Article

Evaluation of a New Urban Cycling Infrastructure in Caceres (Spain)

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Abstract: The purpose of the research is the evaluation of the impact of a new bike lane network built in Cáceres (Spain) in October 2019, a city with a weak tradition in the use of bicycles. Prior to the new project, the percentage of displacement by bicycle was under 0.2% (by contrast, private cars was 56%). The project has introduced a real network in 33 new streets and avenues, and 250 new parking places for bicycles. The impact has been evaluated by two online surveys, one conducted in November–December 2019 just after the inauguration, and the other conducted in January–February 2020. For that, the impact evolution after the first 3 months has also been evaluated. The result allows to analyze the citizens' response to the new infrastructure; the main conclusion is that the effect of the built infrastructure is clearly positive in terms of new users, new potential users, and bike general image for the citizens. Moreover, this positive effect has grown after the first 3 months.

Keywords: bicycle network; surveys; new infrastructure; planning; mid-size city

1. Introduction

Urban cycling has been gaining significant political and public support in Spanish cities in recent years. Policies and new projects have been introduced to increase the number of bike lanes, in order to change the traditional urban mobility paradigm, which has been car-centric for decades.

The situation was very different a few years ago. Even though the advantages of using the bicycle as a means of urban transport are well known in the subjects of environment or improving health, to mention only a few [1–3], Spain has traditionally shown strong resistance to accepting the bike as an urban vehicle. For instance, the Special Eurobarometer on Attitudes of Europeans towards urban mobility [4] questioned "How often do you cycle?": Spain was in the last position (only ahead Cyprus and Malta), with only 4% the citizens using a bicycle everyday (far from 43% of Netherland, and from 12% of the EU28), and 73% the citizens who did not use anytime (50% in the whole EU28). Moreover, in the Special Eurobarometer on Quality of Transport [5], to the question "On a typical day, which mode of transport do you use most often?", bicycle was the answer chosen by 8% of the EU28 citizens, while in Spain this figure was 3%, far from Netherlands (36%), Denmark (23%) or Hungary (22%).

However, the reports from the Observatory of urban mobility [6] show a significant increase of bicycle facilities built in Spanish cities (Table 1): Seville was the first big city in working on these policies, after the 2007 municipal Bicycle Plan for Seville [7]; while bicycle facilities in Madrid, Barcelona, and Alicante have risen since 2012. The cases of Malaga, Granada, and Tarragona prove that some other cities are still reticent about constructing a cycling infrastructure in their streets.

One of the most important questions is the impact these new infrastructures have on generating new users. Several studies [8,9] have shown a clear correlation between the number of cycling facilities provided and the percentage of people that use the bicycle for commuting. It has been reported that "if bicycling is to be a viable mode of transportation, it must have appropriate facilities" [10].

Table 1. Bicycle lanes length in metropolitan capitals (km), and density (km bicycle lanes/million inhabitants). The expression "bicycle lane" covers all types of lanes conceived for bikes, including shared roadways.

	2008	2010	2012	2014	2016	2018	% Increase
Madrid							
Length (km)	151	151	290	447	590	601	298%
Density (km bicycle lanes/million inhabitants)	47	46	90	88	186	186	296%
Barcelona							
Length (km)	140	159	187	558	1167	1468	949%
Density (km bicycle lanes/million inhabitants)	87	98	115	-	725	906	941%
Valencia							
Length (km)	80	139	137	168	168	175	119%
Density (km bicycle lanes/million inhabitants)	99	171	172	174	212	220	122%
Sevilla							
Length (km)	147	147	136	136	166	166	13%
Density (km bicycle lanes/million inhabitants)	210	209	194	195	240	241	15%
Málaga							
Length (km)	25	30	35	-	35	44	76%
Density (km bicycle lanes/million inhabitants)	44	53	62	-	62	77	75%
Granada							
Length (km)	9	9	9	27	27	27	200%
Density (km bicycle lanes/million inhabitants	38	38	38	116	115	117	208%
Alicante							
Length (km)	23	41	111	155	155	174	657%
Density (km bicycle lanes/million inhabitants)	69	122	332	-	469	522	657%
Tarragona							
Length (km)	-	6	10	11	13	14	133%
Density (km bicycle lanes/million inhabitants	-	42	75	76	91	99	136%

Source: Observatory of urban mobility [6].

Some studies have also demonstrated the reluctance of countries with less cycling culture to accept new bike infrastructures than countries with a longer cycling tradition [11,12], and the need for local authorities to create a cycling-friendly culture to encourage its use by citizens [13].

Another idea merges from other studies: the importance of safety over other parameters like time travel or surface quality for cyclist [14,15]. Safety has been directly linked to good facilities [16,17], and also to respect from other users: car drivers. Some studies have detected problems due to drivers who don't know how to drive safely near bicycles [18,19]. It is clear that if motorists or car drivers do not have previous experience with bikers, the respect to bikers will only emerge after some time sharing the streets.

This implies that most of potential users will not ride their bike until a bicycle infrastructure has been built and until drivers have become aware that there is a new user in the streets who must be respected. It is also known that those who usually ride bicycles feel safer than new users [20], so the lack of safety is a dissuading factor for the use of bicycles in cities without a cycling tradition.

Therefore, during a time, cyclists will make little use of the new bicycle infrastructure, which will be very underused during the first months. This reality could even dissuade

government administrations from making such investments, which may at first not be well understood by the traditionally car-centered citizenship.

Thus, it would be of interest to know the evolution of acceptance of a new infrastructure during the first months after it has been put into service in a city with no previous cycling culture, which is the case of most Spanish cities. Some before–after studies have been developed concerning the implementation of bike sharing schemes [21–23], and an excellent review was recently made by Mölenberg et al. [24], with an evaluation of 31 studies extracted from 125 full-text articles; although there are a wide range of experiences analyzed, none of them cover the evolution of the acceptance during the first 6 months and/or examines the case of a whole new cycling network in the city with no previous cycling culture. As an example, Vasilev et al. [25] launched a survey for a research on a new infrastructure around a year after the changes took place, and Goodman et al. [26] evaluated the impacts after the first and the second year of commissioning; moreover, a huge number of studies evaluated the impact of singular new infrastructures (a new bridge for bicycles and pedestrians [27], a street intervention [28], a new cycleway [25,29]), but to our knowledge, the case of a whole new infrastructure is yet to be researched. Hence, this study pretends to cover this gap.

Hence, the aim of the research is to evaluate the early impact of the construction of the very first cycling infrastructure network in an underdeveloped city in terms of bicycle infrastructures. Cáceres, a Spanish city which previously had hardly anything conceived for bicycles, in which a new bicycle infrastructure was constructed in 2019, has therefore been taken as the study case. At the end of construction, a first public survey was taken to find out its impact, and 6 months later a second one.

