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The perspective of cyclists on current practices with digital tools and envisioned services for urban cycling

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Abstract. As cycling becomes increasingly important in sustainable mobility policies, there is also an urge for new digital applications and services for urban cycling. This new generation of cycling applications should be able to connect cyclists with their local cycling ecosystem, promote cycling, and empower cyclists to become active agents of urban mobility. In this work, we aim to explore the new opportunity space of digital tools and applications designed specifically for urban cycling. We pursue this goal by trying to uncover current practices associated with digital tools that are already available and also by trying to uncover new information needs, even those that cyclists are not yet able to fully express. To explore these topics, we conducted 2 focus group sessions and 10 interviews with cyclists. The result is a set of design opportunities for the development of new applications, tools and methods for improving the cycling experience in the context of urban mobility. We expect this contribution might help to better define the design space of innovative digital tools for urban cyclists.

Keywords: Digital Practices, Cycling, User Research

1 Introduction

Cycling is assuming an increasing role in sustainable mobility policies. Leading cities and central governments all over the world are making significant investments to bring cycling, and other micro-mobility modes, to the forefront of their mobility strategies. This transition is being fuelled by a combination of sustainability [1, 2], public health [3, 4], urban life [5] and economic [6, 7] agendas. It is also happening in a context of major technology trends and new mobility paradigms, such as shared, electric, and connected bicycles, which are reshaping our perception of bicycles as a core element of urban mobility.

This disruptive change is strongly driven by the increasingly pervasive presence of digital platforms and mobile applications in cycling systems, which is likely to become

a decisive element for the success of cycling as a modern urban mobility mode. Smartphones are already playing a key role in these new connected cycling paradigms, especially in bike sharing systems. They can be a valuable resource for cyclists, and a plethora of mobile applications is now available to offer cyclists a diverse set of services. They explore the huge convenience associated with the immediate availability of advanced interaction, computation, communication, positioning and sensing capabilities, and also their unique capability to scale deployment of new applications.

However, current applications are mainly conceived for the cyclist as an individual (e.g. quantified self) and for cycling as a leisure or sports activity (e.g. performance goals). They do not usually consider the role of cyclists as agents of urban mobility, or the role of cycling as being primarily a mobility mode to just reach a destination as safely, smoothly and efficiently as possible.

Urban cycling calls for a new generation of cycling applications and tools, designed to connect cyclists with their local cycling ecosystem, to promote cycling, to provide safe paths, and to empower cyclists to be active on mobility policies, by expressing their preferences, report problems, get together with other fellow cyclists, or simply share their route to feed local mobility services. While many of the features from current applications may also migrate to urban cycling tools, a design mindset focused on urban cycling would certainly call for new specific features or redesigned versions of existing ones.

1.1 Objectives

In this work, we aim to explore the new opportunity space of digital tools and applications designed specifically for urban cycling. We pursue this goal through two complementary paths. The first path explores in more detail what is already available, and the emerging practices associated with digital tools. This path is particularly relevant to identify elements that may be appropriated by urban cycling, in their current form or with only minor adjustments. It may also enable us to identify ways in which people use technology that was not primarily designed for that purpose. Such cases may provide alternative mindsets throughout the design process [8].

The second path is to uncover new information needs, even when cyclists are not able to fully express them. Some of these are not supported by current tools and might correspond to the more utilitarian perspectives of cycling as an urban mobility mode. The result is a set of design opportunities for the development of new applications, tools and methods for improving the cycling experience in the context of urban mobility.

2 Related Work

In recent years, cycling and other soft mobility modes are being increasingly recognized as a key element for sustainable mobility policies of the future [9]. At the same time, bicycle technology has improved significantly and is now much more capable of offering quality solutions to different cyclists profiles [10].

Smartphones are a powerful tool for large-scale data collection [11]. They already integrate a very vast range of sensors, enabling the collection of substantial data about people and their movements. Using data provided by urban cyclists through the smartphone sensors can enable the generation of collective knowledge to improve the quality of cycling mobility. BeCity [12] is an example of a mobile application that allows riders to share their tracks and comments, working as a distributed data collection system. It also includes the ability to recommend routes, considering factors such as distance, presence of bike paths and even the attractiveness of those paths. Another example is the BikeNet, a mobile application that gathers data about the rides to provide cyclists with a general perspective of their experience and performance. This system is able to obtain information about the environment and the entire experience along the way, such as pollution levels, noise and floor condition [13].

Meireles and Ribeiro [14] explored the use of digital platforms and smartphone applications as fundamental behavioral change tools that may help to promote the growth of the bicycle as a main means of transport, especially for mid-sized starter cycling cities. Based on a survey targeting cyclists, the authors concluded that even though most cyclists (77%) used at least one cycling application, there is a lack of digital solutions to promote cycling. This is also suggested by the fact that most respondents used generic cycling apps such as Strava (39 %), mainly to track their daily bicycle trips, and Google Maps (51 %), mainly for navigation. Regarding what could be added to a cycling application or platform, cyclists referred a compilation of features of already existing solutions, and their integration into a single platform.

