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# Participatory Scenario Development for Sustainable Cities: Literature Review and Case Study of Madrid, Spain

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## Abstract

Sustainable mobility policies are unlikely to succeed without efforts to tackle disagreement between different social groups. In this context, we describe a participatory process based around semi-structured interviews with expert stakeholders in sustainable mobility in the city of Madrid. Information elicited from interviews was structured using the Natural Step approach, based on detailed analysis of stakeholder discourse, into four scenarios of sustainable mobility: Remote Working, The 15-min City, Electric City and Public City. Subsequently, the four scenarios were subject to critical analysis by a second group of experts during a stakeholder workshop. The Remote Working scenario was considered a partial solution applicable to only ~30% of the population and saved commuter trips might be canceled out by increased mobility elsewhere. The 15-min City was seen as desirable but utopian and dependent on political consensus and major public investment. The Electric City was thought useful for reducing emissions but hard to implement due to infrastructure limitations and cost. The Public City was seen as an integrated vision from which other solutions should flow but also politically divisive. While no single scenario was unanimously backed by all participants, different coalitions of interest tended to support different approaches. Collectively, the four scenarios reveal divergent pathways to the same goal (a more sustainable city), suggesting ways forward for policy.

**Keywords:** participation; sustainable mobility; transport policy; pollution; scenarios

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## 1. Introduction

### 1.1. General Introduction

The EU's Climate and Energy Policy for 2030 sets out clear strategies to help member states meet the goals of the Paris Climate Agreement and the UN Sustainable Development Goals, including reducing greenhouse gas emissions, increasing renewable energy and improving energy efficiency by 2030. At the same time, concern about poor air quality in European cities has led the EU to adopt clean air policy measures with targets for 2030, in particular the reduction of contaminants like $PM_{2.5}$, largely from residential, commercial

and institutional energy consumption, and $NO_2$, mostly associated with motor vehicle combustion engines [1]. European cities, such as London, Paris and Madrid, are addressing these issues through a range of measures, including transport-oriented strategies that seek to reduce vehicle circulation and promote sustainable mobility. However, incorporating such schemes into broader urban planning strategies remains a challenge, and achieving buy-in from stakeholders often means the difference between success and failure. In two recent cases, an attempted increase in fuel duty in France and the introduction of a low-emissions zone in central Madrid, were met with furious responses from some citizens and parts of the political spectrum [2,3]. In both instances, ideological arguments around the role of government and the freedom of citizens to choose were prominent in discourse of the policies' opponents. In Madrid, disagreements broke down along party political lines, mirroring the division noted by [4] in transport policy generally, between stakeholder coalitions prioritizing values like material growth and individual freedom and those concerned with environmental health and social equity. However, the forceful rejection of sustainability policies by large sectors of society can also be seen as a symptom of poorly designed policy which viewed attaining consensus as impossible or unimportant.

In this sense, for sustainable transport policies to be effective, they need to show how restrictions like increased fuel costs or low-emissions zones are clearly linked to benefits, and, crucially, who benefits from the proposed changes. Even if policymakers feel that the benefits are obvious (i.e., in terms of avoided deaths from contaminated air, safer streets, reduced congestion etc.), the argument needs to be clearly articulated and buy-in needs to be sought from a range of social actors. One way to do this is to build consensus widely through participatory approaches that seek to reconcile conflicting points of view [4]. Different perspectives on how to achieve common goals can be structured through formal narratives called scenarios [5–7]. Participatory scenario development is increasingly commonly used in deliberative approaches to environmental policy [8,9].

This paper presents and discusses the results of a participatory scenario development approach to exploring the feasibility of possible future sustainable mobility, social conflict points and implementation problems in the case of the city of Madrid. A range of future mobility scenarios in Madrid was developed from information supplied through interviews and a workshop by local stakeholders with specific knowledge of the city and its problems around mobility, air quality and urban planning.

The paper is structured as follows. After this introductory section, we place our study in its international policy context through a brief literature review of urban sustainability transformations worldwide. Next, we explain the importance of sustainable mobility to the specific case of Madrid, which justifies its selection as a case study to inform sustainable mobility policy elsewhere. In Section 2 (Methods) we describe the stakeholder engagement process and the methods used to elicit information from them. In Section 3 (Results), we analyze stakeholders' discourse based on the verbatim responses from the semi-structured interviews and propose four distinct scenarios emergent from that discourse. In Section 4, we provide a detailed discussion structured around a strengths, weaknesses, opportunities and threats (SWOT) framework, developed together with stakeholders, to identify pathways and barriers to the implementation of policy actions embedded in the four scenarios. Finally, we offer some policy recommendations that arise from the work undertaken. Section 5 concludes.

### *1.2. Research Background: Urban Mobility Transformations in Europe and Beyond*

Moving urban mobility onto a more sustainable footing is a stated goal of many local, national and supra-national policies worldwide. While most of the literature on urban mobility transitions remains focused on European cities, promising initiatives are

emerging elsewhere. In China, low-emissions zones (LEZs) have been in use for many years, leading to important improvements in urban air quality (see, e.g., [10]). In Indonesia, the new capital city of Nusantara is expected to host an LEZ [11]. Oviedo et al. [12] examine sustainable mobility transitions in African cities, noting two distinct tendencies that emerge as GDP increases, one where private transport increases as a share of total trips and another where it remains static or decreases. This highlights the clear interdependency between urban transport and land use and points to the huge opportunity for many African cities to develop along sustainable lines by prioritizing public over private transport.