2. Materials and Methods

The method of study was to take two surveys after the new infrastructure was put into use. The first survey was taken 2 months after construction, and the second, 3 months from the first (Figure 1). This was intended to find out the impact of construction of the new cyclist infrastructure in Cáceres and also the extent of its acceptance a few months after opening. Data collected with surveys provide essential information for traffic planners, public transport providers, infrastructure authorities, and transportation scientists; the survey methodology is used for studies on bicycles in many cases [30–32].
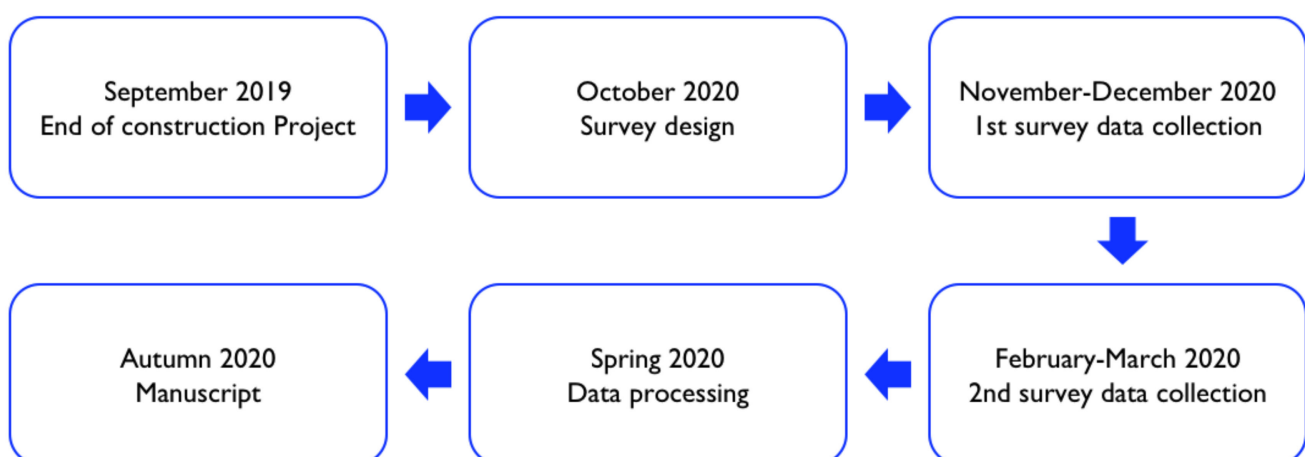

Figure 1. Data flow diagram, describing the timing and the methodological steps.

2.1. Description of the Case Study

Cáceres is a small provincial capital in Spain with no cycling tradition. It has a classic European urban structure, with a walled historic city center, originally Roman and Moorish, today a World Heritage site, and entirely zoned for pedestrians only. City development

mostly began in the 20th century, and today has a wide area of expansion with successive enlargements, a series of peripheral neighborhoods that have grown up following the suburban model, and some single-family housing developments on the outskirts [33]. In general, it is a compact city with streets and avenues, with well-defined parks, and sidewalks that are not very wide with some exceptions (4.2 m wide in the remodeled Av. Virgen de Guadalupe). According to 2019 data, the city population is 96,720 [34].

In Cáceres, the summers are short, hot, dry, and mostly clear, and the winters are cold and partly cloudy. Over the course of the year, the temperature typically varies from 1 °C to 34 °C and is rarely below −4 °C or above 38 °C. The wetter season lasts 8.2 months, from 19 September to 26 May, with a greater than 14% chance of a given day being a wet day. The chance of a wet day peaks at 26% on 30 October. The drier season lasts 3.8 months, from 26 May to 19 September. The smallest chance of a wet day is 1% on 30 July. Wet days are differentiated between those with rain alone, snow alone, or a mixture of the two. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 26% on 30 October [35].

In 2004, a bicycle lane was built in the outskirts along a bypass, and some streets with parking spots for bikes were usually empty. However, less than 0.14% of daily travel was by bicycle in 2014 according to the PIMUS Urban Mobility Plan PIMUS [36], despite its Mediterranean climate and its relatively good orography in the expanded part of the city and in the south (somewhat more complicated than in the north). The PIMUS states that "there is no reason for the scant use of bicycles", also emphasizing the scant effect of parameters such as the urban structure, gender or the demographic pyramid on people's willingness to use bikes.

In 2019, from July to September, a project drafted the year before, which introduced a connected enmeshed bicycle network along with other elements for cyclists, was constructed in the city (Figure 2). The budget was 143,250 €, and the main facilities were (Figure 3):

- Bike passes in the main junctions
- Segregated bike lanes in some roundabouts
- Desire lanes making it possible to go between streets that are close to each other, but poorly connected
- Introduction of slow streets: shared roadway with speed limited to 20 km/h, and with a bike-friendly road bump each 300 m
- New bicycle lanes in some points
- Installation of 250 bicycle parking points
- Shared roadway net open to both bicycle and motor vehicle travel (30 km/hr. speed limit and bicycle signs)

Although the project was modified (it included also a segregated cycle light signal in some traffic lights, for instance), the constructed facilities conserved the main objectives of the original proposal.

2.2. Procedure

A survey was designed as an online questionnaire; this modality has been proved to be as good as telephone or direct surveys [37,38] and is regularly employed by scholars and planners [39–41]. The target group included people who lives in Cáceres or regularly visit the city, as many people do not live there each working day. Questions are reflected in Table 2.

