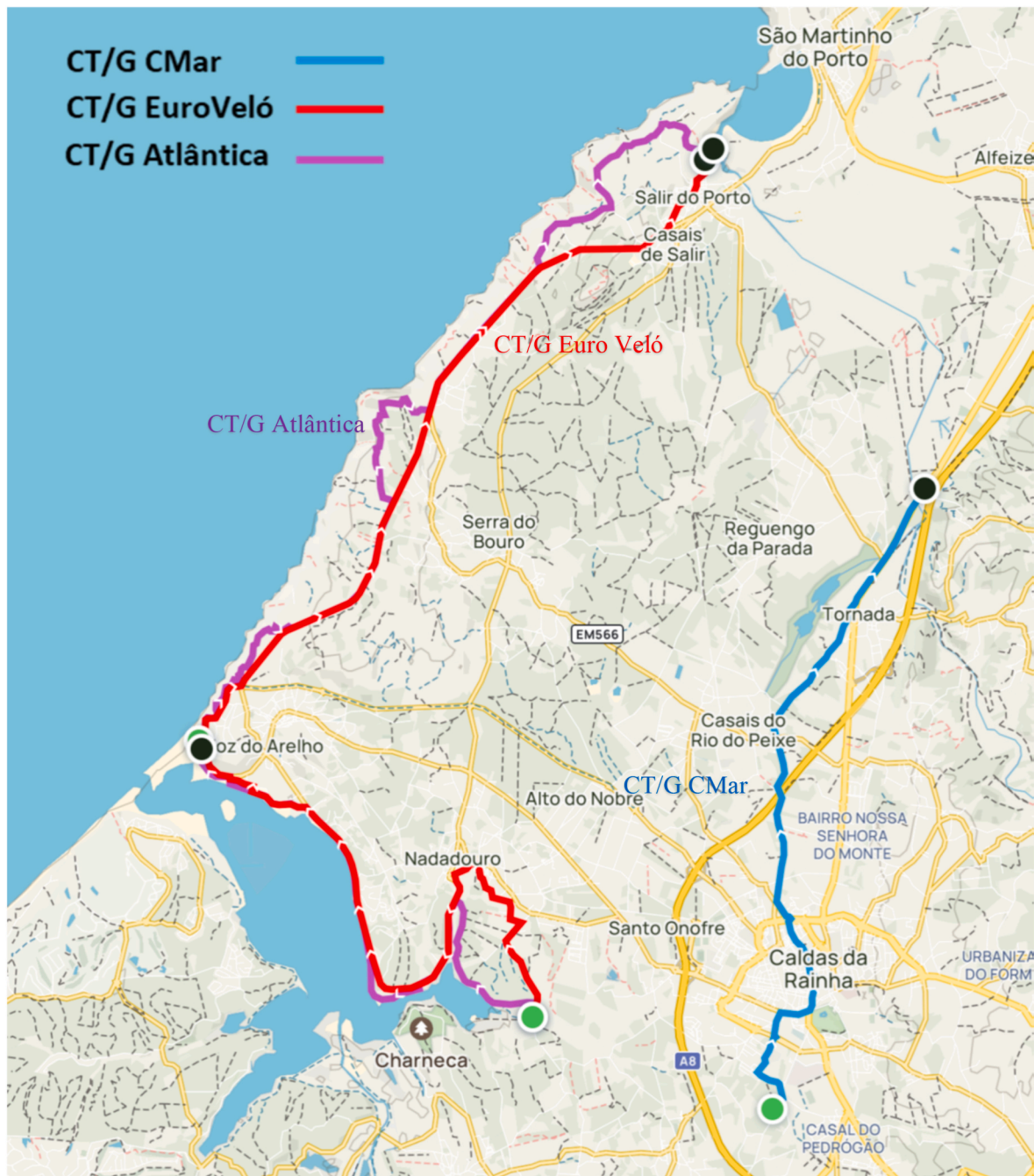


Fig. 5. Cyclotourism/Gravel routes map. Source: Own production using AllTrails®.

moments of assessment (office and field), and the broad participation of the community were very positive aspects of this project, allowing us to accurately identify the critical points of each route, danger zones, steep descents, potholes, obstacles, tight turns, fun zones, jumps, single tracks and the various POIs as was also concluded by the work of [Silva et al. \(2021\)](#). However, other useful points can also be added, such as supply and eating places, cycling stores (for sales, maintenance and rental equipment), pharmacies, health center, fire department and local police, since these parameters, according to the results of [Mundet et al. \(2022\)](#), are important features to be considered in cycling routes planning. The road types are appropriate for the different route networks, with dirt roads and trails in MTB, with good quality asphalt roads for RC, and mixed road surfaces between secondary roads and dirt roads for CT/G. Some of the cycling routes, MTB 2, MTB 3, RC 1, RC 2, RC 6,