Even in Europe, where sustainable mobility is high on the EU policy agenda and clear policies and strategies exist to drive the transition (e.g., [13]), decades of car-centered transport and urban planning policy have created enormous challenges. Tsavachidis and Le Petit [14] address these challenges comprehensively, proposing a citizen-centered approach to mobility in cities, in which building public acceptance is prioritized to drive priorities like repurposing streets designed from motor vehicles as public spaces and the development of locally-based neighborhoods. In this context, our study engages diverse stakeholders to identify feasible future directions for sustainable mobility in Madrid, as an important European capital which has seen widespread disagreement between different social and political groups.

### *1.3. Madrid and the Sustainability Challenge*

Madrid is a municipality with more than 3 million inhabitants, with an area of 604.3 $km^2$. The urban area occupies 330 $km^2$ and has a population density of 5265.91 inhabitants/$km^2$. A city of these dimensions, under the current model of mobility, inevitably generates major emissions of greenhouse gases and other airborne contaminants arising from travel within it, from the first-line metropolitan suburbs that surround the municipality of Madrid, comprising the core city, and further afield in the wider region, for which the city is the most important economic attractor. In the whole Madrid region of 6,507,184 inhabitants, this gives an estimated total of 15,847,266 trips per day (2.44 daily trips per person) [15]. Of those 15.8 million daily trips, 39% are made by private vehicle, 34% on foot and 24% by public transport [15]. This gives a total of 6,280,433 daily trips by car [15]. This amount of travel places transport as the sector that emits the most greenhouse gases (GHGs), accounting for 29% of emissions in terms of $CO_2$ equivalent. Specifically, in the Community of Madrid, cars are responsible for 23.49% of GHG emissions, thanks to the high percentage of cars per inhabitant and the high number of trips made with this mode. At the same time, air pollution in Madrid causes 88 deaths per year from particulate matter ($PM_{2.5}$, $PM_{10}$) and 519 by nitrogen dioxide ($NO_2$), which is equivalent to 4 deaths per 100,000 inhabitants in the first case and 23 deaths per 100,000 cases in the second [16]. Within the municipality of Madrid, it has been estimated that 74.4% of all local $NO_2$ emissions are attributable to road traffic [17]. The scale and severity of this problem, together with the high economic and social cost of pollution caused by this mobility model, highlight the need to actively seek a more sustainable future for the city. There are many stakeholders, including public or private transport users, policymakers, businesses and civil society collectives, with rich and diverse perspectives on how a more sustainable future might be attained. The main goal of our work is therefore to uncover and analyze these diverse visions emergent from existing stakeholder discourse around sustainable mobility. To address this goal, we apply a participatory scenario development approach based around semi-structured interviews and a stakeholder workshop.

### *1.4. Scenarios in the Social and Environmental Sciences*

Though a number of formal definitions exist (see e.g., [18]), the term "scenarios" is ordinarily used to refer to structured representations of future events or, in the words of Dean [19], "consistent and plausible description(s) of possible future realities". In the social and environmental sciences, scenarios are typically purposefully constructed narratives that aim to highlight a key feature of some system that is changing or expected to change (e.g., the climate in IPCC scenarios). Multiple scenarios or ensembles are typically used to manage uncertainty, where decisionmakers cannot agree on, or do not know, the key elements that are likely to shape the future [20]. There is no single established methodology for scenario development, which some authors have referred to as "methodological chaos" [21]. However, as Bibri [22] has noted: "Most methods for futures studies focus on one or two of these goals: assessing the probable, imagining the possible, and deciding on the preferable". In the first category, we find business foresight analyses, like that used by the cement maker Lafarge, who correctly predicted the decline of the cement industry and shifted investments to biotechnologies [23]. In the first and second categories, we find the IPCC climate forcing scenarios (e.g., [24]) and the related shared socioeconomic pathways (SSPs) in which possible future pathways are often grouped into extremes or opposites (e.g., [25]). Bibri's third category (deciding on the preferable) would include, for example, energy system scenarios (e.g., [26]) whose usual goal is to find the optimal solution (lowest emission, least cost etc.) for a given power system under particular conditions.

### *1.5. Participatory Scenario Development Approaches for Urban Sustainability*

Participatory and deliberative approaches to urban planning begin to appear in the literature during the 1960s (see, e.g., [27]). Scenario development, in the very broad sense of future visioning around key issues of public controversy such as road construction or urban regeneration projects, can be found in many publications from the 1970s. Many such studies used a Delphi process, in which groups of domain or disciplinary experts are consulted on a specific question, typically through anonymous questionnaires, over several rounds, with increasing refinement towards a consensus opinion (see e.g., [28]). During the 1980s and 1990s structured participatory planning exercises, with broader participant communities than the experts traditionally recruited for Delphi processes, began to emerge. Alterman [29] advocated for the deliberate structuring of public participation around scenario-building approaches, "whereby several alternative trajectories of the . . . implementation process would be outlined and analyzed". Khakee [30,31] describes a "municipal futures study" for the Swedish town of Västerås, in which municipal planners and politicians were recruited to develop four scenarios. The study seems to have been entirely embedded in the municipal planning process and is thus very radical for its time. However, the outcome of the work, in terms of the feasibility and implementation of actions developed by the participant group, was not described. Street [32] describes a participatory scenario development process for the UK city of Preston, in which 20 participants were invited to develop their visions for the future sustainable city over two days, later selecting their top five ideas for putting their plans into action. Key questions around the viability of proposals or conflict between stakeholder visions were not addressed. The subsequent decade saw an enormous expansion in the application of participatory scenario development approaches in land and environmental planning (e.g., [33–36]). Mayer et al. [37] describe a simulation gaming approach in which participants were tasked with planning the sustainable regeneration of a fictitious neighborhood, leading to practical insights that could be applied in real contexts. Conflicting stakeholder priorities and real-world feasibility were not discussed. Loukopoulos and Scholz [38] used an area development and negotiation (ADN) approach, a methodology grounded in psychological decision research

