

## Article

# Reasons to Pedestrianise Urban Centres: Impact Analysis on Mobility Habits, Liveability and Economic Activities

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**Abstract:** Pedestrianisation entails the full removal of motorised vehicles. It promotes walking and active means of transport and has a wide range of benefits in terms of health, the environment, mobility and the economy. However, it often faces widespread opposition. This results in a lack of political will and, to a lesser degree, in temporary pedestrianisations, which can be reverted. We consider that infrastructural change and long-term pedestrianisation are key for long-lasting benefits and more resilient and sustainable cities. To explore and assess this, a survey of pedestrians and semi-structured interviews with businesses were conducted in recently pedestrianised areas of Madrid, a large capital city. Data on satisfaction and changes in mobility, liveability and business were gathered. Over 755 citizens and 38 local businesses answered. The results show high levels of satisfaction (2/3) among citizens, while 1/2 businesses consider it positive for their commercial activity. Car use has fallen, active means of transport have been fostered and perceived attractiveness has increased, although some congestion has been noticed in nearby streets. This and the rest of the evidence presented in this paper can be used to back long-term restrictive policies in other dense and busy cities.

**Keywords:** pedestrianisation; car restriction; user survey; citizen acceptability; city centre liveability; impact on local business



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## 1. Introduction

Even though walking is the oldest mode of transportation known to humankind, it is clearly not a thing of the past. With interest in walkability increasing, the benefits of a more active lifestyle and of walking [1–3] have been thoroughly studied. Walking is recommended and promoted by researchers in the fields of transport and health [4–7]. What is more, in recent years, decision makers and society as a whole have become more environmentally conscious, which has also led to changes in urban mobility and the promotion of active means of transport by a diversity of institutions [8–10]. The European Union (EU) has established several policy frameworks, such as the European Green Deal or the Sustainable, Smart and Resilient Mobility Strategy, that pave the way for improved urban mobility [11]. Along these lines, the sustainable mobility paradigm, as defined by Banister in 2008 [6], highlights the need to shift from understanding the street as a road to seeing it as a communal space and slowing movement down instead of speeding it up. In alignment with this idea, pedestrianisation schemes, considered a key policy to promote walking [5], have been introduced in many cities worldwide, including Copenhagen, Oslo, Paris, Milan, New York and Singapore [12,13].

On the whole, walking is good for society, the environment and the economy [1]. The climate emergency and COVID-19 have also highlighted the need for more sustainable urban mobility, and measures such as pedestrianisation have been promoted. In addition,

research shows that people's spatial environment, among other factors, is key to the promotion of walking [14,15]. Therefore, actions such as restricting traffic and, even more so, pedestrianising can result in walking being more attractive. The benefits of pedestrianisation are also known and include a range of positive impacts on transport, health, society, the environment and the economy [16–18]. Although these benefits have been widely studied, to our knowledge, there is a lack of a holistic approach, with efforts concentrating on one type of impact and disregarding the rest. What is more, as found by Keseru et al. [18], pedestrianisation schemes are not always rigorously followed up and assessed.

In addition, pedestrianisation often faces widespread public opposition [19–21], especially from citizens and businesses, resulting in a lack of political will, hampering its implementation. However, support levels have been found to improve after its implementation [22,23].

Tactical urbanism measures, characterised by their short-term, low-risk, and local-scale nature [24], have gained significant popularity recently. Pedestrianisations, whether tactical or conventional, often exhibit similar qualities. This holds true for those introduced during the pandemic [25] or other temporary car restrictions, such as designated pedestrian-only days. However, evidence suggests that despite their appeal, these actions may have a reduced impact [21] compared to permanent pedestrianisations.

Realising that there is a gap when it comes to assessing pedestrianisation schemes holistically as well as effectively monitoring them, this paper aims to do so. To this end, two distinct target groups have been identified, namely (1) pedestrians and (2) retailers, in relation to the current pedestrianisation scheme being implemented in the city of Madrid. Furthermore, to our knowledge, research is still needed to effectively highlight the need for permanent measures in order to produce a long-lasting impact, particularly in regard to mobility.

Regarding pedestrians, the main goal is to present the impact of pedestrianisation on mobility and liveability, as well as overall satisfaction. Pedestrianisation is a mobility measure in itself, with unavoidable impact on citizens' trips. In parallel, it is related to liveability, since it produces changes in the public space and in third places [26]. This enables us to discern what aspects are most affected by pedestrianisation and whether its impacts are positive or negative.

In relation to retailers, the goal is to identify impacts on local economic activities and overall satisfaction with pedestrianisation. This allows acceptability to be assessed.

Two distinct neighbourhoods belonging to a central area of Madrid are used as a case study. This allows us to identify differences between residential/small commerce and large retail/tourist areas, boosting the applicability of these results to a wider variety of urban contexts. Additionally, they serve to examine the benefits of long-term infrastructural change, since they are being implemented permanently. As well as the neighbourhood where pedestrianisation is being implemented, factors like income, frequency with which the pedestrianised area is visited or the reason for visiting it have been considered throughout the analysis.

This article is structured in seven sections. Section 1 is the introduction, followed by Section 2, which includes the literature review. Section 3 describes the case study analysed. Section 4 addresses the methodology followed and the data gathering and analysis process. Section 5 presents the measured impacts and in Section 6, the discussion brings to light the most relevant findings. Finally, Section 7 includes conclusions and future research.

## 2. Literature Review

Walking has a wide range of benefits, resulting in happier communities, a greener environment and an improved economy [1]. Some of its reported positive impacts on society are that it is good for health, reducing the risk of obesity [2] and even reducing all-cause mortality, with just an 11-minute daily walk lowering it by 25% [3]. Economically, pedestrians spend 65% more at local businesses than drivers [1], and considering that real

car ownership cost can reach 60% of a person's lifetime earnings [27], reducing car use means large savings for households. It is the cleanest mode of transport, and an increase in walking trips with a consequent reduction in car use results in lower carbon emissions [28]. It is evident that in the current state of climate emergency, travelling on foot is key to reducing travel-related emissions. However, walking has often been the most neglected mode of transportation [29,30].

Nonetheless, the advantages of walking, such as those noted previously, have increasingly become more accepted, and the term walkability has slowly gained popularity. Walkability can loosely be understood as "overall support for the pedestrian environment" [31]. However, the concept has many definitions [32] due to the many fields of study addressing it (urban design and planning, health and transport planning) [33,34]. Concerning walkability and its relation to urban planning, it is worth noting that throughout the 20th century, the quality of the pedestrian environment has been degraded. The availability of motorised modes and the rapid growth of cities, linked to modern planning principles, led to zoned and low-density settings, resulting in less walking [35,36]. Nevertheless, actions such as pedestrianisations, and more so if overall street quality is improved, can serve to foster walking [15,37].

Restrictions on private cars in cities have become mainstream, with cities such as Madrid, Hamburg, Oslo, Helsinki, Paris, Milan, Chengdu, Dublin, Brussels, Copenhagen or Bogota implementing them in different degrees [12]. These restrictions can take many shapes, from pricing measures and tolls, to Low-Emission Zones and pedestrianisations. Of these, pedestrianisations are the most restrictive and are defined as converting a street to an area of only pedestrian use, excluding all motor vehicles.

Pedestrianisations are low cost, high benefit, easy and fast to implement [16]. Pedestrianisations have many positive impacts [22,38,39], which can be categorised into five main groups: transport, social, environment, economy and health [16]. Economic impacts are found to be the most commonly assessed [39,40], although environmental and even social impacts are also monitored [22,41]. In addition, impacts on transport are also studied [18], using indicators such as traffic volume, pedestrian count, modal split, parking or occupancy. The most common impacts reported by different authors are included in the following lines. In many cases, the ex post focus has been placed on the impact on local retail [21]. Commercial activity [39] and sales volume have been observed to increase in pedestrianised areas. It has also been observed that people tend to prefer pedestrian areas [42] for certain economic activities such as having a drink or eating. Regarding transport-related impacts, previous studies have identified a reduction in traffic volumes and modest changes in modal split [43–45]. These impacts also affect the environment and air quality, and have the potential to reduce air pollution [46]. In regard to society, pedestrian streets have been found to encourage social interaction and communication. In addition, pedestrian environments also improve liveability [47].

However, monitoring and evaluating pedestrianisations is not always straightforward [48], due to the difficulty in identifying which changes are linked directly to the pedestrianisation and not to other factors. Additionally, the methods employed for data gathering and data sources can also bias the evaluation. [49]. Furthermore, pedestrianisations are not always followed up throughout time [18], resulting in their benefits not being so widely known.