The first survey was conducted between 11 November and 13 December 2019. Respondents were invited to participate using different tools: Facebook groups, Twitter, and also posters; moreover, different email invitations were sent to most of the associations listed in the municipality web page. The second survey was conducted between 16 February and 25 March 2020; the questionnaire's link was disseminated through the same channels, with the clear warning of being the second part of a previous survey. For that, respondent of the first survey could answer the second one, too.
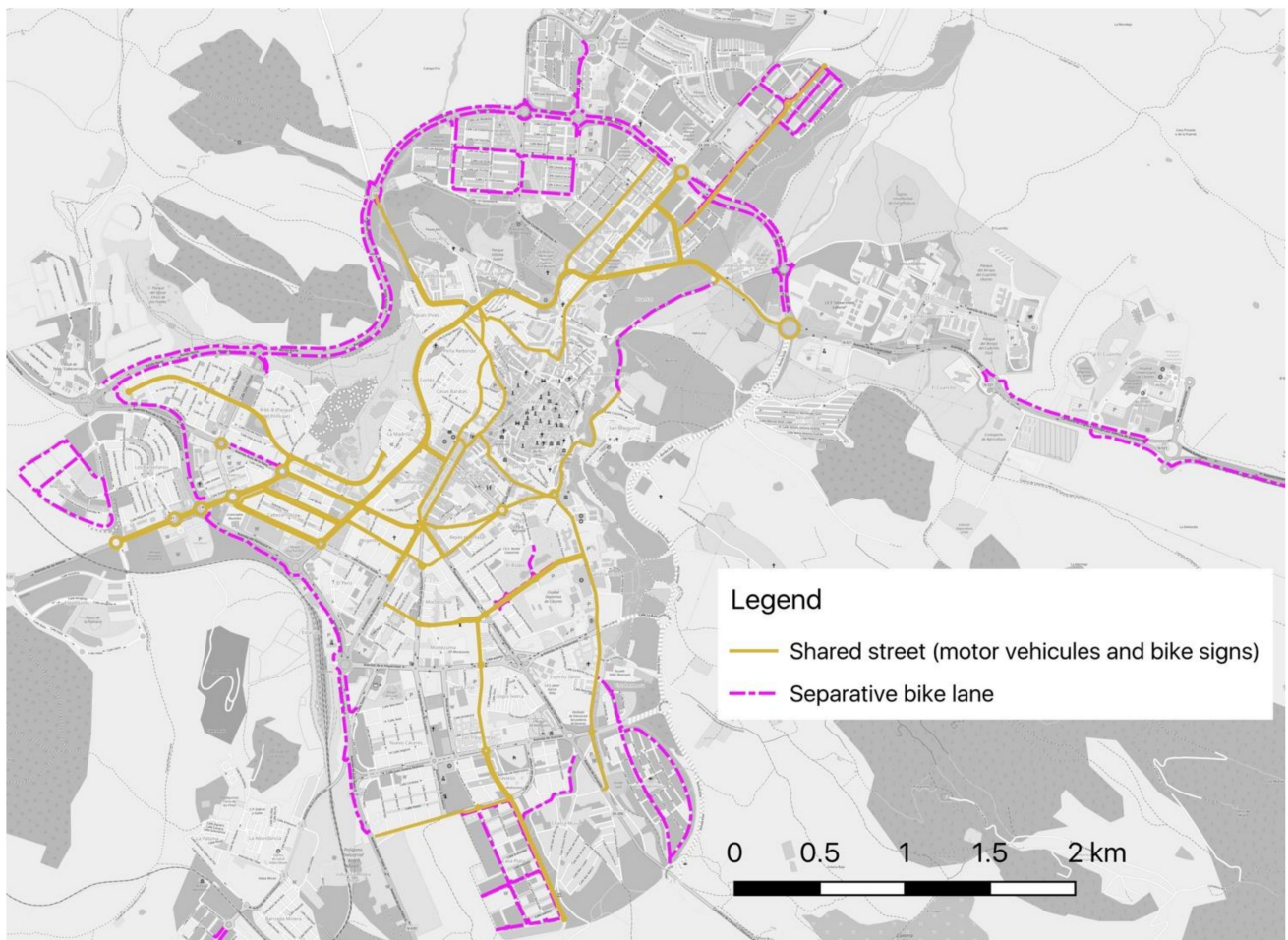
Figure 2. Current bike lane network in Cáceres. All the shared streets and some new segregated bike lanes are part of the new project. Source: developed by the authors, QGIS and OpenStreetMap were used for the geographical background design.

2.3. Sampling

From the first survey, a total of 407 responses were obtained, 196 being the number of responses obtained from the second wave (Table 3). Respondents who did not answer the second question or under 16 years old were removed, as they are not allowed to ride a bicycle without supervision; those who did not answer the third question were also removed from the sample, as the most relevant background characteristic was not. As a result of the above criteria, 374 valid responses remained in the first survey, and 167 in the second one. The people surveyed were aged 16–70 in the first round and 19–71 in the second survey.

The margin of error can be calculated according to the following formula:

$$n = \frac{N \cdot z_{\frac{\alpha}{2}}^2 \cdot p \cdot (1 - p)}{e^2 \cdot (N - 1) + z_{\frac{\alpha}{2}}^2 \cdot p \cdot (1 - p)}$$

The values to be set are population size $N = 81,507$ (people over 15 years old living in Cáceres); sample sizes $n = 374$ and $n = 167$, with $p = 0.5$. Considering the normal distribution, value $z_{\frac{\alpha}{2}} = 1.96$ is set for a confidence level $(1 - \alpha) = 95\%$. Therewith, the margin of error is $e = \pm5.06\%$ for the first survey and $e = \pm7.58\%$ for the second one.

Facility	Picture	Facility	Picture
Bike passes in the main junctions		New bicycle lanes in some points	
Separative bike lanes in some roundabouts		Installation of 250 bicycle parking points	
Construction of a bike pass in a desire lane		Shared roadway net open to both bicycle and motor vehicle travel (30 km/hr speed limit)	
Introduction of slow streets			

Figure 3. Facilities built in Cáceres (photographs by David Asunción).

Table 2. Questions and answers.

Questions	Possible Answers
Gender	Women; Men
Age	Open
You live in the city...	Every day; Working days; Weekends; Some weekends, to visit family and Friends; Some working days each month
Have you ridden a bicycle for some new reason in recent weeks due to the new bicycle facilities?	Yes; No
If you have to choose between these new bike infrastructures, which one has been the most positive?	Segregated bike lanes in some roundabouts; New shared roadway net open to both bicycle and motor vehicle travel; Installation of new bicycle parking points; New segregated bike lane in Ronda Vadillo; Bike passes in the main junctions; None of them
Do you think that new bicycle facilities projects promote travel by bicycle?	Yes; No; Maybe
You think that investing in bicycle infrastructure in Cáceres is: (you can answer simultaneously up to three possible options)	Recommended; Important; Necessary; Positive; Innovator; Absurd; Excessive; Unnecessary; Premature
In Cáceres, in your opinion, what further steps should be taken by government administration, concerning bike or VMP mobility? (you can answer simultaneously several choices)	It is enough; Increase the number of bike passes at stoplights; Increase segregated bike lanes, even reducing parking slots or car lanes; Increase bicycle parking points; Increase shared lanes open to both bicycle and motor vehicles; Implement an electric bicycle rental service; Eliminate one of the parking lanes in Av. España and include a segregated bike path; Allow bicycles on urban buses; Subsidize the purchase of electric bicycles and electric scooters; Other . . .
In your opinion, has the new bicycle infrastructure increased traffic safety for bikes in Cáceres?	Quite, the difference is appreciable; A lot, it has changed noticeably; Nothing; A little, although much remains to be done.

Source: the authors.

Table 3. Respondents by gender and age, and comparison to real population in Cáceres.

Category		Sample 1st Survey		Sample 2nd Survey		Cáceres
		Frequency	Percentage	Frequency	Percentage	
Gender	Female	164	43.8%	70	42%	51.9%
	Male	210	56.2%	97	58%	48.1%
Age	16–29	80	22.6%	30	18.0%	16.8%
	30–49	193	54.7%	90	53.9%	35.1%
	50–64	74	21.0%	38	22.7%	26.9%
	>65	6	1.7%	9	5.4%	21.2%

Source: the authors.

The samples in both surveys, in terms of gender and age, were similar. However, there were notable differences with respect to reality. Women are underrepresented in both samples. Furthermore, people over 65 years are hardly represented at all, while there is a significant overrepresentation of people aged 30–49.