on negotiation and bargaining, to understand public preferences for different future urban mobility scenarios. Participants evaluated seven scenarios around mobility and shopping for the town of Lundby, Sweden. The participants, however, did not develop the scenarios themselves and the scenario variants were relatively narrow, since the study did not seek to develop overall visions. More recently, several scholars have sought to consolidate the field through systematic reviews (e.g., [39–41]). Abou Jaoude et al. [40] emphasize the transition in urban planning from a rational model in which forecasting approaches were used to search for an optimal outcome to the idea of planning as a consensus between individuals at a particular place and moment in time. Recent studies show exciting advances in the field. Soria-Lara et al. [42] note that transport visioning exercises fail to account for unexpected incidents and processes beyond ordinary bounded rationality. Participants in this study of sustainable future transport in the Henares corridor, Madrid, were explicitly instructed to identify disruptive changes, arising from both imaginable and unimaginable processes [42].

On the basis of this brief survey of the literature we can identify some key research gaps. Though the importance of policy implementation, rather than policy formulation alone, in participatory scenario development work has long been recognized [29], few studies actually address this directly. The long evolution from urban scenario planning as a search for the most optimally rational outcomes to consensus-based decisions, and more recently to innovative visioning (e.g., [42]), has mostly left to one side the vexed question of feasibility of different outcomes envisaged in scenarios. Second, recommendations for policy arising from such studies are typically generic in nature and rarely offer specific advice. Thirdly, while studies around sustainable mobility, urban regeneration or urban planning are frequent, these aspects are rarely addressed together. Further, a great many studies develop scenarios with stakeholders but do not offer any evaluation or critique of the results, for example, using participatory evaluation techniques such as the dartboard technique [43] or SWOT analysis [44].

Our work therefore aimed to tackle these key gaps. We wished to address feasibility of implementation of sustainable mobility proposals, rather than simply develop "blue sky" future visions. We aimed to provide specific recommendations in terms of barriers and future policy pathways rather than vague aspirations of generic utility for "planners". We sought to develop scenarios that address sustainability in an integrated way, rather than limiting discussions to mobility or urban design, and we tasked our participant group to deliver critical feedback, rather than neutral "values-free" approval, by employing an appropriate evaluation technique.

The choice of scenario development method was informed by the need to understand the possible strategies that could be employed in future sustainability transitions and, specifically, the feasibility (barriers and policy pathways) of different sustainable mobility options. We did not seek open-ended visions or difficult to imagine outcomes. On this basis we decided to follow a backcasting approach, based on a well-known and robust method which has been applied in Sweden in the context of strategic planning in sustainability, known as the Natural Step (NS) approach [45]. The Natural Step approach, as described by [46], comprises a four-phase sequence as follows: (1) define a framework and criteria for sustainability; (2) describe the current situation in relation to that framework; (3) envisage a future sustainable situation; and (4) find strategies for sustainability.

### *1.6. Aims and Research Questions*

The aim of our work was to identify sustainable mobility solutions proposed by expert stakeholders from diverse sectors and backgrounds and test their feasibility, drawing out lessons learnt and recommendations for sustainable transport policy in other large cities. To achieve this aim, we define three research questions (RQs):

RQ1: What sustainability problems do expert stakeholders identify in their city (Madrid) and what solutions do they propose?

RQ2: Do "consistent and plausible description(s) of possible future realities" (scenarios) emerge from stakeholder discourse? If so, what are their characteristics?

RQ3: What strengths and weaknesses can be identified for each of these scenarios, and how can these lessons learnt be applied to other large cities worldwide?

## 2. Methods

### *2.1. Semi-Structured Interviews*

Our research began with a series of semi-structured interviews with key informants with specialist knowledge about transport and mobility in Madrid. Interviews were carried out with 18 representatives from diverse sectors including public policymakers, academics, businesses and civil society organizations of various kinds, this being the number required to ensure representation of the most important stakeholder groups. Expert consultations with the same or similar sized groups are abundant in the literature (e.g., [47–49]. Interviewees were asked two questions. The first (Q1) (*What are the key challenges for environmental sustainability related to transport in Madrid?*) provided a loose common framework for participants but allowed them to interpret this as they wished through their definition of challenges. Q1 thus elicited responses to the first 2 stages of the NS approach (definition of framework and criteria for sustainability, description of the current situation in relation to that framework). The second interview question (Q2) (*What solutions can be proposed to address these challenges?*) was directed towards the last 2 stages of the NS approach (envisage a future sustainable situation, find strategies for sustainability).

Interviews were carried out between October 2020 and August 2021. Most interviews were carried out with 1 interviewee, with the exception of Participants 10–16, a group of 7 researchers specialized in transport, and Participants 17–18, a group of 2 researchers specialized in air quality. In the detailed systematization and transcription the last two groups were treated as a single participant each, "a research group", to avoid overweighting the discourse towards academics. The interviews were conducted in a semi-structured format, with interviewees able to withdraw at any time. We began by interviewing research colleagues to help us identify relevant stakeholders. From this starting point, we followed a snowballing approach, in which interviewees were asked to identify other relevant stakeholders, allowing new participants to be included in the snowball. Once the interviews were completed, the information was transcribed, and the answers were classified. Each interviewee was assigned a code to preserve their anonymity (Table 1).