The fact that pedestrianisations have gained popularity can be related to two main causes: Firstly, the positive outcome of pedestrianisations schemes such as Copenhagen Stroget (one of the first major pedestrianisations, 1962) and learnings from Jan Gehl's studies pushed other cities such as New York or Melbourne to follow suit [50]. It is fair to say that pedestrianisations have taken place at different speeds and contexts during the last 50 years. In Spain, for instance, Puerta del Sol (case study in this paper) suffered progressive pedestrianisation actions until the latest and complete pedestrianisation of the area [51]. Another noteworthy Spanish example is Pontevedra. Pedestrianised in the 1990s, it turned a car-oriented city into a city for people [30].

Secondly, CO<sub>2</sub> reduction targets and the COVID-19 pandemic have also driven pedestrianisation. Many cities implemented pedestrian-friendly actions temporarily during the pandemic and, in some cases, have maintained them; however, they have not committed to fully pedestrianising [52].

The temporary character of these actions is similar to tactical urbanism measures, which allow cities to test solutions and help citizens become used to changes [53]. However, these temporary interventions are often not enough to create more resilient cities and mobility and do not have significant impacts on modal shift as seen, for instance, in the case of Brighton [21].

Although the benefits of pedestrianising are many, these actions usually face a large deal of public opposition. This opposition comes from different sectors of society, ranging from the car-manufacturing industry to retail and business owners, and citizens [12,54,55]. This is of great relevance, since it is vital for the general public to be in favour of more controversial measures for politicians to actually carry them out [5]. In general, acceptability levels increase overtime [22,23]. Additionally, opposition to car restriction has also been found to be more directly linked to negative externalities due to construction works than to the actual pedestrianisation [22].

In this research work, the scope is on integrated urban and transportation planning, exemplified by pedestrianisation actions, that also serve to promote walking, especially if overall street quality is improved. Data were gathered through surveys and semi-structured interviews and public open-access databases. The focus has been placed on citizens' and retailers' acceptability and perceptions of the pedestrianisation being implemented in the study areas belonging to Madrid, as part of its undergoing pedestrianisation scheme included in its Sustainable Urban Mobility Ordinance Madrid360 [56]. Although the impacts of pedestrianisations have been studied before, they have usually focused on one type of benefit or have analysed a case study as part of an impact evaluation. To our knowledge, there is a lack of a holistic approach to present evidence of beneficial impacts on pedestrians and retailers concerning mobility, liveability, and economy. In addition, we consider that there is a sustained belief in there being a general opposition to pedestrianisations. However, we do not agree this is true for all contexts and wish to present evidence that satisfaction levels can be higher than expected, especially considering that many studies dealing with this issue are not very recent. This also allows us to promote permanent infrastructural changes instead of temporary measures, which have a lower impact. This work can be of special interest to policy makers, and due to the case study, findings can be useful and transferable to many other urban contexts worldwide.

### 3. Case Study

To fulfil this research's goals, it was necessary to select a case study where there was currently a pedestrianisation scheme under implementation. Madrid was selected for three main reasons, which are detailed in the following subsections: (1) transferability and complementarity, (2) policy framework and (3) its variety.

#### 3.1. Transferability and Complementarity

This research aims to be of use and interest to policy makers and stakeholders involved in pedestrianisation processes (among other sustainable mobility measures). For this reason, Madrid has been defined as a case study since it possesses qualities that ensure both the transferability of findings and new insights that can complement previous studies.

Madrid is one of the largest capital cities in Europe and is currently undergoing a pedestrianisation scheme, affecting certain areas throughout the municipality. One of them is in Sol, the city's most central and busiest area. It is a commercial and tourist area which resembles central areas of other large cities. Other large cities such as New York or Melbourne or capital cities like Brussels, Dublin or Paris have undertaken pedestrianisations in central areas. Madrid also presents a similar density (average 5000 inhab/km<sup>2</sup>) to other cities such as Milan, Vienna, Lisbon or Rome. However, Madrid presents slight differences

to these examples, which makes it more interesting. Spain has a considerably higher walking share than other EU countries, with 59% of the population considering walking their main means of transport (in combination with others or not) compared to the 42% of the EU overall. Additionally, public transport (PT) use is also higher than EU levels (33% vs. 27%) (Urban Mobility and Transport, Special Eurobarometer 495, September 2019. European Commission. Available at [https://data.europa.eu/data/datasets/s2226\\_92\\_1\\_495\\_eng?locale=en](https://data.europa.eu/data/datasets/s2226_92_1_495_eng?locale=en), accessed on 15 September 2023). In Madrid alone, 40% of trips are made on foot, and there are approximately 425 vehicles per 1000 people, while the European average is 570 per 1000. Taking into consideration these facts, we believe Madrid is more than adequate to explore pedestrianisation schemes and their relation to mobility and liveability, since findings can be transferred to other cities, and at the same time, it has certain characteristics that add value to the findings.

### 3.2. Policy Framework

Madrid is committed to removing cars from the city through different policy actions. In 2010, the city council implemented Resident Priority Zones, allowing only residents to park and drive in specific areas. In 2018, the first Low-Emission Zone (LEZ) in the city was implemented, known as Madrid Central, which restricted the most polluting vehicles (based on a labelling-system) from entering the designated area. In March 2021, Madrid implemented its latest sustainability strategy, 'Madrid 360', aimed at helping Madrid City Council comply with the air quality limits set by the European Parliament. This strategy was later accompanied by a Sustainable Urban Mobility Plan "Madrid 360", implemented in 2022. Among its measures, it is worth mentioning the progressive expansion of the LEZ (to cover the whole city by 2024) and Special Protection Low-Emission Zones deployed in the most polluted areas of the city, including the city centre. Lastly, the Zero-Emission Zones under implementation are of special relevance to this paper. This pedestrianisation scheme that addresses 21 districts of the city aims to pedestrianise 1,700,000 m<sup>2</sup>, removing 40,000 vehicles daily, which adds up to 14,600,000 vehicles removed annually (Madrid City Council Information on Pedestrianisations Madrid 360. Available at <https://www.madrid.es/portales/munimadrid/es/Inicio/Movilidad-y-transportes/Peatonalizaciones-Madrid-360/?vgnnextfmt=default&vgnnextoid=1bc7d45e72b66710VgnVCM2000001f4a900aRCRD&vgnnextchannel=220e31d3b28fe410VgnVCM1000000b205a0aRCRD&idCapitulo=11288068>, accessed on 15 September 2023). This paper focuses on two of the pedestrianisation actions taking place in the city centre: Olavide and Sol.

### 3.3. Madrid: A Varied Case Study

Madrid is the capital city of Spain and the most populous one, with 3.2 million inhabitants in the city and a total of 6.9 million in the Functional Urban Area (FUA) as of 2022 (Spanish Statistical Office) (Spanish Statistical Office. Data on FUA: <https://ine.es/jaxiT3/Datos.htm?t=30142> Data on the city: [https://ine.es/nomen2/index.do?accion=busquedaAvanzada&entidad\\_amb=no&codProv=28&codMuni=79&codEC=0&codES=0&codNUC=0&denominacion\\_op=like&denominacion\\_txt=&L=0](https://ine.es/nomen2/index.do?accion=busquedaAvanzada&entidad_amb=no&codProv=28&codMuni=79&codEC=0&codES=0&codNUC=0&denominacion_op=like&denominacion_txt=&L=0) accessed on 15 September 2023). In the city, two areas with different socioeconomic characteristics and mobility can be distinguished: the Central Business District (CBD), and the urban periphery. In this paper, the focus is on the CBD.