3. Results

Question 4 asked whether the respondents had ridden a bicycle for some new reason in recent weeks. The affirmative answers in the first survey were 12.8% of the total; in the second survey, this percentage rose by 4.5%. This increase was by both men and women, although somewhat more men (Table 4).

Table 4. Question 4. Have you ridden a bicycle for some new reason in recent weeks due to the new bicycle facilities? (by gender).

	1st Survey						2nd Survey						Difference
	Women		Men		Total		Women		Men		Total		
Yes	14	8.5%	34	16.2%	48	12.8%	8	11.4%	21	21.7%	29	17.4%	4.5%
No	150	91.5%	176	83.8%	326	87.2%	62	88.6%	75	77.3%	137	82.0%	−5.1%
Blank	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	1.0%	1	0.6%	0.6%
Total	164	100.0%	210	100.0%	374	100.0%	70	100.0%	97	100.0%	167	100.0%	0.0%

Source: the authors.

On the age, the affirmative answers grew up in almost all the groups between the first and second surveys. The biggest increase was detected in the 16–29 years old group; in contrast, people over 65 increased the negative answer (Table 5).

Table 5. Question 4. Have you ridden a bicycle for some new reason in recent weeks due to the new bicycle facilities? (by age).

	1st Survey								2nd Survey							
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
Yes	7	8.8%	27	14.0%	10	13.5%	1	16.7%	7	23.3%	18	20.0%	4	10.5%	0	0.0%
No	73	91.2%	166	86.0%	64	86.5%	5	83.3%	23	76.7%	72	80.0%	33	86.9%	9	100.0%
Blank	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	2.6%	0	0.0%
Total	80	100.0%	193	100.0%	74	100.0%	6	100.0%	30	100.0%	90	100.0%	38	100.0%	9	100.0%

Source: the authors.

In Question 5, there is a choice of several possible answers about the types of infrastructures created. A first analysis was based on rejection of the facilities constructed: In this case, the choice "none of them" must be studied with particular interest. A small decrease may be observed in the group of persons who chose this answer: 23.0% in the first round and 22.7% in the second (Table 6). The same analysis done by age shows that the option "none of them" increased in the 16–29 and 50–64 age groups and fell in the 30–49 and over 65 age groups (Table 7).

Table 6. Question 5. If you have to choose between these new bike infrastructures, which one has been the most positive? (by gender).

	1st Survey						2nd Survey						Difference
	Women		Men		Total		Women		Men		Total		
Segregated bike lanes in some roundabouts	12	7.3%	12	5.7%	24	6.4%	8	11.4%	10	10.3%	18	10.8%	4.4%
New shared roadway net open to both bicycle and motor vehicle travel	28	17.1%	28	13.3%	56	15.0%	11	15.7%	28	28.9%	39	23.3%	8.3%
Installation of new bicycle parking points	40	24.4%	40	19.1%	80	21.4%	12	17.1%	20	20.6%	32	19.2%	−2.2%
New segregated bike lane in Ronda Vadillo	16	9.8%	16	7.6%	32	8.6%	14	20.0%	13	13.4%	27	16.2%	7.6%
Bike passes in the main junctions	12	7.3%	12	5.7%	24	6.4%	2	2.9%	5	5.1%	7	4.2%	−2.2%
None of them	43	26.2%	43	20.5%	86	23.0%	19	27.1%	19	19.6%	38	22.7%	−0.3%
Blank	5	3.0%	1	0.5%	6	1.6%	2	2.9%	0	0.0%	2	1.2%	−0.4%
Other	8	4.9%	58	27.6%	66	17.6%	2	2.9%	2	2.1%	4	2.4%	−15.2%

Source: the authors.

Table 7. Question 5. If you have to choose between these new bike infrastructures, which one has been the most positive? (by age).

	1st Survey								2nd Survey							
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
Segregated bike lanes in some roundabouts	8	10.0%	7	3.6%	7	9.4%	0	0.0%	4	13.2%	8	8.9%	3	7.9%	3	33.4%
New shared roadway net open to both bicycle and motor vehicle travel	12	15.0%	45	23.3%	17	23.0%	1	16.7%	6	20.0%	24	26.7%	7	18.4%	2	22.2%
Installation of new bicycle parking points	21	26.3%	32	16.6%	11	14.8%	1	16.7%	8	26.7%	20	22.2%	2	5.2%	2	22.2%
New segregated bike lane in Ronda Vadillo	10	12.5%	23	11.9%	12	16.2%	1	16.7%	2	6.7%	14	15.6%	10	26.3%	1	11.1%
Bike passes in the main junctions	7	8.8%	15	7.8%	5	6.8%	0	0.0%	2	6.7%	3	3.3%	2	5.3%	0	0.0%
None of them	17	21.3%	53	27.5%	15	20.3%	2	33.3%	8	26.7%	17	18.9%	12	31.6%	1	11.1%
Blank	1	1.3%	2	1.0%	2	2.7%	1	16.7%	0	0.0%	2	2.2%	0	0.0%	0	0.0%
Other	4	5.0%	16	8.3%	5	6.8%	0	0.0%	0	0.0%	2	2.2%	2	5.3%	0	0.0%

Source: the authors.

In addition, there is a certain uniformity insofar as acceptance of bike passes in the main junctions: The percentage of people who select it as the most positive decreases from the first to the second survey in all the age groups and in both genders.

However, a second analysis was based on acceptance of the new facilities. In this case, the option "other" would be understood as another rejection, since such persons were not satisfied with the new infrastructures and criticized or commented on them or felt the need to express their own ideas. Figure 4 groups the options "none of them + other" and shows an increase in overall acceptance of the infrastructures built from 57.8% to 73.7%. That is, not only did a majority of the population take a positive view of at least one of the new facilities, a few months later this percentage increased by nearly 16 percentage points. Of the new infrastructures, the two with the majority were parking space and creation of shared bicycle lanes.

Question 6 asked citizens if they thought that new bike facilities projects helped promote travel by bicycle. The opinion of a total of 76.5% of those surveyed was "yes" or "maybe" in November–December 2019, while in February–March 2020, the percentage of these two choices rose to 79.6% (Table 8). By age, a significant decrease was observed in those who answered "no" between the first and second survey among the youngest (10 points), moderate in the 30–49 age group (6 points), an increase in the 50–64 age group (11 points), and a decrease among those over 65 (22 points) (Table 9).