3 Method

To expand our knowledge on the perspective of cyclists regarding digital services, we conducted focus groups and individual interviews. Next, for each method, the participants and procedure are described.

3.1 Focus Groups

A total of 10 participants (all men) aged between 24 and 59 years (M = 36.20, SD = 10.82) participated in the focus-group sessions, divided into two groups of 5. Participants were internally recruited BOSCH employees at Braga, Portugal, and the only criteria to participate in the focus group was to own and ride a bicycle (n = 9) or a standing scooter (n = 1). Two cyclists used the bicycle only to commute, 4 used it for leisure and 4 used in both contexts. For most participants (n = 6), rides usually take less than one hour.

Both focus groups explored: (1) the experience of riding a bicycle and (2) the use of digital technologies for cycling. On each focus group, there was a moderator and a note-taker. At the beginning of each session, we explained that the objective of the focus group was to gather information about the current practices and needs of cyclists and that there were no right or wrong answers. We explained that the session was going to

be recorded and that all video and audiotapes were confidential and would only be used by researchers of the project. After that, all participants signed an informed consent. The moderator started the session following the script. The sessions took 60 to 90 minutes.

3.2 Interviews

A total of 10 participants (7 men and 3 women) aged between 23 and 53 years (M = 35.70, SD = 8.96) were interviewed. For recruitment, we used LinkedIn and Facebook, and those interested were contacted. All except one cyclist used the bicycle to commute, and for those, the rides were usually short, taking less than one hour.
The interviews were semi-structured and focused on several topics including (1) the use of digital technologies for cycling, and (2) the ideal mobile application for urban cyclists.

The interviews were online and were image and sound recorded with Zoom recording tools, for later analysis. To start the interview participants were asked some demographic questions, and a verbal consent was made to record the session. After that, the recording started, and the interview script was followed. The interview took approximately 40 minutes.

3.3 Data Analysis

For the focus groups, sessions were transcribed from audio to text and a qualitative content analysis was implemented, where materials with similar meaning were classified into categories [15].

For the interviews, the recordings were listened, and detailed notes and partial transcriptions were made. Similarly to the focus groups, the results for each topic in the interview from all participants were aggregated and summarized. At the end, the results of the focus groups and interviews were aggregated. The analyses were conducted using the qualitative analysis software MAXQDA version 10 [16].

4 Results

After aggregation of the content analysis of both the focus groups and interviews, the following main final themes emerged: (1) Current practices in digital tools, wearables, and sensors, (2) Technological difficulties and needs, and (3) Useful features of a mobile application.

4.1 Current practices in digital tools, wearables, and sensors

One of the themes that emerged from the results of both focus groups and interviews was how cyclists currently use digital tools, wearables and sensors to support the cycling activity. Several cyclists reported using mobile applications and forums or websites related to cycling. The forums and websites (e.g., Reddit, Facebook) are

sporadically used to search for specific information, such as where to buy a bike or how to modify it, to look for trails or information regarding some brands, and to share experiences and doubts. The use of apps, however, is more prevalent and covers more needs. Participants use Strava (to register routes and activities with several statistics), Garmin and TomTom (GPS or smartwatches connected to the smartphone), the iPhone Find My app (to share location with family and friends), Google Maps (to navigate), and Wikiloc and AllTrails (to save, find, and share trails). Cyclists also referred using COBI (from BOSCH), Bike Citizens, See.sense, and a local app to register the routes.

Some of these apps are more suitable for leisure purposes, while others are specifically designed for city riders. For instance, one cyclist uses GARMIN GPS when riding for leisure. The equipment has an associated app that saves information about the route and the physical performance of the cyclist. Also, it provides an indication of when the cyclist should rest. It communicates with social apps such as Facebook, Instagram or Strava, and the cyclist can share routes and photographs, among others.

One of the most commonly used applications, Strava, provides several features that cyclists appreciate: routes for leisure, slope, distance, speed, time, heart rate (when paired with a band or smartwatch), calories burned, and effort. Another referred feature is gamification, which ranks cyclists according to their time in given route segments. Some cyclists like this competitive feature, while others use it more to challenge themselves by setting goals for riding distances, number of days per week, etc.