The CBD is made up of seven districts and is delimited by the M30 ring road. It covers an area of 42 km<sup>2</sup> and has a population of almost 1 million people. It is very dense, with an average of 23,800 inhab/km<sup>2</sup>, although it can reach 40,000 inhab/km<sup>2</sup> in some areas. It is accountable for 29% of workplaces. In regard to mobility, 40% of trips are made on foot, followed by 35% by public transport, 20% by car, and 5% by other modes [57]. It is worth noting the high walking share, with 40% of total trips on foot, and an even higher 53% of all trips originating and ending within the Central Business District being made on foot. Nonetheless, street quality is poor in some cases, with at least 31% of streets having narrow (less than 3 m wide) pavements, and only 13% having zebra crossings every 100 m (Madrid

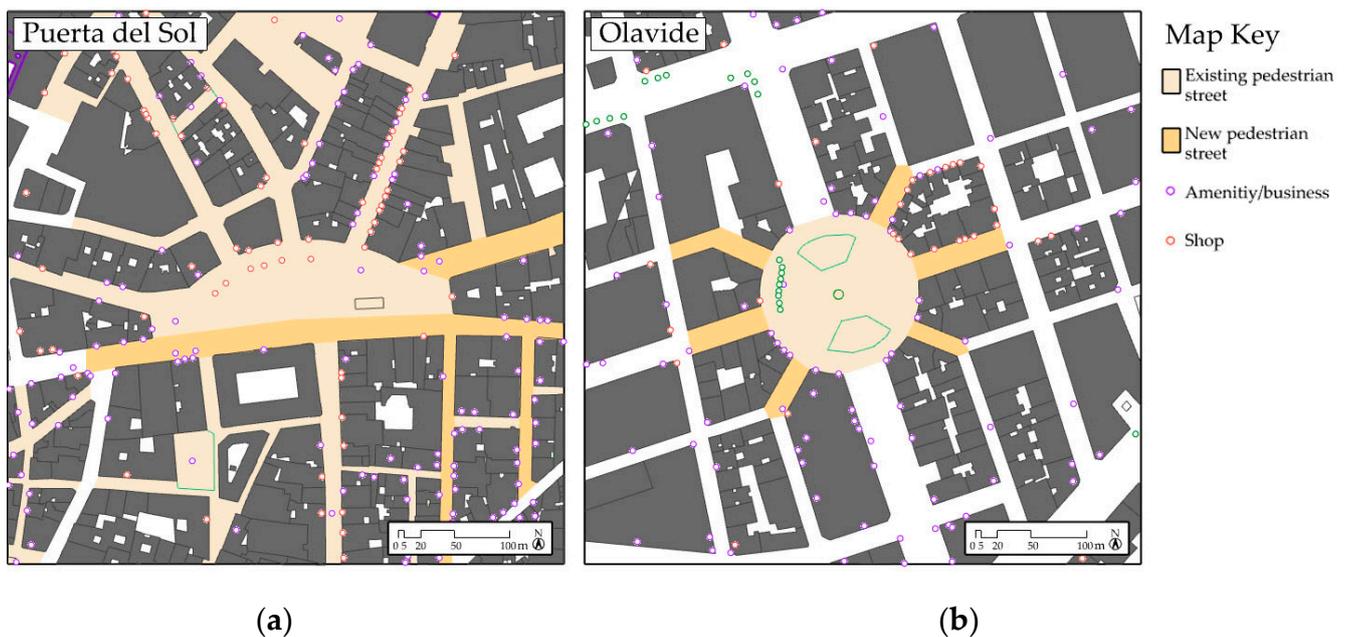
City SUMP. Available at: [https://www.comunidad.madrid/transparencia/sites/default/files/regulation/documents/22-018\\_220131e\\_plan\\_movilidad\\_sostenible\\_360.pdf](https://www.comunidad.madrid/transparencia/sites/default/files/regulation/documents/22-018_220131e_plan_movilidad_sostenible_360.pdf), accessed on 15 September 2023).

Among the districts belonging to the CBD, two are of particular interest for this research due to their characteristics. The first one is the Centro District, or city centre, which is the oldest part of the city, and is known for its high level of activity, tourism and shopping. The second one is the Chamberí District, a traditional neighbourhood of the city, mainly residential and dating back to the mid-19th century. In this article, the pedestrianisations being developed in both districts are addressed since although they are both in the CBD, they have significant differences:

- **Puerta del Sol pedestrianisation.** In Centro District, the most ambitious Zero-Emission Zone is being deployed. It covers an area of 5546 m<sup>2</sup> and has meant the elimination of almost 1 km of road. Puerta del Sol is the central square of the city and symbolizes the centre of Spain (0 km). Sol is known for its bustling activity, shops and bars. A total of 80,000 people walk through it on a Sunday. The square has progressively been pedestrianised since the 1960s, and this action has meant the definitive removal of cars in the area. The latest pedestrianisation has addressed the streets leading to the square that still allowed traffic, and the single-lane road that crossed the square. It is also worth highlighting that this pedestrianisation has meant cutting off one of the main east–west axes of the city centre. This means, on the one hand, that driving through the centre has become more difficult for private motorised vehicles, and on the other hand, it has also meant that three bus lines have been diverted. The 9 day-time bus stops, and 12 night-time bus stops have been relocated to nearby streets (<https://www.madrid.es/portales/munimadrid/es/Inicio/Movilidad-y-transportes/Peatonalizacion-de-la-Puerta-del-Sol/?vgnnextfmt=default&vgnextoid=3bbdc0c2e5153710VgnVCM1000001d4a900aRCRD&vgnnextchannel=220e31d3b28fe410VgnVCM1000000b205a0aRCRD>, accessed on 15 September 2023). Please see Figure 1a for more details.
- **Plaza de Olavide pedestrianisation.** This action is being deployed in Chamberí District, 2 km north of Puerta del Sol. It consists of the removal of cars in six out of eight streets leading to Olavide Square, changing 361 m of road to pedestrian streets, resulting in 26,776 m<sup>2</sup> of pedestrianised area. There are two remaining streets that have not been affected by the pedestrianisation since an underground tunnel connects them without interfering with Olavide Square. This district is known for being an upper middle-class residential area. Businesses in the area are of local character and small trades. Olavide Square is a meeting place for residents in the neighbourhood and has different amenities such as many seating areas, trees, a fountain and a playground. It is a traditional Madrilenian neighbourhood, with a tight community and neighbour associations. Nonetheless, many similar neighbourhoods can be found in other cities, since it is characterised by being upper middle class with mixed uses. The table below (Table 1) gives an overview of the main characteristics of each district and pedestrianised area. Please see Figure 1b for more details.

**Table 1.** Case study characterisation.

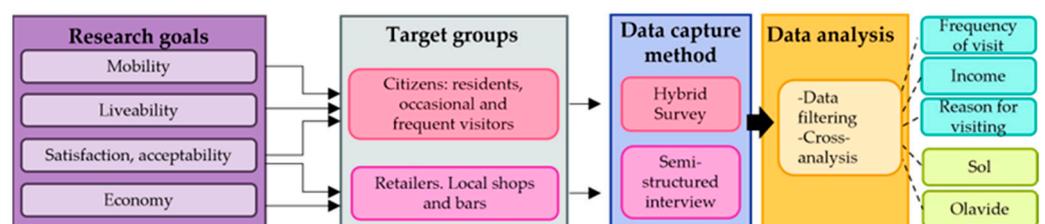
Pedestrianised Area (Name)	Pedestrianised Streets (m)	District Population (pers.)	District Area (km <sup>2</sup> )	District Density (pers./km <sup>2</sup> )	Average Annual Income
Puerta del Sol	921	139,682	5.23	26,717	36,072
Olavide	631	137,280	4.68	29,340	54,372



**Figure 1.** (a) Puerta del Sol and (b) Olavide. Source: Own elaboration.

#### 4. Materials and Methods

To be able to fulfil the aims of this research, it was necessary to evaluate and propose an adequate methodology for data collection and analysis. The overall aim is to reach a holistic understanding of benefits derived from pedestrianising, as well as identifying drawbacks. Therefore, bearing in mind the interest in mobility, liveability, satisfaction and the economy, two target groups most affected by these aspects were identified: (a) citizens and (b) local retailer businesses. Taking into account how different these groups are, two different data collection methods were defined: a hybrid survey and semi-structured interviews. Data were filtered and analysed similarly, cross-analysing the data with a series of variables of interest, as explained in more detail throughout the text. The following figure (Figure 2) summarises the approach followed.



**Figure 2.** Methodological approach. Source: Own elaboration.

##### 4.1. Hybrid Survey to Citizens

Any given person can be potentially affected by the pedestrianisation. Therefore, our main target group is citizens in general who have at least been in the newly pedestrianised areas once. This condition makes it clear that to gather data regarding the target group, it is necessary to deploy a survey addressed to citizens. Surveys are widely used in the field of transportation to gather data for different purposes, such as predicting the effects of system and behaviour changes [58,59]. They are also frequently employed when addressing walkability either from a transportation perspective or health point of view, and furthermore, when exploring citizen perception and acceptability of different measures [5,18,54,60,61].

In this research, the method used to assess the acceptability and impacts of the pedestrianisation is a hybrid survey, specifically, the TRANSyT Hybrid Survey method [48].

This method combines personal interviews with direct face to face contact and an online questionnaire. Using both these techniques has the advantage of being able to target the required sample while maintaining confidentiality and privacy with the online questionnaire. The process consists of 3 steps, described in the following subsections.