Question 7 offered the possibility of choosing up to three possible answers from a total of seven choices. If positive choices are grouped together (investment in new facilities is recommended, important, necessary, positive, innovator) and compared to negative (absurd, excessive, unnecessary, premature), in both rounds, the first group was clearly in the majority. Furthermore, in the second survey, it was found that the total of favorable opinions grew 9.9%. Both genders had plainly positive opinions both times, and their interest also grew over time (Table 10). By age, in general terms, however, a favorable opinion was observed to grow among those under 50 years and fell in those over 50 (Table 11).
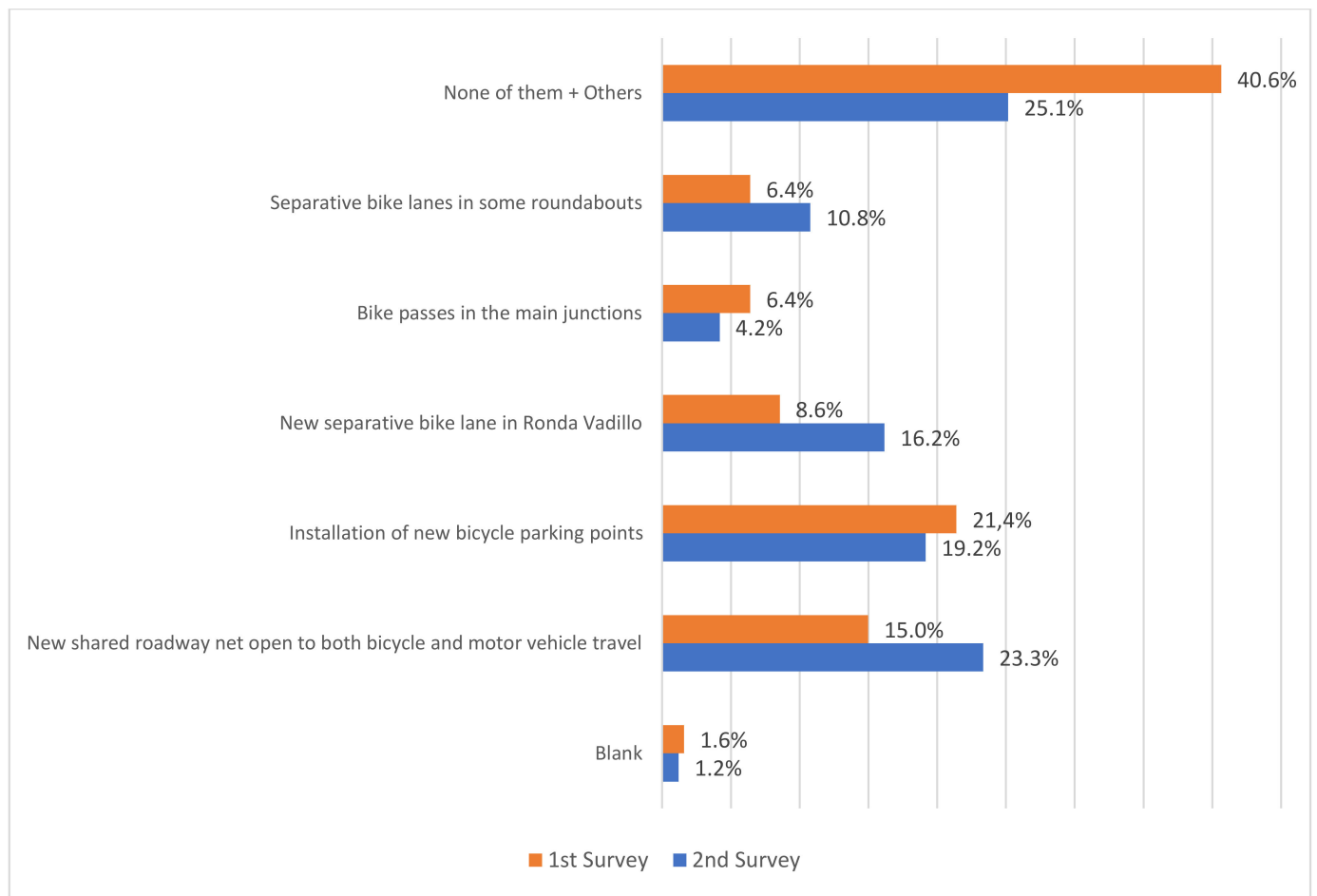
Figure 4. Question 5 responses, grouping the options "none of them + other".

Table 8. Question 6. Do you think that new bicycle facilities projects promote travel by bicycle? (by gender).

	1st Survey						2nd Survey						Difference
	Women		Men		Total		Women		Men		Total		
Yes	70	42.7%	122	58.0%	192	51.4%	32	45.7%	58	59.8%	90	53.9%	2.6%
No	44	26.8%	44	21.0%	88	23.5%	14	20.0%	19	19.6%	33	19.8%	−3.8%
Maybe	50	30.5%	44	21.0%	94	25.1%	24	34.3%	19	19.6%	43	25.7%	0.6%
Blank	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	1.0%	1	0.6%	0.6%

Source: the authors.

Table 9. Question 6. Do you think that new bicycle facilities projects promote travel by bicycle? (by age).

	1st Survey								2nd Survey							
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
Yes	33	41.2%	94	48.7%	48	64.9%	3	50.0%	17	56.7%	46	51.1%	21	55.3%	6	66.7%
No	19	23.8%	53	27.5%	9	12.1%	2	33.3%	4	13.3%	19	21.1%	9	23.7%	1	11.1%
Maybe	28	35.0%	46	23.8%	17	23.0%	1	16.7%	9	30.0%	25	27.8%	7	18.4%	2	22.2%
Blank	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	2.6%	0	0.0%

Source: the authors.

Table 10. Question 7. Do you think that investing in bicycle infrastructure in Cáceres is: (you can answer with up to three choices) (by gender).

	1st Survey						2nd Survey						Difference
	Women		Men		Total		Women		Men		Total		
Recommended	49	14.1%	100	18.9%	149	17.0%	34	22.2%	51	21.3%	85	21.7%	4.7%
Important	47	13.5%	84	15.9%	131	14.9%	24	15.7%	39	16.3%	63	16.1%	1.2%
Necessary	49	14.1%	87	16.4%	136	15.5%	20	13.1%	43	18.0%	63	16.1%	0.6%
Positive	55	15.8%	99	18.7%	154	17.6%	35	22.8%	51	21.3%	86	21.9%	4.3%
Innovator	23	6.6%	25	4.8%	48	5.5%	9	5.9%	9	3.8%	18	4.6%	−0.9%
Total positives	223	64.1%	395	74.7%	618	70.5%	122	79.7%	193	80.7%	315	80.4%	9.9%
Absurd	37	10.7%	40	7.6%	77	8.8%	11	7.2%	13	5.4%	24	6.1%	−2.7%
Excessive	29	8.3%	21	4.0%	50	5.7%	6	3.9%	8	3.4%	14	3.5%	−2.2%
Unnecessary	30	8.6%	39	7.4%	69	7.8%	11	7.2%	14	5.9%	25	6.4%	−1.4%
Premature	29	8.3%	34	6.4%	63	7.2%	3	2.0%	11	4.6%	14	3.6%	−3.6%
Total negatives	125	35.9%	134	25.3%	259	29.5%	31	20.3%	46	19.3%	77	19.6%	−9.9%

Source: the authors.

Table 11. Question 7. Do you think that investing in bicycle infrastructure in Cáceres is: (you can answer with up to three choices) (by age).