CT/G-Eurovelo, and CT/G-Atlantic, use segments of the city's existing cycleways. Enhancing the use of cycleways is an important factor for the development of populations, especially children, making them more active and healthier ([Roth et al., 2012](#)). A variety of landscapes can also be observed along the different routes, combining rural, urban, mountainous, and coastal areas, which proves to be an important factor for the diversity of the experience, as well as a significant motivational element associated with the contemplation and appreciation of the scenery ([Watthanaklang et al., 2016](#)). The georeferencing work produced and made available demonstrates that there was the necessary rigor and quality in terms of planning and design of the project. The current trends of supply and demand for this type of products ([ATTA, 2017](#)), necessarily implies a systematized organization of information, with the ability to promote the respective products and services in the area,

Table 7
Number of georeferenced POI on each cycling route, by parish.

Parish	MTB 1	MTB 2	MTB 3	MTB 4	RC 1	RC 2	RC 3	RC 4	RC 5	RC 6	CT/GCMar	CT/G EuroVelo	CT/G Atlântic
ADF	0	0	0	0	0	0	0	0	0	2	0	0	0
ALV	0	0	0	0	0	0	0	1	1	1	0	0	0
CB	0	0	0	0	0	0	0	0	0	3	0	0	0
FA	0	5	7	2	2	0	1	1	0	5	0	6	7
L	0	0	0	0	0	0	0	0	0	1	0	0	0
N	1	3	3	0	3	0	0	0	0	5	0	5	4
PCG	0	0	0	3	0	4	4	4	4	4	2	0	0
SM	0	0	0	0	0	1	0	1	0	1	0	0	0
SC	0	0	0	0	0	0	0	0	0	1	0	0	0
OSB	1	1	1	5	1	2	4	2	1	2	2	0	0
TSP	1	1	1	5	0	2	1	3	1	4	2	2	6
V	0	0	0	0	0	0	0	1	1	1	0	0	0
T=	3	10	12	15	6	9	10	13	8	30	6	13	17
N°Freg	3	4	4	4	3	4	5	7	5	12	3	3	3

Legend: A-dos-Francos (ADF), Alvorninha (ALV), Carvalhal Benfeito (CB), Foz do Arelho (FA), Landal (L), Nadadouro (N), Nossa Senhora Pópulo, Coto e São Gregório (PCG), Salir de Matos (SM), Santa Catarina (SC), Santo Onofre e Serra do Bouro (OSB), Tornada e Salir do Porto (TSP), Vidais (V).

Source: own elaboration

Table 8
- Distribution of routes (kms) in the territory by parish.

ROUTES	Distance		Parishes												
	km	Sub T (km)	ADF	ALV	CB	FA	L	N	PCG	SM	SC	OSB	TSP	V	
MTB 1	14,00	156,50						3,00				6,00	5,00		
MTB 2	27,80					8,00		7,80				8,00	4,00		
MTB 3	45,00					5,00		11,00				19,00	10,00		
MTB 4	69,70				5,00	10,00		11,40	8,00	7,00		15,00	13,30		
RC 1	24,10	320,50				7,00		7,10	4,00			6,00			
RC 2	33,70								11,00			11,70	11,00		
RC 3	37,00								9,00	8,00		10,00	10,00		
RC 4	60,30			6,00	5,00	5,00		4,10	8,00	8,00		11,20	10,00	3,00	
RC 5	66,20			12,00	8,00		3,10		6,10	8,00		10,00	11,00	8,00	
RC 6	99,20		7,00	9,00	12,00	4,00	5,40	10,80	13,00	8,00	8,00	7,00	11,00	4,00	
CT/G CMar	9,60	51,80										5,60	4,00		
GC/G EuroVelo	19,40								10,00			9,40			
CT/G Atlantica	22,80					5,00		5,00				7,80	5,00		
	528,80	528,80	7,00	27,00	30,00	44,00	8,50	60,20	69,10	39,00	8,00	126,70	94,30	15,00	

Source: own elaboration.

attracting more users, visitors and tourists in this niche market, increasingly demanding from the point of view of comfort and ease of access to all information.