#### 4.1.1. Customised Survey

The first phase consisted of designing a survey to gather the data needed for the research. To this end, a review of surveys used in previous studies was performed. This allowed us to outline the main sections of the survey and define all the questions. The questions are diverse in type, combining single-answer questions with multi-answer questions along with ranking questions and assessment matrixes. This enables the collection of more precise information, and keeps the respondent focused, reducing the risk of random answers. The order of the sections is also determined with the aim of avoiding people dropping out, with sensitive aspects (socioeconomic) left for the end since they have been found to be the most skipped answers in walkability surveys [62]. The survey consisted of the following sections:

- (A) Pedestrian general aspects. The first subsection was designed to capture relevant information regarding the respondents' pedestrian behaviour, such as the most valued attributes of the street and the reason for being in a pedestrian area.
- (B) Mobility. It is key to analyse attributes related to mobility, such as car ownership, since they have been found to be related to the acceptability of other car-restriction measures [61].
- (C) Impacts. Regarding liveability of the pedestrian areas and changes in habits, questions were asked addressing the built environment, mobility habits, and economic and environmental factors based on walkability and pedestrianisation surveys [17,54].
- (D) Assessment and satisfaction. These two aspects are presented separately, considering them dependent variables of the rest.
- (E) Socioeconomic data. Elements such as gender, age, wealth, and education have been found to be related to travel choices [54].

For further details, please check Appendix A, Table A1.

#### 4.1.2. Survey Campaign

The questionnaire was uploaded to an online platform—in this case, Survey Monkey. A pilot survey was also conducted to check the survey's performance and make small modifications to the questions. Having validated the survey during the pilot, the next step was to capture respondents. To do so, cards with basic information on the survey were printed with a QR code and URL link to access the web-based questionnaire. The opportunity to enter a prize draw was offered to all those who completed the survey to attract more respondents. The interviewers were in charge of capturing the attention of passers-by in the pedestrianised areas and delivering them the card while briefly explaining the objective of the survey, how to access it, the project it belonged to, the institutions behind it, and emphasising the chance to win one of the gift vouchers raffled. This strategy, based on the TRANSyT method described earlier, encourages citizen engagement and improves answer rates.

Following this approach, a total of 422 people filled in the survey in Olavide and 498 in Sol. Of these, 386 and 369 were complete. It took approximately 10 min to complete. The survey campaign lasted two weeks and took place in March 2023. The response rate was approximately 11%, having handed out 8000 survey cards. It is worth highlighting that at the time, although the traffic restrictions were in place, construction work was still under way, especially in Sol. This is of interest, because opposition levels are usually higher at the beginning of pedestrianisations.

#### 4.1.3. Data Analysis

The last phase took place once the campaign was over. Two separate databases were built with all the data gathered from Sol and Olavide. It is key to understand the differences between both areas, since although they are in the centre of the city, they are different in character and enrich the research as well as boost the transferability of results to more contexts. The databases were cleaned, and for this research, only fully complete surveys were taken into account, disregarding incomplete ones.

Having built both databases, an exhaustive analysis was carried out. In the first place, most relevant questions for the aim of this research were selected. In parallel, dependent variables were identified, in terms of what aspects of the citizens could be more explanatory of their views and perceptions. The main dependent variables identified were age, income, frequency of visiting the area and the reason for visiting the area. These were crossed with the questions addressing mobility choices, liveability and general satisfaction.

#### 4.2. Semi-Structured Interview with Retailers

The second target group was local businesses, particularly retail and hostelry establishments. To boost engagement, face-to-face semi-structured interviews were carried out. These are widely used in qualitative studies and allow the exploration of subjective responses from people regarding a specific situation [63]. They were spontaneous, in the sense that the businesses did not know beforehand they would be interviewed. All types of businesses in terms of size, age, or type were targeted.

##### 4.2.1. Interview Structure

The interview is divided into five sections, which are ordered from less sensitive to most sensitive information. Although there is a set of questions (for full details, see Appendix A, Table A2) the interviewers were allowed to explore some of them further or to prompt more comments from the retailer than those contemplated in the design.

- (A) Pedestrianisation assessment. A series of short questions regarding the pedestrianisation action.
- (B) Impacts of the pedestrianisation. In this section, the aim was to learn about changes regarding customers and logistics, addressing therefore, social and environmental elements.
- (C) Expected changes in revenue. This section focused on the economic aspect.
- (D) Acceptability and satisfaction. As in the case of the citizens' survey, acceptability and satisfaction were left separate as dependent on the other variables.
- (E) Data on commercial activity. The age of the business, number of employees, or turnover are asked about in order to be examined as variables affecting acceptability in future research.

For further details, please check Appendix A, Table A2.

##### 4.2.2. Interviewing Process

The target group was local businesses located in the newly pedestrianised streets and streets nearby. All types of businesses were targeted, ranging from small shops, beauticians, large chain stores, and luxury shops. In addition, businesses from the hotel and catering sector were also surveyed, including bars, restaurants and hotels. Interviewers addressed business owners/managers or workers in the businesses so long as they had enough knowledge of the business to answer reliably. Interviewers asked them about the different aspects based on the questions designed in Section 4.2.1. They could carry on working while they answered, which also helped engage workers. The interview lasted approximately 10 min, sometimes longer due to having to stop occasionally for workers to see to clients, etc. The results were uploaded manually to Survey Monkey and finally exported as a spreadsheet for cleaning and filtering. The interviews were carried out in parallel with the citizens' survey. A total of 52 establishments were interviewed, 30 in Sol

and 22 in Olavide. However, of these, only 20 fully answered all the questions in Sol, and 18 in Olavide. This is due to the fact that one of the questions addressed annual turnover, and many businesses were not comfortable sharing that information, although the exact figure was not requested. However, since the aim was to explore acceptability and future expectations (detailed further in Section 4.2.3), all available answers for the questions of interest were considered. This means it was not necessary for them to be one of the fully complete interviews. The semi-structured format allowed interviewers to also discuss what was important to the retailers, even if it had not been considered in the design or was slightly off-topic.

#### 4.2.3. Interview Answer Analysis

In regard to retail activity, because of the lower number of responses, instead of identifying dependent variables, the focus is on general opinion and assessment of the benefits of pedestrianisation and expected impacts in the future. The aim is to compare present opinion (benefits assessment) and expectations for the future. In turn, this comparison will facilitate a follow-up interview after the pedestrianisation has been implemented for an extended duration, enabling a comparison over time. All the answers were uploaded to a database, filtered and cleaned. The result is a descriptive analysis of the current assessment and expectations for the future.

### 5. Impacts

#### 5.1. Sample Description

In the first place, it is of interest to characterise the analysed areas. As explained in Section 3, Sol and Olavide are noticeably different. This becomes evident also when analysing the sample corresponding to each area (please see Table 2), considering that the exact same technique was employed to capture answers in both places but revealed different profiles. In both cases, to ensure the sample was representative, a random selection of respondents was carried out by targeting citizens in specific sites of the case studies based on the more frequent type of users detected in them. For example, interviewers targeted passers-by in strategic areas such as the nearby metro station, close to seating areas or besides shopping areas, where different user profiles in age, gender or reason to be in the area can be found.

Gender rates are practically the same in both, with 55% females in Sol and 52% females in Olavide. The same can be said in regard to physical impairments, with a 5% of impaired in Sol and 2% in Olavide. However, the rest of the variables show some differences. In Sol, the main age group is people between 18 and 29 (46%) followed by 30 and 44 (23%), whereas in Olavide the age groups are more balanced, with the largest group being adults between 30 and 44. It is worth clarifying that the low number of those under 18 is due to the fact they could not be approached directly for legal reasons; however, they could complete the survey if they came across a card given to an adult. Regarding education, in Olavide, the majority have a university degree or higher (81%), while in Sol the majority (71%) have higher secondary school/vocational training or a university degree. Nonetheless, it is worth highlighting that the average age to obtain a PhD is 34 in Spain, which could be related to a lower number of post-graduates in Sol, considering the percentage of those under 29 surveyed. When it comes to occupation, in both cases, the majority of respondents are currently working, although in a higher proportion in Olavide (75% versus 58% in Sol). In Sol, there is also a high proportion of students (26%). In regard to household structure, the largest group in Olavide is couples with no children (27%), while in Sol, more respondents declared to live with parents (27%). In Olavide, groups are quite balanced, and there is a slightly larger proportion of households with young children (15% versus 8% in Sol) and elderly people (3.7% versus 0.2%). Nevertheless, it must be brought to attention that only 6% of respondents in Sol live in the area, compared to 42% in Olavide. Most respondents (56%) in Sol declared to be in the area for shopping and leisure, while in Olavide, the figure is 39%. Finally, regarding wealth, the most representative groups

are earning less than EUR 1000 (34%) or between EUR 1000 and EUR 2000 (40%). On the other hand, in Olavide, the largest groups earn between EUR 1000 and 2000 (36%) and between EUR 2000 and 3000 (26%), which is in line with the annual income per household of each district.