	1st Survey								2nd Survey							
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
Recommended	25	12.4%	72	16.0%	39	23.1%	2	16.7%	13	18.6%	43	19.3%	23	33.8%	6	24.0%
Important	27	13.4%	67	14.9%	31	18.4%	1	8.3%	14	20.0%	39	17.5%	7	10.3%	3	12.0%
Necessary	27	13.4%	74	16.4%	28	16.6%	2	16.7%	17	24.3%	37	16.6%	2	2.9%	2	8.0%
Positive	35	17.4%	79	17.6%	27	16.0%	4	33.3%	18	25.8%	49	22.0%	12	17.7%	7	28.0%
Innovator	20	10.0%	17	3.8%	8	4.7%	1	8.4%	2	2.9%	11	4.9%	4	5.9%	1	4.0%
Total positives	134	66.6%	309	68.7%	133	78.8%	10	83.4%	64	91.4%	179	80.3%	48	70.6%	19	76.0%
Absurd	24	11.9%	35	7.8%	11	6.5%	1	8.3%	2	2.9%	14	6.3%	7	10.3%	1	4.0%
Excessive	9	4.5%	32	7.1%	8	4.7%	0	0.0%	1	1.4%	9	4.0%	3	4.4%	1	4.0%
Unnecessary	15	7.5%	39	8.6%	10	5.9%	1	8.3%	1	1.4%	14	6.3%	7	10.3%	2	8.0%
Premature	19	9.5%	35	7.8%	7	4.1%	0	0.0%	2	2.9%	7	3.1%	3	4.4%	2	8.0%
Total negatives	67	33.4%	141	31.3%	36	21.2%	2	16.6%	6	8.6%	44	19.7%	20	29.4%	6	24.0%

Source: the authors.

Figures 5 and 6 show the evolution of the answers. In general, it was found that positive attributes were maintained or increased, and some relatively homogeneous figures were maintained. Finally, the percentage of persons surveyed who considered the construction of a bike lane innovative is not very high and diminishes in both men and women over time. This is surprising because in Cáceres there were hardly any bike lines, and only on the outskirts. Those surveyed therefore think the city lacked an infrastructure, which in 2020 was already hardly innovative and at the same time was important, necessary or advisable. By age, those under 50 were grouped together on one side and those over 49 on the other. Clear uniformity was observed in the growth of the "recommended" label in all the sections, and in the decrease in values referring to "innovative" and "premature". In the rest of the positive labels, a clear generational divergence was found, especially in "necessary".

The next question, no.8, referred to further steps to be taken by government administration. In this case, the questionnaire made it possible to answer simultaneously to several choices and also provided the possibility of adding suggestions. In this case, the variety of answers was grouped together in a single line to compare them with the option "There is enough with what there is." This choice was picked by 15.2% of those surveyed the first time, and by 12.0% the second. This leaves a 3.2% decrease between the two. The overall set of answers to the choice "There is enough" decreased in both genders, although

the percentage of women who thought no more action needed to be taken was almost double that of men (Table 12). The data by age show that "it is enough" dropped in the 16–29 group, went down slightly in the 30–49, went up slightly from 50–64, and increased sharply among those over 65. There is, therefore, an inverse relationship between age and what could be called "conformism" with what was constructed (Table 13).
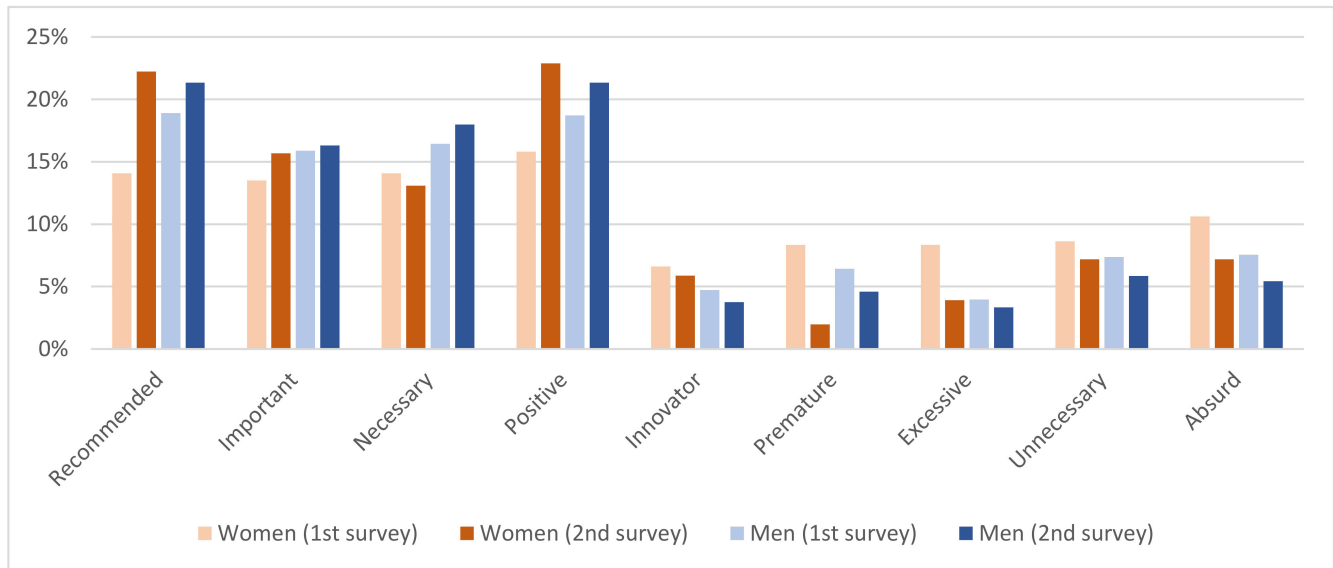
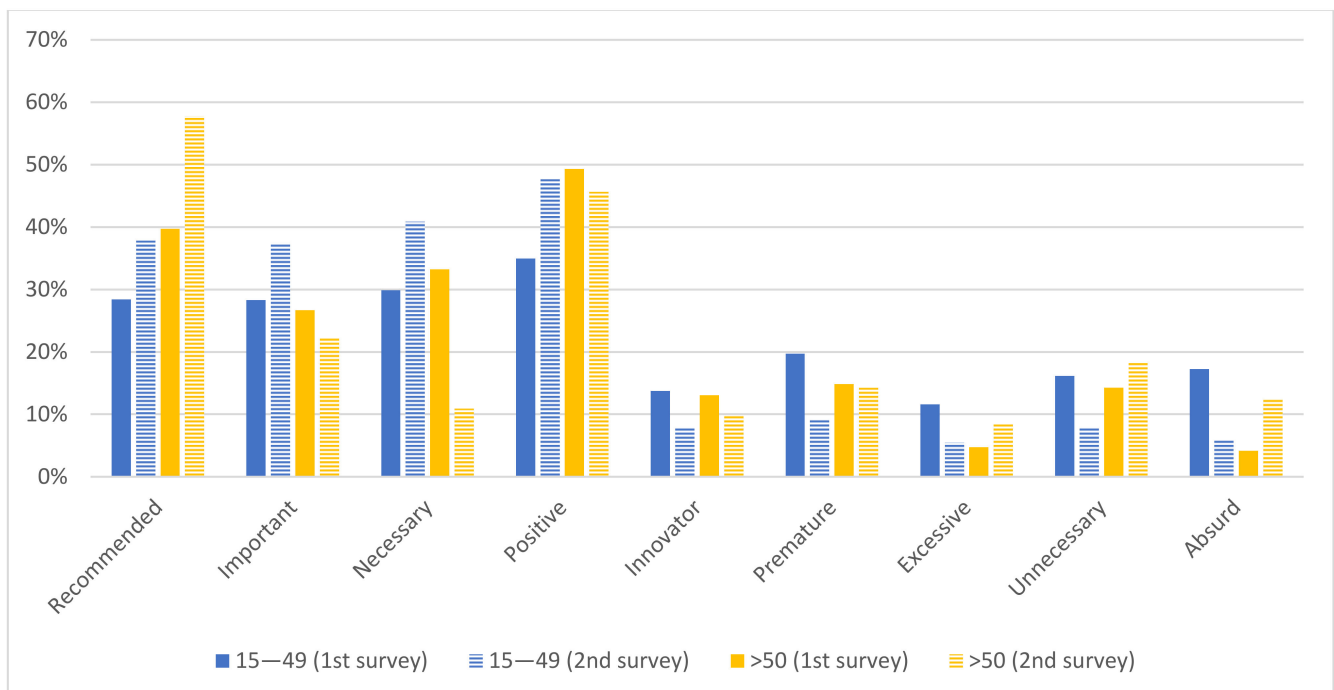