**Table 1.** Key informants interviewed about sustainable mobility in Madrid.

| Institution | Code | Group/Sector |
| --- | --- | --- |
| Municipal Transport Company of Madrid | Participant 1 | Public administration (city) *managing director of the municipal transport company.* |
| Cambiamo Cooperative | Participant 2 | Not for profit. *Bicycle mobility advocacy group* |
| Regional Transport Consortium of Madrid | Participant 3 | Public administration (region). *Autonomous body coordinating public transport operations across multiple providers in the Community of Madrid.* |
| Vallecas Neighborhood Local Forum | Participant 4 | Neighborhood association for a central district |
| Regional Federation of Neighborhood Associations of Madrid | Participant 5 | Neighborhood association collective |
| "A Pie" (On Foot) Association | Participant 6 | Not-for-profit pedestrian advocacy |
| Sub-Department of Energy and Climate Change, Madrid City Council | Participant 7 | Public administration (city). *Responsible for city energy and climate change strategy* |
| Associated European Motorists | Participant 8 | Not-for-profit association of motor vehicle users |
| Tomillo Foundation | Participant 9 | Not-for-profit organization specialized in social justice |
| Transport, Infrastructure and Territory Research Group (t-GIS) of the Complutense University of Madrid (UCM) | Participants 10–16 | Academics specialized in transport geography |
| Department of Industrial Chemical Engineering and the Environment of the Polytechnic University of Madrid (UPM) | Participants 17–18 | Academics specialized in air pollution |

### 2.2. Stakeholder Mapping and Sociogram

Having identified key stakeholders involved in sustainable mobility in Madrid and interviewed those who were available, we then used a participatory action research technique called a *sociogram* to identify their *affinity* and *influence* [43] with the question of sustainable mobility. The sociogram took the form of a graph with two variables on a conventional x–y-axis. Each stakeholder was classified according to their broad sector (Figure 1) and assigned a color (blue for public institutions, green for non-profit organizations, violet for specialists such as researchers and consultants and orange for the business sector including professional associations and trade unions). On the x-axis of the graph, stakeholders were located according to their approximate affinity with the overall aims of sustainable mobility, defined simply as a specific intent to reduce vehicle contamination and promote green mobility alternatives. This x-axis aimed to discriminate between actors who are "supportive" (far left), "neutral, indifferent or external" (center) or "opposed" to the aims, actions and policies to drive sustainable mobility. The supportive position corresponds to those agents that actively include sustainable mobility approaches and goals in their policies, economic projects, social mission, advocacy, activism or research. At the other end of the sociogram, in the "opposed" position, are the organizations which are openly critical towards private traffic reduction policies, e.g., automobile associations or motorists' advocacy groups. Between both extremes, we find those stakeholders who neither oppose nor support sustainable mobility measures.

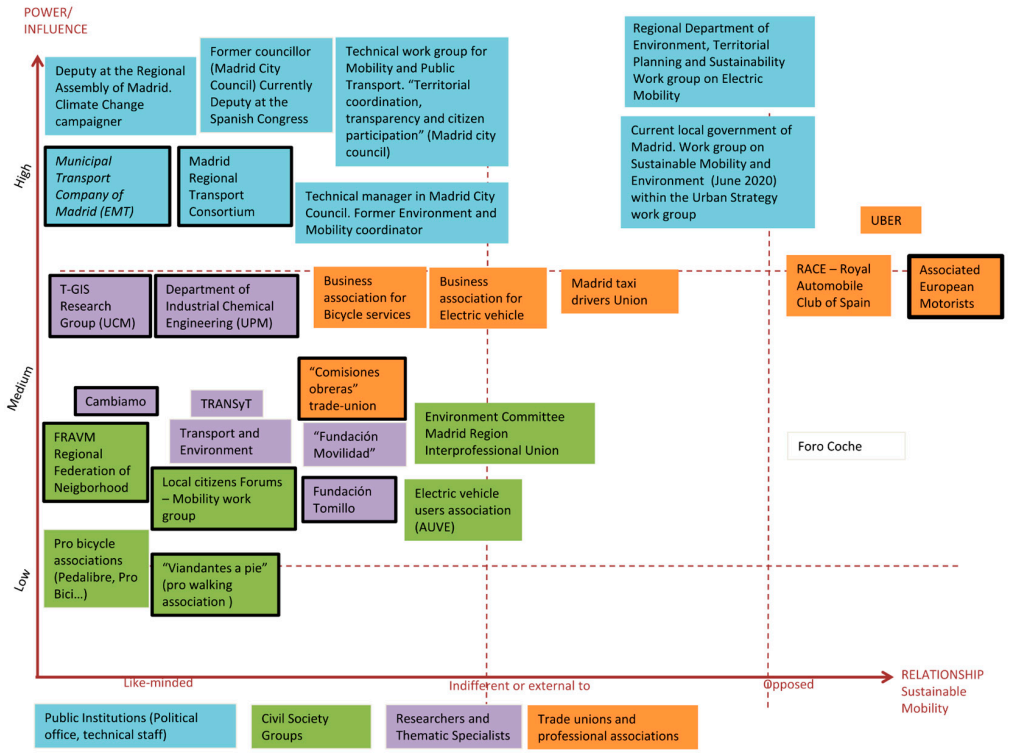



**Figure 1.** Sociogram showing affinity with the goal of sustainable mobility in Madrid (x-axis) and power to influence its implementation (y-axis). Creator: Charlotte Astier.