**Table 2.** Socioeconomic characterisation.

Variables	Categories	Sol		Olavide	
		Respondents ( <i>n</i> = 369)	% Sample	Respondents ( <i>n</i> = 386)	% Sample
Age	<18 *	9	2	3	1
	18–29	170	46	100	26
	30–44	85	23	131	34
	45–59	76	21	97	25
	>60	29	8	55	14
Gender	Female	202	55	202	52
	Male	158	43	173	45
	I prefer not to say	9	2	11	3
Level of education	Primary/Secondary education	26	7	15	4
	Higher secondary education/ Vocational training	112	30	57	15
	University degree	151	41	151	39
	Post-graduate degree	80	22	163	42
Occupation	Student	96	26	36	9
	Employed	215	58	289	75
	Unemployed/Not working	33	9	26	7
	Retired	25	7	35	9
Mobility impairments	Yes	19	5	9	2
	No	350	95	377	98
Household structure	I live alone	44	12	52	14
	I live with my parents	100	27	40	10
	I share a flat	71	19	55	14
	Couple, no children	73	19.8	105	27
	Household with children under 10	30	8	59	15
	Household with all children over 10 years old	50	13	71	18
	Household with elderly people	1	0.2	3	3.7
	Household where someone is physically impaired	0	0	1	0.3
Monthly income	Less than EUR 1000	128	35	62	16
	EUR 1000–2000	150	41	142	37
	EUR 2000–3000	56	15	98	25
	More than EUR 3000	35	9	84	22

\* Due to legal reasons it was not possible to directly approach pedestrians under 18, which explains the low number of respondents.

Having characterised the pedestrians of both case study areas, it is of interest to analyse the sample of the businesses surveyed (please see Table 3), even more so considering the significant amount of people in both areas who declare shopping and leisure as their reason for being there.

**Table 3.** Retail characterisation.

Variables	Categories	Sol		Olavide	
		No. of Business	% Sample	No. of Business	% Sample
Annual turnover K EUR/year	0–30	3	15	3	17
	30–100	6	30	7	39
	100–500	5	25	6	34
	500–1000	2	10	1	5
	1000–3000	2	10	1	5
	More than 3000	2	10	0	0
Number of employees	0–5	10	38	17	85
	5–10	9	36	1	5
	11–20	5	19	2	10
	21–50	2	7	0	0
	Over 50	0	0	0	0
Age of the business	Less than a year	6	24	2	10
	1–3 years	2	7	1	5
	3–5 years	3	12	2	10
	5–10 years	2	7	3	15
	More than 10 years	13	50	12	60

As mentioned in Section 4.2.2, many types of businesses were targeted. We found that there were three main types of businesses: (a) retailers in general, selling a wide range of products; (b) hospitality services, including bars, restaurants and hotels; and (c) businesses selling services, where consumers pay for a service instead of a product (for example, beauticians, hairdressers, tattoo parlours or academies). Interviewers were responsible for targeting all of these in a balanced way, ensuring a minimum of 5 of each, considering there are more businesses belonging to a and b than c. There are several differences between the types of businesses in both areas. In Sol, businesses have a higher turnover than in Olavide, with 30% earning more than EUR 500,000 compared to only 10% in Olavide. In this area, most of the businesses who answered the survey earn between EUR 30,000 and 100,000 a year. When it comes to the number of employees, in Olavide, 85% of businesses are small, with less than 5 people working, whereas in Sol, 7% employ between 21 and 50 people. It is worth noting that there were some difficulties experienced when presenting the survey to larger businesses, in particular chain stores. In most of these, workers are not allowed to answer questionnaires regarding the business or do not have enough information on the business to fill in reliably. Nonetheless, the sample surveyed is characteristic of each case study area. When addressing the age of the business, a clear difference can be observed. In Sol, half of the businesses are old (more than 10 years), and one-quarter are very new (less than a year). This is consistent with the context, popular for its shops and services, and also very popular among tourists, national and international. Although some businesses are old, it is also a popular place for new enterprises. On the other hand, Olavide has a larger offer of old businesses, with 75% being older than 5 years, which can be expected from a traditional and old neighbourhood.

### 5.2. Impact Assessment: Pedestrians' Perspective

In this paper, there are three areas of interest regarding citizens and pedestrianisation. The first one is related to the change in mobility habits due to pedestrianisation. The second one is linked to perceived liveability and use of public space, among other habits. And finally, the third one concerns overall satisfaction with the pedestrianisation. The

results are presented by case study area and crossed with socioeconomic variables or others when considered of added value. Then, they are expressed in terms of probability for the socioeconomic variable.

### 5.2.1. Impacts on Mobility

Pedestrianisation has a clear impact on mobility. Therefore, it is of interest to see if this also results in a change in mobility habits, and whether more sustainable means are fostered. In this sense, it is also worth examining what the trade-offs for pedestrianisation are and whether it has negative effects on mobility. To this end, two aspects related to mobility have been examined. The first one focuses on whether it nudges citizens to take up more sustainable mobility habits. In the second one, the scope is on how citizens reach the pedestrianised area, before and after the pedestrianisation.

Concerning taking up more sustainable mobility habits, the analysis was made considering income levels due to the fact that economic factors can be related to these types of choices. Neighbourhood was not considered as relevant since the goal is to see general perceptions, regardless of the area. This question is also of added value when taking into account the next one, where respondents indicated how they had changed their mobility habits. In this case, they show how they perceive to have changed their mobility. Respondents were asked whether they did a certain activity more/less/the same as before the pedestrianisation. Table 4 presents the results.

**Table 4.** Intention to use modes after the pedestrianisation (%).

Income	Walk			Cycle			PT			Car		
	More	Same	Less	More	Same	Less	More	Same	Less	More	Same	Less
Less than EUR 1000	51.6	39.5	8.9	12.6	75.8	11.6	33.2	51.6	15.3	6.8	50.5	42.6
EUR 1000–2000	42.5	52.7	4.8	9.6	83.2	7.2	25.0	63.4	11.6	3.1	65.8	31.2
EUR 2000–3000	42.9	53.9	3.2	8.4	89.6	1.9	22.7	70.1	7.1	1.3	68.8	29.9
More than EUR 3000	47.1	50.4	2.5	0.0	100.0	0.0	20.2	71.4	8.4	4.2	70.6	25.2
All	45.6	49.3	5.2	8.6	83.0	6.1	25.8	63.0	11.1	3.8	63.3	32.8

Of all income groups, the lowest one shows the largest variations, walking, cycling and using public transport (PT) more and cars less. In relation to active modes, cycling seems to be the less affected by pedestrianisation, with an average 83% staying the same and lowest income groups increasing and reducing the most. In regard to walking, the highest income group is walking more (47.1), while only 2.5 consider walking less (the lowest percentage of all groups). In general, walking is fostered in all groups, while cycling remains similar. Walking is also the mode that varies more due to pedestrianisation, with practically the same percentage of people walking the same and more.

In relation to PT, larger variations can be seen in the lower incomes, while one-quarter of respondents state that they use it more. However, it is stated to be used less than, for instance, active modes. And finally, car use sees a reduction which is more significant for lower incomes, with the wealthiest group being the one to reduce it less.

Respondents were also asked to indicate the modes they used to access the area before and after the pedestrianisation. The analysis is carried out by area, and by age group. Table 5 shows the change in modal choice per age group surveyed, meaning that the variation expressed is in proportion to the age group, with the aim of finding differences in habits between age groups.

PT includes bus, metro and light rail. The bicycle and scooter category does not distinguish between private or e-sharing services. The variation experienced by each mode has been calculated. The first thing that can be observed is that walking has seen an increase for all age groups in both areas except for one: >60. In the case of Sol, it is the younger age groups that are walking more, while in Olavide, older groups of citizens such as 30–44 are walking 7.1% more. However, it is important to reflect on the reduction in older people

going on foot to the area, 15.4% less in Sol and 26.5% less in Olavide. When it comes to motorised means, it is positive to see that they have suffered a significant reduction for all age groups in both areas, except for the elderly in Olavide. Bicycles and scooters do not undergo great changes in either area. PT is of interest because its variation is noticeably different in each area. While in Sol it sees a slight increase, in Olavide, its use is reduced to a surprising  $-3.9$ , even more so than car use. In contrast, in Sol, motorised means are the ones seeing a larger reduction ( $-7.1$ ). Pedestrianisation fosters active modes, although walking is more fostered by it than cycling. However, it must be stressed that regarding mechanical modes, it can cause less use of PT since it is also affected by car restriction. It must also be noted that in Sol, there are other car restrictions in place, such as the Special Protection Low-Emission Zones, which can also be related to lower car use. Additionally, it is worth highlighting that the increase in Olavide is due to people over 60. This could be linked to the fact that active mobility can be more tiring for elderly citizens, who rely on other options such as PT or cars and might be more negatively affected by pedestrianisations.