Figure 5. Evolution of answers in Question 7 (by gender).

Figure 6. Evolution of answers in Question 7 (by age).

Table 12. Question 8. In Cáceres, in your opinion, what further steps should be taken by government administration, concerning bike or VMP mobility? (you can answer with several choices) (by gender).

| | 1st Survey | | | | | | 2nd Survey | | | | | | Difference |
	Women		Men		Total		Women		Men		Total		
It is enough	35	21.3%	22	10.5%	57	15.2%	12	17.2%	8	8.3%	20	12.0%	−3.2%
Sum of responses but blank answers or "it is enough"	118	72.0%	179	85.2%	297	79.4%	54	77.1%	85	87.6%	139	83.2%	3.8%
Blank	11	6.7%	9	4.3%	20	5.4%	4	5.7%	4	4.1%	8	4.8%	−0.6%

Source: the authors.

Table 13. Question 8. In Cáceres, in your opinion, what further steps should be taken by government administration, concerning bike or VMP mobility? (you can answer with several choices) (by age).

| | 1st Survey | | | | | | | | 2nd Survey | | | | | | | |
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
It is enough	14	17.5%	34	17.6%	7	9.5%	1	16.7%	1	3.3%	12	13.3%	5	13.2%	2	22.2%
Sum of responses but blank answers or "it is enough"	64	80.0%	149	77.2%	63	85.1%	3	50.0%	29	96.7%	74	82.2%	29	76.3%	7	77.8%
Blank	2	2.5%	10	5.2%	4	5.4%	2	33.3%	0	0.0%	4	4.5%	4	10.5%	0	0.0%

Source: the authors.

Question 9 asked whether bicycle traffic safety had increased. It may be observed that the percentage that chose "a lot, it has changed noticeably" was very low: 2.6% in the first round and 2.4% the second time. However, there are two intermediate groups (those who indicated that it was "quite a lot, the difference is noticeable" and "a little, although there is still much to be done"), which increased over the months, (by 7.5% and 8.1% respectively). Furthermore, the percentage of those who marked "not at all" diminished by 15.0%. By gender, there were notable differences in the answers to this choice: 44.3% of men chose it in November–December 2019, and however, in February–March 2020, it went down to 23.7%. For women, it was 39.0% in November–December and fell to 31.4%. Men were therefore observed to be more unwilling to admit some type of improvement in bike traffic safety in the beginning, but 3 months later were more enthusiastic (Table 14). By age, there was a clearly uniform response in all the groups with regard to growth of "quite a lot", "the difference is noticeable" and decrease in "nothing" (Table 15).

Table 14. Question 9. In your opinion, has the new bicycle infrastructure increased traffic safety for bikes in Cáceres? (by gender).

| | 1st Survey | | | | | | 2nd Survey | | | | | | Difference |
	Women		Men		Total		Women		Men		Total		
Quite a lot, the difference is noticeable	11	6.7%	17	8.1%	28	7.5%	9	12.9%	16	16.5%	25	15.0%	7.5%
A lot, it has changed noticeably	7	4.3%	3	1.4%	10	2.6%	1	1.4%	3	3.1%	4	2.4%	−0.2%
Nothing	64	39.0%	93	44.3%	157	42.0%	22	31.4%	23	23.7%	45	26.9%	−15.1%
A Little, although much remains to be done	82	50.0%	96	45.7%	178	47.6%	38	54.3%	55	56.7%	93	55.7%	8.1%
Blank	0	0.0%	1	0.5%	1	0.3%	0	0.0%	0	0.0%	0	0.0%	−0.3%

Source: the authors.

Table 15. Question 9. In your opinion, has the new bicycle infrastructure increased traffic safety for bikes in Cáceres? (by age).

	1st Survey								2nd Survey							
	16–29		30–49		50–64		>65		16–29		30–49		50–64		>65	
Quite a lot, the difference is noticeable	4	5.0%	11	5.7%	8	10.8%	1	16.7%	5	16.7%	11	12.2%	8	21.0%	1	11.1%
A lot, it has changed noticeably	2	2.5%	5	2.6%	3	4.1%	0	0.0%	1	3.3%	3	3.3%	0	0.0%	0	0.0%
Nothing	28	35.0%	87	45.1%	31	41.9%	2	33.3%	8	26.7%	26	28.9%	10	26.3%	1	11.1%
A Little, although much remains to be done	45	56.2%	90	46.6%	32	43.2%	3	50.0%	16	53.3%	50	55.6%	20	52.7%	7	77.8%
Blank	1	1.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Source: the authors.

4. Discussion

The two surveys enabled two types of conclusions to be arrived at: those derived only from analysis of the first survey, and those derived from studying both.

In the first survey, incidence of the bike lane was positive, as 12.8% of the population had used the bicycle for some new reason. This figure approached those who thought traffic safety had improved much or rather a lot: 10.1%. Therefore, there seems to be a direct relationship between appreciation of an improvement in safety and use of the bicycle. In addition, one group of the population rejected installation of the bicycle infrastructure: 40.6% did not see anything good about any of the facilities built, 23.5% thought that the introduction of new projects would not cause any increase in use of bicycles, and 15.2% thought there was enough with what there is. That is, one group of the population (at least 15.2%) did not even accept that the use of bicycles could be induced by building cyclist infrastructures. Of these, 15.2–23.5% and 40.6% of those who did not see any good in any of the facilities, a second group, was more tolerant of the bicycle as a means of urban transport but distrusted the new intervention.