Affinity was determined according to the official public or declared position of each actor, found on their websites, official communications or press releases. On the y-axis, stakeholders were located in vertical space according to the level of influence that they were considered to have with respect to the goal of sustainable mobility (to drive it or to block it), with 3 categories from the lowest to the highest influence capacity. The influence score was assigned partly as a function of size (small lobby groups scoring lower than

larger advocacy organizations) and partly on the basis of proximity to the policy process, estimated, as for affinity, from the visible public profile of each actor. For example, groups with clearly identifiable associations with policy bodies were scored higher than those without, with those directly engaged in enacting policy scoring the highest of all.

### *2.3. Analysis of Interview Results and Scenario Development*

Once the interviews had been carried out, response frequencies of words and tokens in interviewees' responses were calculated using the R package *quanteda* (R version 4.4.2). This provided a starting point for analysis of the participant group's main concerns (Q1) and their proposed solutions (Q2), allowing us to envision future approaches to designing the sustainable city which accounted for the diversity of views within the participant group. The frequency of particular words or expressions in each of these two question blocks directed the researchers' attention to key themes in participants' discourse. The research team then followed the NS approach described above to construct plausible scenarios out of these main themes.

Once the scenarios had been developed, interviewees were invited to provide critical feedback and policy recommendations through a dedicated participatory workshop, held in June 2022 (Appendix A). In the workshop, participants evaluated the limitations and challenges for policy of actions identified in the four scenarios and analyzed possible pathways and barriers to implementation through a strengths, weaknesses, opportunities and threats (SWOT) analysis approach. After the SWOT analysis was completed, stakeholders were invited to share their individual viewpoints and to debate these 4 scenarios.

## 3. Results

### *3.1. Structure of Power and Affinity in the Stakeholder Community*

The sociogram (Figure 1) shows the results of the stakeholder mapping exercise. Eight public institutions were identified (blue in Figure 1), of which representatives of two were interviewed. The business sector was represented by trade unions and professional associations, of which seven were identified (orange in Figure 1); representatives of two were interviewed. Seven research or thematic specialist organizations in mobility, air pollution, sustainability or social justice were identified and, of these, four were interviewed (two private associations specializing in bicycle mobility and social justice, respectively, and two university research groups, specializing in transport and mobility and air pollution, respectively; mauve in Figure 1). Finally, seven civil society groups were identified (green in Figure 1), of which two were interviewed.

Power or influence to drive a transformation to sustainable mobility (y-axis) was considered largely to be a function of a particular agent's proximity to the policy process, but the individual activities of the different stakeholders were also taken into account. The x-axis, which depicts affinity with the overall aims of sustainable mobility, was easier to construct, since sustainable mobility in Madrid is mostly defined by those who vigorously support it, or vocally oppose it, with most undeclared actors generally indifferent.

Civil society associations with a particular advocacy position (pedestrian mobility, for example) were assigned a low rank on the influence scale since they tended to be distant from the policy process and dependent on lobbying to make their voices heard. Research organizations, especially those with thematic specialisms in sustainable transport, for example, the Chair of Bicycle Mobility at the Madrid Complutense University (UCM), tended to have formalized links with policy actors and were assigned a higher influence rank. Public institutions with direct responsibility for policy implementation were ranked at the top of the influence scale. This is, of course, a simplification, and in practice, there is likely to be greater complexity than Figure 1 indicates. However, it

is intended as a general organizational framework, rather than a conceptual straitjacket, and is a broadly adequate representation of the different actors' positions relative to each other and to the sustainable mobility objective. Taken together, the sociogram exercise reveals a cluster of advocates of sustainable mobility either in the thematic specialist or civil society groups category, which is not unexpected—researchers, especially those working on aspects of public concern, like sustainability or air pollution, are often sympathetic to civil society movements and indeed disciplines like sociology and participatory planning often provide academic articulation and support to social movements. Though most of these stakeholders tended to be rather limited in influence, some have risen right to the top of the influence scale, becoming policymakers themselves (e.g., the climate change campaigner who was elected to the regional assembly of Madrid and the former manager of the Madrid public transport company (EMT) responsible for establishing the Madrid Central low-emission zone). This is largely a result of the local government elections of 2015, in which bottom-up social movements coalesced into political parties and took over local governments across Spain [50]. In Madrid, this led to measures designed to address emissions and promote sustainable mobility like the low-emissions zone and the municipal bicycle company. Nonetheless, despite the return of the right-wing parties—who are vocal critics of sustainable transport policies and low-emissions zones in particular—to both the regional government and the town hall, there is a degree of consensus around the need for more sustainable mobility in Madrid, as the sociogram clearly shows (Figure 1).

### *3.2. Keyword Frequency in Participants' Discourse*

For the challenges (Q1), *public transport* ($n$ = 24) and *car/s* ($n$ = 15) were most frequently mentioned. Next came *bicycle/s* and *journeys/trips* (both $n$ = 13) followed by *pollution* and *reduce* (both $n$ = 9). *Policy/politics, foot, vehicle/s, emission/s* followed close behind (all $n$ = 8). Tokens mentioned more than five times in the transcribed interview corpus included *demand* ($n$ = 6), *air* ($n$ = 6), *electrification* ($n$ = 5) and *Madrid Central low-emissions zone* ($n$ = 5).