**Table 5.** The % variation in modes chosen to access the area by age group compared to before the pedestrianisation.

Age	Sample (Sol)	Sol				Sample (Olavide)	Olavide			
		On Foot	PT	Car/Moped	Bicycle/Scooter		On Foot	PT	Car/Moped	Bicycle/Scooter
18–29	170	7.4	−3.3	−9.3	3.0	100	6.3	−8.0	−2.5	4.4
30–44	85	5.9	2.8	−6.3	−0.9	131	7.1	−5.4	−1.8	1.3
45–59	76	2.5	−1.7	−3.8	0.5	97	2.6	0.1	−1.8	−1.5
>60	29	−15.4	26.2	−5.7	−5.8	55	−26.5	16.4	13.5	−2.7
All	-	4.8	0.9	−7.1	1.1	-	3.3	−3.9	−0.7	1.7

All in all, results from both questions show there is an effect on car dependency and a general shift to more sustainable modes, particularly walking for all income groups. However, it must be highlighted that Sol is in a Special Protection Low-Emission Zone (the most restrictive in the city). Therefore, citizens may notice having reduced their car use, but it cannot be attributed only to the pedestrianisation. However, it is possible to compare results between Sol and Olavide, which is outside the Special Protection Low-Emission Zone even though it is in the centre. It becomes clear that pedestrianisation does have an effect on motorised mobility and can cause a significant reduction in car use, more so if encouraged by other measures. Nonetheless, it must not be disregarded that PT use is also reduced.

### 5.2.2. Impacts on Liveability

Changes can also be seen in citizens' activities in the area, which in turn affects an area's liveability. These activities can be influenced by economic factors, so they have been examined taking into account the income group of the respondents. This also allows us to consider the equity in car restrictions and their effects on other aspects than mobility.

Respondents were asked whether they did a certain activity more (1)/less (−1)/the same (0) as before the pedestrianisation. This allowed us to calculate the percentual growth (+) or decrease (−) for each considered activity in relation to its income group. To see the details of the results, please see Table 6.

In regard to the use of public spaces, such as the streets, squares or parks, we received positive answers in both cases. In Sol, however, it is the lowest income group which states they use them more (50% increase) followed by the second highest group (EUR 2000–3000). In Olavide, the average is a 50% increase in the use of public space, which is consistent with the pedestrianised area, considering that it leads to a square with many amenities. In Sol, the average is 40%, lower than Olavide, but consistent with a busy central area. In regard to shopping and eating out in the area, there is a larger increase for the higher income group in Olavide, while in Sol, it is the lowest income group that eats out more. Regarding

shopping, there are similar increases in all groups. There are no significant reductions in any area for any income group. On average, in Sol, shopping has increased, while in Olavide, it is eating out (including having a drink) in local bars and restaurants which has increased more.

**Table 6.** The % variation in the frequency of different habits by income.

Income	Sol			Olavide		
	Use Public Space	Eat Out	Shop	Use Public Space	Eat Out	Shop
Less than EUR 1000	50	31	32	44	23	18
EUR 1000–2000	33	14	17	51	32	27
EUR 2000–3000	44	29	33	44	32	27
More than EUR 3000	34	26	37	57	30	26
All	40	22	26	50	29	25

It is also worth examining what impacts are perceived by citizens, regarding whether they are positive or negative and to what degree. In this case, these perceptions have been linked to the frequency with which they visit the area (daily/every 2 weeks/monthly/very rarely). Respondents were asked on a Likert-type scale to express their level of agreement with three statements, ranging from not at all (1), a little (2), neutral (3), quite a lot (4), to very much (5). The goal was to examine perceptions linked to attractiveness, impact on local business and on liveability and mobility (congestion). To see these data in full detail, please check Table 7.

**Table 7.** Agreement with statements regarding pedestrianisation and perceived changes in the area.

Frequency	Sol			Olavide		
	It Makes the Area More Attractive to Live in, Work in or Visit	Neighbours Prefer to Shop in the Neighbourhood Instead of Other Areas	Has Caused Traffic Congestion in the Area	It Makes the Area More Attractive to Live in, Work in or Visit	Neighbours Prefer to Shop in the Neighbourhood Instead of Other Areas	Has Caused Traffic Congestion in the Area
Daily	3.72	3.34	3.39	4.11	3.57	3.16
Every 2 weeks	3.77	3.30	3.37	4.30	3.88	2.70
Monthly	3.91	3.55	3.27	3.91	3.42	3.18
Very rarely	3.77	3.47	3.28	3.79	3.41	3.35
All	3.78	3.39	3.35	4.09	4.02	3.94

Regarding attractiveness, the vast majority of the citizens in both areas think that pedestrianisation makes the area more pleasant. In the case of Sol, it is its monthly visitors who agree more (3.91). In Olavide, especially, citizens seem to agree to a large extent. It is also interesting that in Olavide, it is people who come to the area every 2 weeks who perceive it as more attractive due to the pedestrianisation (while in Sol, it is monthly visitors). Those who visit it very rarely are more neutral.

Whether neighbours shop in the area more because of the pedestrianisation, it is curious to see that, in Sol, respondents who say they visit the area monthly have a better perception (3.55), while in Olavide, it is those who visit it every 2 weeks (3.88). Those who disagree most with pedestrianisation favouring local commerce are visitors every 2 weeks in Sol, and very rarely visitors in Olavide. The fact that there is no clear similarity in perceptions can be due to the differences between both areas, and therefore linked to other issues such as high tourism rates in Sol. On the other hand, and based on comments collected by the interviewers, in Olavide, there are people who express a certain resistance to change, combined with residents who seemed quite content with the general pedestrianisation. Nonetheless, the levels of agreement are high in both areas.

Respondents also showed their perceptions on congestion in the area due to the pedestrianisations. Regarding Sol, there are similar perceptions in all the groups, with the one perceiving more congestion being daily visitors. On the other hand, in Olavide, perceptions change more, with most frequent visitors considering that there is no congestion while less frequent visitors consider there is more congestion. Once again, the difference between both areas becomes clear, with the most frequent visitors having the most positive perceptions in Olavide, and on the contrary, the less frequent visitors in Sol being the most positive.

Overall, results are very positive and show very high levels of agreement regarding attractiveness and local commerce. Perceived congestion is also lower than expected.

### 5.2.3. Overall Satisfaction

Finally, satisfaction with the pedestrianisation is assessed. Additionally, the reason for visiting the area is also considered to be closely related to how satisfied/dissatisfied a citizen is. For instance, a resident might be more affected by car access restriction than a person who just visits the area to go shopping. Therefore, it is determined whether there are significant differences between the four groups. The average satisfaction is expressed based on the Likert Scale, with 1 being not at all satisfied, and 5 being very satisfied. Please see Table 8 for more details.

**Table 8.** Average satisfaction with pedestrianisation.

Reason for Being in the Area	Sol	Olavide
Work	3.76	4.06
Leisure/Shopping	3.89	4.17
Place of residence	3.86	4.01
Passing by	3.93	3.65
All	3.84	4.05

As can be seen in Table 8, satisfaction levels are high for both districts and all groups; however, there are noticeable differences between Sol and Olavide. In Olavide, levels are higher for what can be considered more regular visitors (residents, workers, and for shopping/leisure) while passers-by are the least satisfied. In Sol, the situation is the opposite, with passers-by being the most satisfied, followed by shoppers, and workers the least satisfied. This can be explained by the different character of both areas. Olavide, as a residential area with local commerce, seems to be more appreciated by frequent visitors, while in Sol, the busiest area of the city, pedestrianisation is more valued by passers-by. Workers may be more dissatisfied because of the difficulty in accessing the area with motorised means. In Olavide, residents are slightly less satisfied than workers. In both cases, it is of interest to see the high level of satisfaction among shoppers, which contrasts with business and retail owners' perception of pedestrianisation being a risk for business.

Table 9 shows satisfaction by population rate, and it can be observed that the high Likert scores result from the high satisfaction rates, with 73% quite (4/5) or very satisfied (5/5) in Olavide and 68% in Sol.