A second group of conclusions emerges from the analysis of both surveys. In the first place, the answers received show that all the indicators chosen developed favorably toward acceptance of the new infrastructure. If October is taken as the first month when the infrastructure was already in use, its perceived acceptance during months 2–3 was demonstrably increased in months 5–6. From this, it may be inferred that the cyclist infrastructures built in Cáceres required a period of acceptance by the citizenship. Thus, the results described in this paper illustrate that there is a period of acceptance.

Five months after the new network was put into use, 17.4% of the population had ridden their bicycle for some new reason. Again, there is a correlation between this figure and those who consider traffic safety much or rather improved: also 17.4%. Therefore, the study confirmed that there is a direct relationship between appreciation that safety has improved and riding a bicycle. The population that rejected installation of the cyclist infrastructure can also be assessed in somewhat more detail: 25.1% did not see anything good in the new facilities built, 19.8% thought that introduction of new projects would not lead to an increase in travel by bicycle, 12.0% considered that there is enough with what there is. That is, the most unwilling part of the population was still above 10% and this second group, which we defined as "tolerant of the bicycle as a means of urban transportation", and which however, "was distrustful of the intervention", decreased considerably.

These figures can be compared with the effect of new bicycles schemes in different medium-size European cities. Freiburg (Germany) increased the bicycle share of trips from 15% in 1982 to 27% in 2007 [42]; Muenster (Germany) from 23% in 1994 to 25% in 2002 [42].

In Seville, a bigger city but also a Spanish one, bicycle trips increased from 5% in 2007 to 9% in 2011 [43], and in Barcelona, a big metropolis but with a lack of bicycle culture until recent years, new infrastructures increased the bicycle share of trips from 0.75% in 2005 to 1.76% in 2007 [44].

Moreover, the study confirmed a gender effect, shown to be an important indicator of the patterns of use of nonmotor vehicles as a means of transportation [45]. In general, the stronger enthusiasm of men for use of bicycles has been observed in studies done in other cities [46]. This reality has also been highlighted in small cities where the climate is warm [47], as precisely in the case of Cáceres, or cities without a relevant cycling infrastructure network [48]. Analyzing the data in the first survey, more use was made of new infrastructure in men's habits (a higher percentage of men who rode a bicycle for some new reason 2 months after the infrastructure went into use: 16.2% compared to 8.5%), even though women were slightly more optimistic insofar as perception of improved safety for bicycle riding (11.0% women compared to 9.5% men). In general, men also rejected the new project and construction of new improvements less. Taking the data from both surveys, it was again found that use of the new infrastructure was stronger by men, who were also more enthusiastic about safety of riding a bicycle. Neither do they reject the new project or construction of new improvements in general.

The study demonstrated the difference in the opinions the age groups had of the bicycle as a means of transportation, an effect usually observed in other studies [48–50]. The data from the first survey showed stronger public interest in older people in the new means of transportation, a more intense expectation that the bicycle infrastructures would promote an increase in use by cyclists, a more positive opinion of investing in new infrastructures and a stronger feeling that the new infrastructures increase safety of bicycle transportation. It was also observed that in all the questions, the positive opinion of the new infrastructure increased with age. If the data from both surveys are analyzed though, there is no direct relationship between age groups and the evolution of the answers to the set of questions. In general, there is strong enthusiasm by the youngest participants (16–29 years old) and a moderate growth in the rest of the age groups. A directly inverse relationship was found between age and what could be defined as "conformism" with what has already been constructed. We should also recall that there were very few participants aged >65, and therefore the analysis of its evolution is not very representative.

In terms of representativeness, the results presented were obtained from a study carried out in the city of Cáceres. The results therefore represent a look at the user in this specific system. Cáceres, however, can be considered an example of a small-size Mediterranean city (97,000 inhabitants) with a narrow range of mobility options, in a country with little cycling tradition. The findings on bicycle facility acceptance period found in this study are expected to be similar in other small-sized cities in countries with a similar cycling tradition. It would be interesting to gain more experience from other urban contexts in order to better understand the interaction between the different factors that shape bicycle acceptance. It would also be of interest to do a comparative study between this city and another located in a country with strong cyclist convictions, although it would be hard to find a middle-sized city without cyclist infrastructures already built in a country like the Netherlands or Denmark, where the first bicycling network had to be built from scratch.

5. Conclusions

This study analyzed the early impact of the construction of a new urban cycling infrastructure in Cáceres, a mid-size city with no previous cycling culture, located in Spain, a country with very little cycling tradition. The study was also intended to find out whether there were any changes in citizen attitude toward the cyclist infrastructure during the first months after it was put into use.

To do this, two online surveys were carried out: The first 2 months after infrastructure inauguration and the second 3 months after the first. The questions were on personal use

of the new infrastructure created, their opinion of the new infrastructures, future steps that should be taken to continue promoting the bicycle, and eventual improvement of safety for cyclists provided by the new actions, among others.

There are some limitations to this study related to the sample size and its representativeness. The population over 15 years of age in Cáceres is 82,615. For a 95% confidence level, the margin of error in the first survey is 5.06%, and in the second round 7.58% (considering a normal distribution). It would have been ideal to have a larger number of participants, especially in the second round. Furthermore, as shown in Table 3, it was found that both women and people over 65 were clearly underrepresented. There were very few participants in this age group (six people in the first survey and nine in the second), so the study of the evolution of this segment of the population is not very reliable. This difference in age may be related to the survey's channels for diffusion and data reception. Therefore, and this is another conclusion of the study, we think the online survey method should be complemented with some other method that ensures better penetration of the survey among the older population (at least in studies in cities where there is a considerable digital divide).

Moreover, this study showed that public policies directed at construction of a new cyclist infrastructure are necessary to generate a change in citizenship attitude toward this new mode of transportation. Other studies [44,51] have shown that to achieve a significant increase in the use of the bicycle, an integrated package of interventions, from the construction of the cyclist infrastructure to education and promotional programs, must also be implemented. It would therefore be of interest for Cáceres to implement an education program in the short term and for its incidence to be analyzed in a study parallel to its implementation. In terms of public investment, the cost of the infrastructure created, 143,000€ for 96,720 inhabitants, equivalent to 1.48€ per inhabitant, according to this survey, has caused a relevant change in the city's transportation dynamics.

Finally, the study done leaves the way open to more detailed studies on the implementation of the cyclist infrastructure in Cáceres. It would be desirable to observe development in the next years, after the COVID-19 effect, to be able to analyze whether the data become consolidated over time. Another interesting field of study would be analysis of the evolution of accidents between bicycles and motor vehicles in a city where a cyclist network has been set up. Gradual awareness (and respect) of motorized drivers for bicycles could thus be found. Elsewhere, the possibility of developing an inferential statistics research with this same data remains open.

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