For the solutions (Q2), the most frequently occurring tokens were *public transport* ($n$ = 18), *vehicle/s* ($n$ = 16), *electrification, car/s* (both $n$ = 12), followed by *parking* ($n$ = 11), *bicycles* ($n$ = 10) and *reduce, lane/s, trip/s, space* (all $n$ = 8). The simple quantification exercise was not especially revealing in itself since the most frequent tokens were rather mundane. However, it provided a starting point for analysis by directing our attention to the phrases which contained the frequently occurring words, allowing us to identify key observations. For example, for challenges (Q1), the frequently occurring keyword *cars* led us to insightful observations related to the excessive use of private transport and the car-centered nature of the city. Searching for the matching keyword *cars* in the solutions (Q2) led us to proposals to reduce citizens' need for mobility and hence to the idea of remote working. Other challenges identified by interviewees related to last mile logistics and home delivery provided a counterpoint to the idea of remote working as a solution. This mix of points in favor and points against fitted perfectly with our conceptualization of a scenario as a container for a series of nuanced arguments about future sustainable transport tendencies, leading to the eventual identification of remote working as a scenario.

### *3.3. Main Themes Emergent from Interviewees' Discourse*

#### 3.3.1. Public Transport Use Should Be Promoted

All participants interviewed ($n$ = 18) consider that public transport is essential to move towards the decarbonization of transport in large cities. It was observed that, while journeys by car represent on average less than 50% of total trips (only 24% according to Participant 1), the resources and public space allocated to the car are extensive. Participants 10–16 (UCM Transport Research group, hereafter UCM) regarded the increased use of

private vehicles, and the parallel decline of public transport use, as a serious problem (the household mobility survey points to a 12% increase in private transport use and a 5% decline in public transport use between 2004 and 2018 [15]).

Many participants were highly critical of the public transport system, which was variously described as "inefficient", in some cases as much as three or four times slower than by private vehicle. The deficiency of metro lines in the lower-income southern part of the city, with correspondingly slower journey times, was also noted. Participant 1 (EMT) observed that that public transport is mainly designed to go from the periphery to the center or vice versa and to move within the center, while intra-suburban services are very poor. However, despite these numerous criticisms of the existing public transport system, and the widespread need for increased investment in public transport perceived by the interviewees, the existing system was regarded as generally good. For example, Participant 1 (EMT), pushing back against the idea that the poorest citizens are those most affected by anti-car policies, stated that:

*"The idea that it's the working class that are going to lose out when it comes to mobility—working class people living on the urban fringe (extrarradio) don't use the car. Public transport in Madrid is pretty good and covers the mobility needs of its inhabitants pretty well".*

Participant 9 (from the Tomillo Foundation, hereafter FT), who travels frequently into the city from a medium-sized town to the east of Madrid, noted that:

*"Madrid has great train infrastructure, especially the cercanias (short distance overland trains). But the different modes need to be better joined up".*

#### 3.3.2. The City Is Designed Around the Car

Three interviewees declared that this factor has resulted in the "subjugation" of the design of the city to the needs of the car. Six interviewees considered that public space has been "invaded" by the car and should be recovered for pedestrians and more sustainable forms of public transport. Participant 9 (FT) also emphasized that the city is designed for transport by private vehicle. The interviewee also drew attention to the health problems derived from excessive use of private vehicles, including deaths, illnesses and injuries from pollution, noise and accidents.

#### 3.3.3. The Influence of Urban Design on Sustainability

Several participants referred to Madrid's current regional development model, which has been much criticized over many years (e.g., [51–54]). Participant 9 (FT) referred to the excessive number of cars in the city and the way this is reflected in urban land use.

*"The most difficult problem is the "oil-slick" development model—the most lucrative activity is building houses, and there are few restrictions. On the other hand, unemployment is high, and Madrid is an economic attractor. But there is little public housing. The labour market attracts you, but the housing market repels you".*

Some participants considered that the urban action plans (PAUs), a specific legally designated framework designed to permit the development of entire districts as a single coherent whole, are a problem for a city that wants to carry out sustainable transport development. Both Participant 4 (Vallecas Local Forum, hereafter Vallecas) and Participant 5 (Regional Federation of Neighborhood Associations of Madrid, hereafter neighborhoods) identify PAUs as one of the most important challenges for sustainable mobility, since their high degree of land use specialization leads to sprawl and reduces the efficiency of public transport. The lack of mixed-use spaces in these suburban districts increases the distances to key services like health centers, leading to higher numbers of journeys by car.

#### 3.3.4. The Role of Electric Vehicles

Participant 4 (Vallecas) declared that the electrification of cars would not be an adequate solution to the problem from their point of view: *"Congestion cannot be solved by investing in vehicle electrification. People should be discouraged from using private vehicles, either electric or combustion"*.

Participant 9 (FT) took a more nuanced view of vehicle electrification, seeing reducing the number of private vehicles as more important. As a solution to the problem of emissions, they suggested:

*"[a solution could be] electrification—but also [reduction of] private transport. Electricity comes from somewhere—we could create a problem. We cannot keep stimulating demand for cars—it's a problem of space. This solves only the emissions. Of course, producing cars is also contaminating. Cultural change is needed"*.

Participants 17–18 (UPM), however, were more firmly in favor of electric vehicles and suggested that the city council could help drive the transition through the large-scale purchase of an electric vehicle fleet as a means to stimulate demand, either for their own needs or for resale or hire to citizens.

#### 3.3.5. The Car as a Cause of Air Pollution

Participants 9 (FT) and 10–16 (UCM) also highlighted the importance of the car as the cause of air quality problems. Participant 1 (EMT) asserted that transport was the most important source of pollution in non-industrial cities and that, in the Madrid Autonomous region, 23% of the region's greenhouse gas emissions in 2018 came from motor vehicles. This was the main topic discussed with the two researchers from the UPM (Participants 17–18).