**Table 9.** Pedestrian satisfaction rates with pedestrianisation.

Area	Not at All (1)	A Little (2)	Neutral (3)	Quite (4)	Very (5)
Olavide (%)	5	6	16	27	46
Sol (%)	5	9	18	33	35

### 5.3. Impact Assessment: Local Retailers' View

Businesses were asked to assess how beneficial they considered the pedestrianisations to be. As mentioned in Section 2, retail is a sector known for being opposed to these actions for fear of lower sales. It is also worth taking into account businesses' expectations for the future in regard to sales and turnover.

As can be appreciated in the following tables (Tables 10 and 11), assessment varies in both case studies. On the one hand, in Sol, half of the businesses feel positive about it, and 30% believe it to be either negative or very negative. On the other hand, in Olavide, there is a lower share of businesses against it (19%) but also a lower share of businesses that consider it to be good (45%) and an important 18% considering it to be very positive, with the largest amount of businesses being neutral about it.

**Table 10.** Assessment of the impact of pedestrianisation on business.

Area	Very Negative (1)	Negative (2)	Neutral (3)	Positive (4)	Very Positive (5)
Sol (%) (n = 30)	3	27	20	43	7
Olavide (%) (n = 22)	5	14	36	27	18

**Table 11.** Expectations for the future regarding clients and volume of business.

Area	Decrease in the Number of Clients and Volume of Business	Will Not Be Affected	Increase in the Number of Clients and Volume of Business
Sol (%) (n = 28)	25	36	39
Olavide (%) (n = 22)	0	73	27

Businesses were also asked to express their expectations for the future in terms of sales. It is of interest to contrast these expectations with the assessment explained in the previous paragraph. There are several points worth noting. Firstly, the majority of businesses in both areas consider that they will not be affected by the pedestrianisations. In the case of Olavide, no businesses expect to lose customers because of the car restrictions, and in both Sol and Olavide more businesses believe they will increase volume of business rather than decrease it. This is slightly contradictory with the most negative perceptions, especially in the case of Olavide, where no retailers consider it will have a negative effect on the number of clients and volume of business; however, 19% consider it to have a negative impact on business.

## 6. Discussion

In the previous section, most relevant results were presented separately. In this section, they are interpreted holistically to present the key impacts of the pedestrianisations in central areas of a large city, commercial and residential alike.

### 6.1. Discussion of Impacts on Citizens

As explained in previous sections, although the two areas are in Madrid City Central Business District, they do have some significant differences. This can also be appreciated in some of the impacts the pedestrianisation has had in each. Table 12 summarises measured impacts.

**Table 12.** Summary of pedestrianisation's impacts on pedestrians.

Topic	Description	Detail	Sol	Olavide
Mobility	Variation in intention to use modes due to pedestrianisation (Sol and Olavide aggregated). % of people who will increase (+) or decrease (−) use of each mode.	I walk	45.6; −5.2	
		I cycle	8.6; −6.1	
		I use PT	25.8; −11.1	
		I go by car	3.8; −32.8	
	Increase (+)/reduction (−) in use of each mode to access the area before and after the pedestrianisation (%).	On foot	5.2	3.4
		Bicycle/Scooter	1.0	2.0
		Public transport	0.5	−4.2
		Private car/Motorcycle	−7.6	−1.0
Liveability	Increase (+)/reduction (−) in the frequency of each habit before and after the pedestrianisation in both areas (%). Respondents were asked whether they did the activities more often than before, less than before or the same.	I use public spaces in the area	40	50
		I go shopping in the area	22	25
		I eat out/go for a drink in the area	26	29
	Agreement with the statements on a scale from 1 to 5, with 1 being totally disagree and 5 totally agree.	They make the area more attractive to live, work in or visit	3.78	4.09
		Neighbours prefer to shop in the neighbourhood instead of going to other areas	3.39	4.02
		Has caused traffic congestion in the area	3.35	3.94
Satisfaction	Respondents were asked to show the level of agreement from 1 to 5, with 1 being not at all satisfied and 5 very satisfied.	Citizen satisfaction level	3.84	4.05

In the first place, pedestrianisation has an impact on the choices citizens make when deciding how to access the newly pedestrianised streets. Sol, the central square of the city, shows some very positive changes, with a reduction of 7.6% in car use and a slight increase in walking (5.2%). This is consistent with impacts measured in other Spanish cities, such as Burgos or Vitoria Gasteiz, in Civitas projects Caravel [44] and Modern [45], respectively, or with studies cross-analysing the built environment and pedestrian streets with modal share [64]. In the case of Burgos, although 10,110 more pedestrians were counted compared to before implementation for the same amount of time, modal split did not show such good results (car use went down 4.5%). However, in the case of Burgos, sustainable modes did not see such a high increase as compared to the findings presented in this study. In Olavide, the results are not as positive as in Sol and show a larger reduction in use of PT than car/motorcycle (−1.0). Nonetheless, active modes do see a rise. It must be taken into account that pedestrianisations are not the only push measures being implemented currently in the city to reduce car use, and therefore these changes can also be influenced by other factors, especially by the Special Protection Low-Emission Zone in the Sol area. However, at least 45.6% of respondents in Sol and Olavide state that they walk more often than before. They also state that they use their car less often. This could be due to many factors such as other restrictions, the location of each area or socioeconomic characteristics. Pedestrianisation does seem to be closely linked to the use of public space, which has increased very significantly (40% in Sol and 50% in Olavide) since freeing up space from traffic fosters other activities, as was previously seen by Gehl [65]. This is also of added value when looking at answers from another question in the survey, in which respondents were asked to rank which aspects are more important to them as pedestrians. Both in

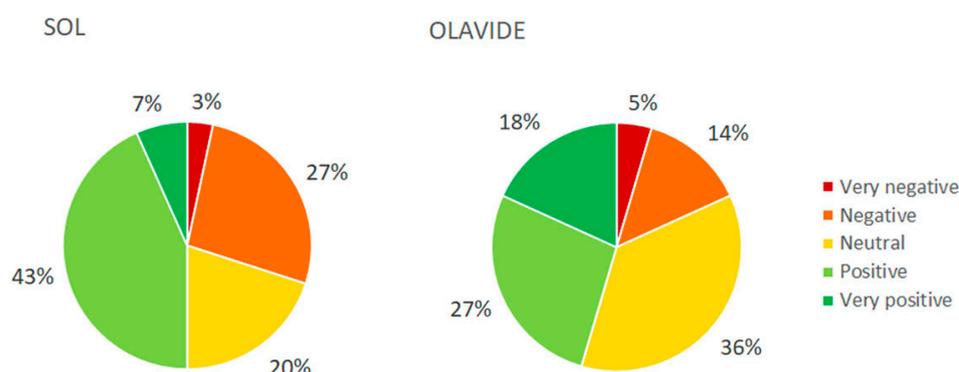
Sol and Olavide, the most appreciated aspect is environmental quality (34% put it first in Sol and 40% in Olavide), followed by feeling safe from traffic (26% ranked it most important in Sol and 38% in Olavide). Perceiving the area as more attractive may be related to these priorities the respondents stated to have since pedestrianisations are known for having positive impacts on both the environment and safety. In regard to shopping and eating out, pedestrianising does not seem to have a deterring effect, or at least it is not perceived as so by citizens, in line with results from previous studies [42]. It is worth mentioning that the results are consistent with another study addressing the impact of LEZ in retail activity in central Madrid (including Sol), where 26.9% of respondents stated their shopping would increase [66]. There is also consensus on pedestrianisations making the area more attractive on the whole, and even more so in Olavide (4.05 score on the Likert scale). There is also general agreement in this area that it is good for local commerce, while in Sol, respondents are more neutral. This can also be linked to the type of areas in which this study has been conducted since Sol is a highly commercial area, where there are many chain stores and not so much local commerce, which at the same time may be less affected by actions such as pedestrianisation. Nonetheless, congestion is also noted to have increased in Olavide, while in Sol the general opinion is neutral (3.35). This is of interest considering that existing literature reports that restricting cars does not displace traffic to surrounding areas but instead causes a reduction in traffic [21,67]. Finally, citizens show a high level of satisfaction with the measure in both areas, with the largest groups being those satisfied. Satisfaction is slightly higher in Olavide. It is worth comparing satisfaction levels in this study with the experience from other Spanish cities like Burgos, where in the initial phases of pedestrianisation, strong support was much lower (2% vs. 46% in Olavide and 35% in Sol). However, satisfaction with pedestrianisation in other contexts, for instance, Edinburgh, is much lower (2.58/5 vs. 3.84/5 in Sol and 4.05/5 in Olavide) [54].