Google maps is another popular app, especially for navigation. If in a familiar city, cyclists may resort to their memory of the city map to choose the best routes, but when in doubt they resort to Google Maps. Unfortunately, in starter cycling cities such as Portugal, Google Maps is not yet optimized for cyclists. Thus, they select either the "by car" or "by foot" option. The by-foot view may be more appropriate when riding downtown, and the car option may be more useful for longer rides. However, some maps do not even identify the existing cycling paths, so sometimes using google maps is more useful to understand distances and not so much to choose the route:

> P14: *"It is more to know where the places are, not so much to use with the bicycle."*

However, this reality is not true in other countries where cycling mobility is more developed. In these places, Google Maps identifies the bicycle paths, and suggests routes specifically for cyclists, who find them appropriate. Some participants have tested it and report that even though the suggested routes are not always the fastest, they are usually the safest. But how do cyclists follow the route? To learn a new route, cyclists usually try to memorize it (e.g., take the third turn on the left and then the first turn on the right). When in doubt, most cyclists prefer to stop to look at the map and then proceed to the route. Another interesting feature of Google Maps is that it continuously registers the GPS position, and that position can be shared with a family member. Its main advantage is that it is not necessary to turn on the app because this position sharing is automatic.

One of the devices that has several advantages for city riders with an electric bicycle is the COBI system. With this system, the smartphone can be used as a bicycle computer that shows instant speed, allows the rider to take a call, choose a song, etc. It also

communicates and transfers data to other apps, such as Strava, but one of the users reported to not take advantage of this because the routes were almost always the same, and there was no advantage of sharing the data with other apps:

> P15: *"The only interesting thing for us is to know how many Km I rode in a week, how many Km per month, what were the average hours, that is interesting. But with time this all dilutes and … it does not change much."*

Even though sharing the routes for those who always do the same route may not be beneficial for themselves, it can be extremely useful for other cyclists. One of the apps that uses this premise is the Bike Citizens app. This app records the routes, creating a cycling flow city map to show the most used routes. The major benefit of this app is to provide data that may be useful to others:

> P15: *"At the end of the day it feels like volunteer work, that is, I use this application to contribute to route log, because I think that if everyone who uses the bicycle used an application like this, it was possible to see exactly which routes people use and then better plan the routes and serve a larger number of people."*

This app also provides detailed and up-to-date maps that can be purchased or acquired in exchange for points earned by the riding.

Regarding wearables or sensors, cyclists may use smartwatches, heart-rate bands, power banks for the mobile phone, cycling computers such as Nyon (from BOSCH), earphones, and sensors in the bicycle to measure cadence or a barometer to measure altitude. Note, however, that not all cyclists are in favour of technology:

> P13: *"I have some aversion to adhere to some digital tools unless they are really necessary. Regarding the bicycle, no, I never joined."*.

The key reasons why participants justified not using technology are as follows: they are usually designed for leisure cyclists, they are sometimes inaccurate (e.g., google maps not identifying cycling paths), and there is no need because cyclists know their cities and feel they can identify the best routes by themselves. Some cyclists referred that one disadvantage of several apps is the need to turn it on and off manually. However, one of the participants also referred to using an app that could activate automatically, but he preferred to control it manually. Another disadvantage of some apps is the battery consumption and occupying memory. To solve the battery problem, urban cyclists could use their electric bicycle to charge it, or a system could use the cycling activity to charge an external battery. Finally, another hindrance to use some apps is that some useful features are only available when paid.

4.2 Technological difficulties and needs

On several occasions, cyclists refer that there are already several sensors on the market that can be added to the bicycle. However, these are usually expensive and different brands have different sensors for different purposes, so there is a need of integrated solutions that can serve several purposes at once. Participants report that they would

rather have one single economical platform or device that integrates all the sensors and devices, as shown in the following transcripts:

> P10: *"Centralized on something, a single tool or device… I'm not going to buy a sensor, a locator, ... no, the cyclist already spends a lot of money ..."*

> P01: *"But we basically already have it all on the smartphone, but then we need duplication. If there were such a thing, it shouldn't be a cell phone, I don't want to have two… but if I had an interface that communicated with my cell phone… it already has music, the applications, it's everything there, that interface."*

Participants recognise the smartphone as an interesting approach for achieving this type of integration. However, they referred that the impact of mobile phone´s battery can be a huge obstacle. A slightly different alternative would be to use a separate bicycle display to mirror the smartphone, where the information to show could be chosen, but again that would be one more, and possibly expensive, item to acquire. To use the smartphone while on the bicycle, the interaction mode should be adapted and fully compatible with the reality of the riding experience.

A smartphone associated with a sensors pack could enable security, safety, and comfort features. Concerning safety, cyclists would like to have an automatic emergency call in case of an accident. To detect the accident there could be sensors in the bicycle, where a sudden brake followed by inactivity or a decrease pressure in the saddle would trigger the alarm. In terms of security, the bicycle could have a sensor and a locator and only the owner could unlock it; also, in case it was stolen, it would send an alarm. In terms of comfort, the bike sensors could help the cyclist adjust the position of the handlebar and saddle or give tips according to the way the person rides the bicycle.