The distribution of routes in the territory favors the coastal parishes bordering the Óbidos Lagoon, due to the specificity of the natural heritage and landscape, presenting in turn, a greater number of POIs. This aspect should deserve everyone’s attention, since we are dealing with sensitive ecosystems. In this case, according to [Rosenberg et al. \(2021\)](#), guides should have a decisive role and an exemplary conduct, regarding environmental issues, so that their clients can follow their guidelines and behavior. This is also an opportunity to promote citizenship, aimed at the sustainability of the territory. On the other hand, the proximity to the city’s sports center, where the Cycling Center headquarters is located, and the impact of its historical hull, also influenced the selection of many itineraries of the respective routes. Here the POIs related to the built, historical and cultural heritage predominate.

The design of the various routes allows the visit to numerous POIs, and the passage through all the parishes of the territory, with greater emphasis on the routes on the coastal strip.

All the information is organized in digital files, in different formats, allowing those in charge to develop, correct and improve each of the routes and their networks, at any time and whenever justified. According to [Calvey et al. \(2015\)](#), this type of project is never completely finished, because it must allow a constant update of information, for the

benefit, comfort, satisfaction and safety of its users ([Koh & Wong, 2013](#)).

The technology used at the service of this project proved to be innovative and effective. Several technological resources of reference in the sector were used, GPS devices, software on online platforms, and specific applications to record physical and sporting performance in cycling activities. In methodological terms, data were collected at different moments and in different assessment contexts, in order to confirm the final assessment of the routes under study. In fact, the assessment of sport infrastructures and spaces in outdoor activities is an emerging need, when we intend to provide safe and quality sport practice conditions to users. On the other hand, the trend to increase the use of new technologies is a reality also in this sports sector ([Ewert & Sibthopr, 2014](#)). With a platform integration, adventure travel and outdoor recreation companies can grow or change their technology solutions in an effective and affordable way as their business grows and changes ([ATTA, 2021](#)).

The approach pursued in this study can support and enrich the policy decision-making process because it is based on a global view of the territory but also because is developed with the territory stakeholders utilizing high-quality and rigorous technology for assessing the diverse profiles of consumers.

6. Conclusions

Considering the outlined objective and starting from the initial assumption that this territory has high development potential in sports, recreational, and tourism areas, 13 routes were assessed using an innovative methodology. Data triangulation was employed, supported by technological resources of reference for cycling activities and by an important consultation process conducted with key stakeholders in the region, which proved to be highly significant. Not only are they the most knowledgeable about their territory, but their active participation also fosters a sense of engagement and ownership in the project.

A total of 528.8 km of routes, divided into three cycling networks, were assessed, and the results of this assessment were presented in a detailed and extensive manner. This allowed us to conclude that the project for the development of cycling in the Caldas da Rainha was well-planned, designed and structured, respecting the regulatory requirements of the FPC (2020). It presents a good quality and diversity of cycling routes, organized in different levels of technical difficulty and physical effort, allowing each user to choose a route according to their objectives, while also considering user satisfaction (Calvey et al., 2015; Koh & Wong, 2013). It also exhibits a balance considering the presence of points of interest (POIs), and provides comprehensive coverage across the entire territory of Caldas da Rainha Municipality.

The results of this work should be shared with the Municipality, enabling them to gain valuable insights of their project from a technical and scientific perspective. This privileged information should be utilized to support decision-making when defining strategies and measures for the development of cycling in both natural and urban territory, in agreement with Ilies, Herman, Dehoorne, and Maduta (2013), and contribute to the improvement of the quality of life of the populations.

7. Limitations and future directions

Considering that no studies with validated instruments were found for this purpose, it was decided to adopt a new methodological approach to evaluate cycling routes. Several technological tools already used by thousands of practitioners, were tested, but they needed to be tested in a systematic and larger-scale manner to increase consistency and validate the respective evaluation instruments for future research. The inclusion of stakeholders in this process was also a new methodological approach, since there are no established habits of cooperative work in this type of case. However, the involvement of a limited number of stakeholders was a limitation in this study. It is essential to have broad participation, which aims to bring benefits and generate consensus, but also presented greater difficulties in the methodological process, particularly in terms of obtaining assertive, quality and scientific contributions.

For the future, it is important for this methodology to be tested in other geographical contexts, not only for evaluating existing resources but also for the development of new sports facilities of this nature. Furthermore, it is essential to instill a culture of monitoring usage within the managing entities. Only through this approach can aspects related to usage, including user satisfaction, be comprehensively understood. In a next phase, to create a comprehensive end-to-end methodology, it is important to incorporate processes for analyzing satisfaction, user profiles, and route governance and management, as for example, including aspects related to maintenance.

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Credit author statement

Luís Carvalho: Conceptualization, Methodology, Validation, Formal analysis, Supervision.

Elsa Pereira: Methodology, Validation, Investigation and writing review.

Rosana Durão: Translation.

Paulo Rosa: Conceptualization, Investigation and writing review, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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