### 6.2. Discussion of Impacts on Retail

Table 13 presents the summary of impacts on retail. An almost insignificant ratio of businesses believe the impact to be negative. This is a finding worth researching further when considering that retailers are known to perceive pedestrianisation negatively [19,55], particularly in the early stages [22]. In Sol, 50% consider it to be positive or very positive even (see Figure 3), which is consistent with the area, since neighbouring streets pedestrianised during the late 20th century are currently the most expensive to lease. What is striking is that although surveyed businesses in Olavide find the impacts more negative, they are more positive about the future and believe pedestrianisations will not result in a reduction in clients or turnover. This seems to be consistent with findings presented by Hass-Klau, where in Berlin, 10% of businesses increased turnover in traffic-calmed streets [40]. In addition, in London, vacant shops were only 3% in pedestrian areas, while on roads with over 500 vehicles/hour, the vacancy rate was 15.1% [40]. However, it is worth taking a look at previous results from Madrid city centre in regard to LEZ deployment, where only 13.7% said they had increased their sales [66]. It is worth mentioning that at the time the surveys were conducted, some work was still under construction in Sol and, to a lesser extent, in Olavide. Therefore, the results are quite positive, even more so considering prior research, which shows satisfaction levels of retailers usually improve with time [16,40]. While conducting the surveys, complaints were received about the construction works being delayed, and dirt and dust making the neighbourhood more unpleasant, which is also consistent with the literature [22]. It is possible that answers could be biased due to this, and for this reason, the outlook for the future is more positive than the current appraisal.

**Table 13.** Summary of pedestrianisation's impacts on retail.

Topic	Description	Detail	Sol	Olavide
Expectations	Effect of the pedestrianisation on business when works are fully finished	Increase in the number of clients and volume of business	39	27
		Decrease in the number of clients and volume of business	25	0
		Not affected	36	73
Impact on business	Retailers were asked to assess the impact of pedestrianisation from 1 to 5, with 1 being very negative and 5 very positive	Retail assessment of impact	3.24	3.39

**Figure 3.** Impact assessment of pedestrianisation by retailers. Source: Own elaboration with own data.

## 7. Conclusions and Future Research

The results from this study show that pedestrianisation has mostly positive impacts on mobility choices, perceived changes in liveability and retailers' satisfaction. However, there are differences depending on the built environment and type of users. In this study, two different areas in Madrid have been surveyed, representing two types of urban developments in the European context: Sol (commercial-oriented) and Olavide (residential). Additionally, it is worth pointing out that this paper aims to address pedestrianisation holistically, giving an overview and presenting evidence based on surveys. Future research will delve deeper into the highlighted findings.

Regarding mobility, two aspects were addressed, access mode to the pedestrianised area and changes in more sustainable mobility patterns. We have found evidence that pedestrianisation has an impact on personal choices and habits and is responsible for a significant reduction in car use to access the areas, even more so in the commercial and historic centre. Based on the surveys' answers, it is also possible to corroborate that it fosters sustainable modes, particularly walking and, to a lesser extent, cycling. However, it can also cause less use of PT. Further, car use is reduced. What is more, pedestrianising also influences citizens' habits: 45.6% of those surveyed claim to be walking more than before, and using motorised means less. In addition, as explained in Section 5.2.1, all income groups experience positive changes to different degrees.

When it comes to liveability, pedestrianisation clearly favours the use of public space (over 50% increase) and the intention to use of commercial and hostelry services (over 20% increase). It can favour diversity and inclusivity by creating safe spaces for citizens (for example, all income groups declare they use public space more after the pedestrianisation, with a noteworthy increase among high-income groups). There is consensus on the pedestrianisation making the area more attractive. However, in Sol, people who visit the area occasionally find it more attractive, while in Olavide, it is frequent visitors.

This is worth analysing further, since it could be an indicator of pedestrianisation causing some negative externalities to residents in very specific cases. Some residents, like elderly people, expressed complaints, because they do not want to walk and prefer

to use a motorised mode instead. Therefore, it is vital to take into account diversity and inclusivity and target different sectors of society, making sure pedestrianisation can cater to their needs. Additionally, attention must be paid to surrounding streets, where citizens have perceived an increase in congestion. Therefore, future research should address these issues, especially bearing in mind that other authors have found that traffic in surrounding streets goes down. Nonetheless, this study has focused on citizen perception and has not carried out traffic counts.

All in all, pedestrianisations are vastly supported by citizens. Over 68% in both areas are quite satisfied or very satisfied, especially people who visit the areas for shopping or leisure. This is of added value, considering that retailers are more wary of car restrictions. Residents and workers both show high levels of satisfaction, and even passers-by appreciate the lack of cars. In addition, results are more positive than those found in other Spanish cities.

Results from retailers are less positive than those from citizens and are consistent with the literature in the sense that the commercial sector is usually less in favour of restricting car access. A small minority of surveyed businesses is against the measure. However, in Sol, half of the businesses are in favour of the pedestrianisation. In Olavide, businesses feel confident in the future, expecting an increase in turnover. It is worth studying further the divergence of opinion between shoppers and retailers. The first group is mostly satisfied in both areas, while retailers are more uncertain of the benefits. Nonetheless, support has been found to be larger than expected based on previous studies.

In view of the findings, it seems clear that pedestrianising has the potential to bring benefits to different types of communities. What is more, it also shows that infrastructural changes, often considered controversial and even feared politically, are supported by the vast majority of citizens (2/3) and by 1/2 of retailers. There also seems to be a misconception on the impact of pedestrianisation on business, with local businesses having more negative perceptions, while shoppers are most satisfied. In addition, it has been found that pedestrianising fosters active modes and also impacts positively on the liveability and attractiveness of the area. This also highlights the need for mobility measures to be permanent for them to reach their full potential in achieving sustainability goals, and also highlights the need to promote them by presenting evidence that public support for such measures can be stronger than expected or found previously.

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## Appendix A

**Table A1.** Survey to pedestrians.

Section	Question Description	Question Type
(A) Pedestrian general aspects	Pedestrian area of the respondent Awareness of Madrid 360 pedestrianisation scheme Frequency with which the respondent visits the pedestrianised area Changes in frequency with which they visit the area Reason for visiting the area Most valued street qualities as a pedestrian	Single-answer question     Ranking question
	Do you have a . . . : car/driving license/public transport pass/motorcycle/bicycle Most frequently used mode to access the area (before and after pedestrianisation) Effect in commute of traffic restrictions caused by pedestrianisation	Multi-answer question Multi-answer question Multi-answer question
(C) Impacts	Level of agreement with effects of the pedestrianisation regarding the following: attractiveness of the area, pedestrian safety, new businesses, shopping in the neighbourhood, traffic congestion, difficulty parking	Likert Scale (1 strongly disagree, 5 strongly agree)
	Changes in habits as a result of pedestrianisation: I . . .walk, cycle, use public transport, use my car, make use of public spaces, eat out in the area, shop in the area . . .more often/the same/less often	Matrix
(D) Assessment and satisfaction	Assessment: How beneficial is it Level of satisfaction	Likert Scale (1 not at all, 5 very)
(E) Socioeconomic data	Age Gender Level of studies Occupation Mobility issues Household structure Monthly income	Single-answer question

**Table A2.** Semi-structured interview guide to retail businesses.

Section	Question Description	Question Type
(A) Pedestrianisation assessment	Pedestrian area where the business is located Awareness of Madrid 360 pedestrianisation scheme Impact on business assessment Possible advantages of the pedestrianisation Possible disadvantages of the pedestrianisation Level of agreement with the following: awareness of air quality problems/environmental benefits of pedestrianisation/pedestrianisation fosters tourism	Single-answer question     Five-point Likert Scale (1 strongly disagree, 5 strongly agree)

Table A2. Cont.

Section	Question Description	Question Type
(B) Impact of the Pedestrianisation	Age of target group Changes in the type of customers Changes in age of customers	Multi-answer question
	Effect on sales level	Five-point Likert Scale (1 gone down a lot, 5 gone up a lot)
	Effect of following factors on sales: difficulty to access by car/lower stock due to logistical problems related to pedestrianisation/customers have changed where they shop/more people in the streets/streets are more pleasant and less noisy	Five-point Likert Scale (1 nothing, 5 very much)
	Effect of pedestrianisation on supply of products needed on a regular basis	Five-point Likert Scale (1 strongly disagree, 5 strongly agree)
	Percentage of online sales Effect of pedestrianisation on online sales: increase in delivery time/increase in costs/problems for delivery/no effect/no online sales service	Single-answer question Multiple-answer question
(C) Expected changes in revenue	Effect on business when pedestrianisation works are finished	Single-answer question
(D) Data on commercial activity	Annual turnover Number of employees Age of business	Single-answer question

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