#### 3.3.6. The Need to Improve Bicycle Mobility

Another common point among the interviewees is the need to improve bicycle mobility. All interviewees were critical of the current approach taken by the municipal bicycle service (BiciMAD). Although BiciMAD was considered to be "a step forward" by participants, it was regarded as insufficient by the group. Participant 3 (the consortium) suggested an extension of BiciMAD to other municipalities, i.e., outside of the core city. The opinion was also expressed that many of the cycle lanes are designed for recreational, rather than functional, use (i.e., for daily commuting). There are lanes that are designed to be used in a recreational way during the weekend, especially, in the view of Participant 4 (Vallecas), those around the central area enclosed by the M30 circular road (*la almendra central).* In addition, Participants 10–16 (UCM) pointed out that it is important to see the profile of the types of trips that BiciMAD eliminates, which are possibly not those that were previously made by car, but other forms of sustainable mobility, such as walking or cycling.

#### 3.3.7. Walkability

Participant 4 (Vallecas) noted that Madrid has a higher percentage of trips on foot than other cities, which suggests that it is a fairly walkable city. Participant 6 ("A Pie" (On Foot) association, hereafter AP) also indicates that adequate steps towards pedestrianization are not being taken. This opportunity to enhance the role of pedestrians was also pointed out by the representative of the consortium. According to Participant 2 (Cambiamo bicycle mobility association, hereafter Cambiamo), the walkability of a city is essential to achieve sustainable mobility goals and advance towards a city where 1/3 of the trips are made on foot, 1/3 by public transport and 1/3 by bicycle. According to this participant, the first of these three objectives (pedestrian mobility) has been achieved, but bicycle mobility has hardly increased in recent years.

#### 3.3.8. Remote Working as an Opportunity to Improve Mobility

Four participants mentioned remote working as an opportunity to improve mobility. Participants saw this as an important way of avoiding unnecessary daily trips but emphasized the need for dialogue between businesses, trade unions and civil society. It was not considered realistic by the participant group to place the entire burden of travel reduction on remote working. Participant 8 (Associated European Motorists, hereafter AEM) noted that reducing the number of vehicles in circulation implied reducing citizens' need for mobility, potentially partially addressed by remote working. This participant (AEM) observed that remote working does not have to be from home but could be from dedicated offices set up in particular locations as part of a plan to reduce travel.

#### 3.3.9. The Madrid Low-Emissions Zone

Participants 4 (Vallecas) and 6 (AP) mention "Madrid Central", the low-emissions zone established in 2018, as a useful measure to control private vehicle traffic. The interviewees who mentioned Madrid Central (4, 6, 7 and 9) think that reducing traffic circulation in the city center is the right thing to do but that it is insufficient. Even sectors presumably favorable to the use of the car, such as the AEM (participant 8), are broadly in agreement with the environmental measures of the air quality plan, known as Madrid 360, and with low-emission zones in general. This participant also spoke about the need for "technological renewal" of traffic circulating in the city.

#### 3.3.10. Last Mile Delivery

A problem that several interviewees mentioned ($n$ = 3) was the externalities generated by the delivery of packages from online commerce. Participants 3 (the consortium), 5 (neighborhoods) and 17–18 (UPM) spoke about the urgent need for a solution to the "last mile" problem (transport from logistics hubs to homes and businesses). These participants were critical of the current approach to this question, which fills the streets with delivery vans, causing traffic congestion, inconvenience for all other road and street users, including pedestrians, and pollution.

### *3.4. Scenario Development*

Scenarios were developed from stakeholder discourse following the NS approach, through four successive steps:

- **Step 1: The common framing and criteria.** This step was provided by the introduction to the project and explanation of the terms of discussion given to the interviewees.
- **Step 2: The current situation in relation to the problem of sustainable transport.** This was defined by four main challenges (Q1) identified from participants' discourse: (1) high number of motor vehicle trips, from which other problems arise; (2) the lack of safe and inclusive cycle and pedestrian infrastructure limiting sustainable travel modes; (3) the serious problem of air pollution and emissions; (4) the decline of public transport and the invasion of public space by cars and car-oriented infrastructure.
- **Step 3: Envisage a future sustainable situation.** This step emerged from the solutions to these problems (Q2): (1) reduction of motor vehicle volumes entering the city; (2) redesign of the city to increase bicycle and pedestrian trips at the expense of motor vehicles; (3) electrification of bicycles, cars, public transport; (4) freeing up space for inclusive public uses, including the widespread promotion of public transport over the car.
- **Step 4. Strategies for sustainability.** These emerged from step 3, in the form of four scenarios covering the four main points of divergence arising from the challenges and their solutions, as follows (Table 2).