4.3 Useful features of a mobile application

During the focus groups, cyclists referred several needs and features that could be integrated in a mobile application for urban cycling. Clearly, the most important feature of an app would be a navigation system with tracking. The ideal mobile application for cyclists should also have social features where cyclists could get together and share information. Another suggestion is that this app should integrate several services within the city.

Table 1 shows the main features that cyclists referred as important for an urban cycling mobile app.

Table 1. User needs: Main features for an urban cycling mobile app.

Category	Specific Need (Cyclists need/want/like to …)
Safety	Be seen by drivers.
	Inform others that they are braking or changing direction.
	Receive alerts of dangerous situations.
	Inform their real-time position.
	Quickly inform others in case of an accident.

Security	Be alerted and alert the authorities in case the bicycle is stolen.
Comfort	Get tips on how to adjust the bicycle or increase comfort.
Communication	Communicate within a group while riding. Communicate with others (i.e., share experiences or doubts). Communicate with other entities (e.g., alert a bus driver that a cyclist needs to carry the bicycle in the bus). Communicate with other platforms (e.g., Facebook or Instagram).
HMI Interaction	Interact with the cell phone or other device while riding.
Bicycle status	Tutorials on regular check-ups and minor repairs. Obtain information on the bicycle status, when is electric or has sensors.
Gamification system	Compare cycling metrics across time, and/or with others.
Bike sharing	Have an easy access to a bike sharing platform.
Associations, groups, activities	Find other cyclists and participate in cycling activities.
Navigation system	Plan and choose the route.

Table 2 shows the information that cyclists would like to obtain and share from the navigation system. These information range from utilitarian features, such as indication the route type, to more social features such as media sharing with GPS tracking.

Table 2. User needs: Types of information to be provided by a navigation map.

Navigation Category	Details
Route planner	Select a predefined route or draw route passing by specific places.
Road type	E.g., pedestrian zone, cycling path, inside a park, etc.
Road condition	E.g., holes or pavement in bad condition.
Type of pavement	E.g., tar floor, cobblestone, etc.
Type of traffic flow	E.g., shared with other vehicles? One way vs. two way?
Traffic	Suggest routes to avoid traffic. Provide the average speed of vehicles.
Frequency of use of roads	Indicate the traffic flow of cyclists. Consider those frequencies, when suggesting a route. Share that information with the City Hall.
Safety alerts	Static dangers (e.g., dangerous crossings) and dynamic dangers (e.g., approaching vehicle).
Weather	Indicate the weather along the route. Route suggestion depending on the weather.
Location of interest points and shops.	E.g., drinking fountains, viewpoints, workshops, restaurants, cafes, diet and health food stores, and highlight the bike-friendly shops (i.e., with parking or discounts for those arriving by bike).
Suggestion of places or things to do	Suggest places (e.g., museum) or things to do (e.g., a theatre play) along the route or in specific locations.
Location of parking and resting zones.	Location of parking with the type of parking (bike racks, bike lockers, covered parking, etc.). Location of benches or resting zones.

Estimated time of arrival and distance	Provide several route options with their distance and estimated duration.
Media sharing	Share photos, videos or other contents associated with a geographic place or route/track (share with everyone or with a close group).

Concerning routes, these could be ranked from 1 to 5 according to: how cyclable they are, beauty, effort, satisfaction, slope, difficulty, distance. Also, they could be categorized according to the type of route (e.g., leisure, sports, and daily use). After following a route, cyclists would like to know: total duration, calories burned, see the route on the map, and CO2 consumption if the route was made by car. Importantly, all these suggestions should be up-to-date and change according to the person's location.

5 Conclusion

In this research, we have studied how current practices with existing digital tools and specific needs expressed by cyclists may inform the design of a new class of cycling tools and applications to address the broader challenges of urban cycling. Based on the results generated from two focus groups sessions and 10 subsequent interviews with cyclists, we identified three main themes: Current practices with digital tools, wearables and sensors; technological difficulties and needs; and useful features of a mobile application. For each of these themes, we presented several insights that summarize the key topics expressed by cyclists, which constitute the main contribution of this work to inform the design of new cycling tools and applications.

Beyond those insights, there is one major issue that deserves some discussion. In this study, cyclists seemed to be very willing to identify and describe ideas for improving the applications and tools they know. This seems to suggest that there might be much space for evolution in these digital tools for cycling. However, most of the features suggested, either explicitly or implicitly, seem to be somewhat incremental, and do not necessarily fit very much into what might be a new class of tools and applications. Whether this represents a general satisfaction with current applications or it is just that those prevailing applications are already shaping our perception and our expectations of what a cycling application should be is a question that remains to be answered.

As future work, we plan to explore the development and evaluation of new digital tools for urban cyclists. We expect that a different set of design principles may help to satisfy and exceed currently envisioned needs and enable digital tools and applications to assume their role as a key enabler for urban cycling.

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