**Table 2.** Scenarios and their links to stakeholder discourse following the Natural Step approach [45,46]. The color scheme connects the table to Figure 2.

| **Natural Step 1 (Common Framework and Criteria)** | **Natural Step 2 (Challenges)** | **Natural Step 3 (Solutions)** | **Natural Step 4 (Scenarios)** |
|---|---|---|---|
| Within the municipality of Madrid, it has been estimated that 74.4% of all local $NO_2$ emissions, are attributable to road traffic. The scale and severity of this problem, together with the high economic and social cost of pollution caused by this mobility model, highlights the need to actively seek a more sustainable future for the city. | **Challenge 1:** High number of motor vehicle trips, from which other problems arise. | **Solution 1:** Reduction of motor vehicle volumes entering the city. | **S1: Remote Working** An economic and social model which facilitates the transition from a system of work centered around the office to one where work is carried out completely or partially from the worker's home or other nearby place (co-working space, café or library). This scenario aims to reduce work related journeys in private vehicles, in order to reduce traffic congestion, air pollution and greenhouse gas emissions. |
| | **Challenge 2:** The lack of safe and inclusive cycle and pedestrian infrastructure limiting sustainable travel modes; | **Solution 2:** Redesign of the city to increase bicycle and pedestrian trips at the expense of motor vehicles; | **S2: The 15-min City** A vision of the city where citizens can satisfy all their needs within a journey time of 15 min away from their home. This is ensured through zoning and policy changes. Although this may imply structural changes in the city, it aims to increase the accessibility of the city for everyone, as well as reducing air pollution and greenhouse gas emissions, and quality of life. |
| | **Challenge 3:** The serious problem of air pollution and emissions resulting from circulation of polluting vehicles. | **Solution 3:** Electrification of bicycles, cars, public transport. | **S3: Electric City** This scenario emphasizes technological development as a solution to air pollution and greenhouse gas emissions. It supposes the complete replacement of the current fossil-fueled vehicle fleet (petrol, LPG, diesel) with electric vehicles, for both public and private transport (buses, trains, trams etc.). It will be complemented by other kinds of electric transport, like bicycles and scooters. This scenario does not aim to change existing mobility patterns, so it would not reduce congestion or provide more space for non-motorized transport or pedestrians. However, it would eliminate most vehicle emissions from the city. |
| | **Challenge 4:** The decline of public transport and the invasion of public space by cars and car-oriented infrastructure. | **Solution 4:** Free-up space for inclusive public uses, including the widespread promotion of public transport over the car. | **S4: The public city** In contrast to problem-solving approaches usually taken by governments, this scenario seeks to build the capacity of individuals and groups (neighborhood associations, cooperative societies and other citizens' collectives) to solve air pollution and greenhouse gas emissions. In this way, the scenario advances social justice and public health as key components for a transition to a pattern of mobility that is inclusive for all. This scenario promotes means of transport that are easily available and accessible without excluding less-wealthy neighborhoods. |

Figure 2 provides an overview of the NS process as it emerged directly from key challenges and their solutions identified by interviewees.

The emphasis of part of the participant group on the need to reduce motor vehicle trips above all else became **Scenario 1: Remote Working**, an idea much referenced by participants and in the minds of everyone due to the COVID-19 pandemic. The need to promote cycling and walking and foster a different vision of the city could be translated into **Scenario 2: The 15-Minute City,** a highly topical concept allied to the transformation of the city of Paris referenced by several participants. The focus of some participants on the need to reduce air pollution and emissions as a priority above other concerns led naturally to the technological vision of **Scenario 3: Electric City**. Finally, the widespread concern of participants for declining and underused public transport, the colonization of public

space by private vehicles and activities and problems of inclusivity and social justice led to a more holistic vision of a "city for all". This became **Scenario 4: Public City**.

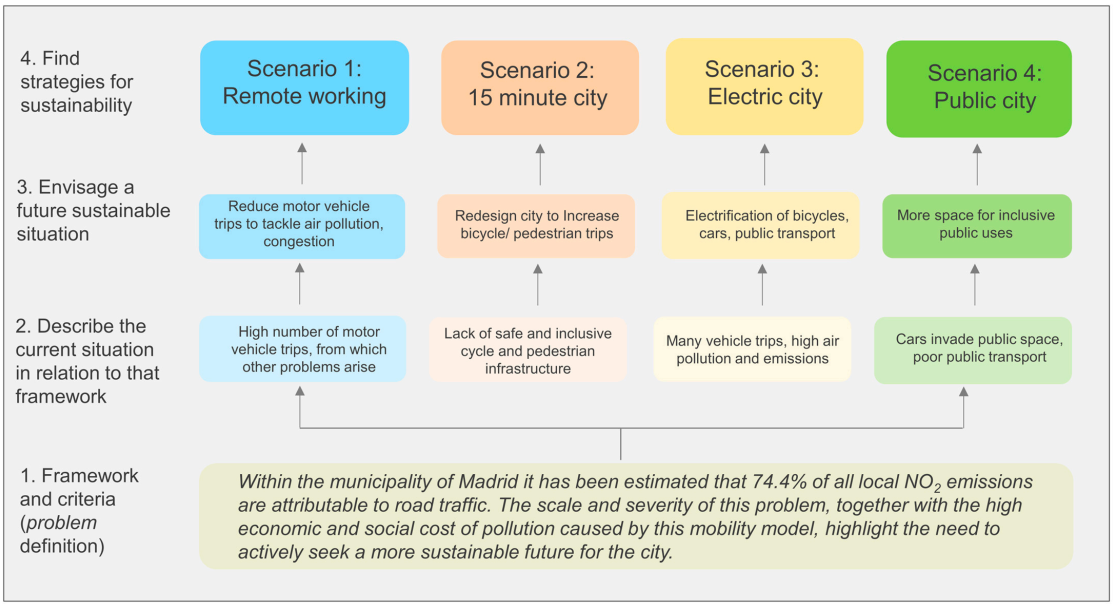



**Figure 2.** Graphical representation of the scenario development process, following the Natural Step approach described by [46]. Authors' own work. The color scheme links this figure to Table 2.

Figure 3 shows the details of the scenario development process as we moved through the four steps of the NS approach.

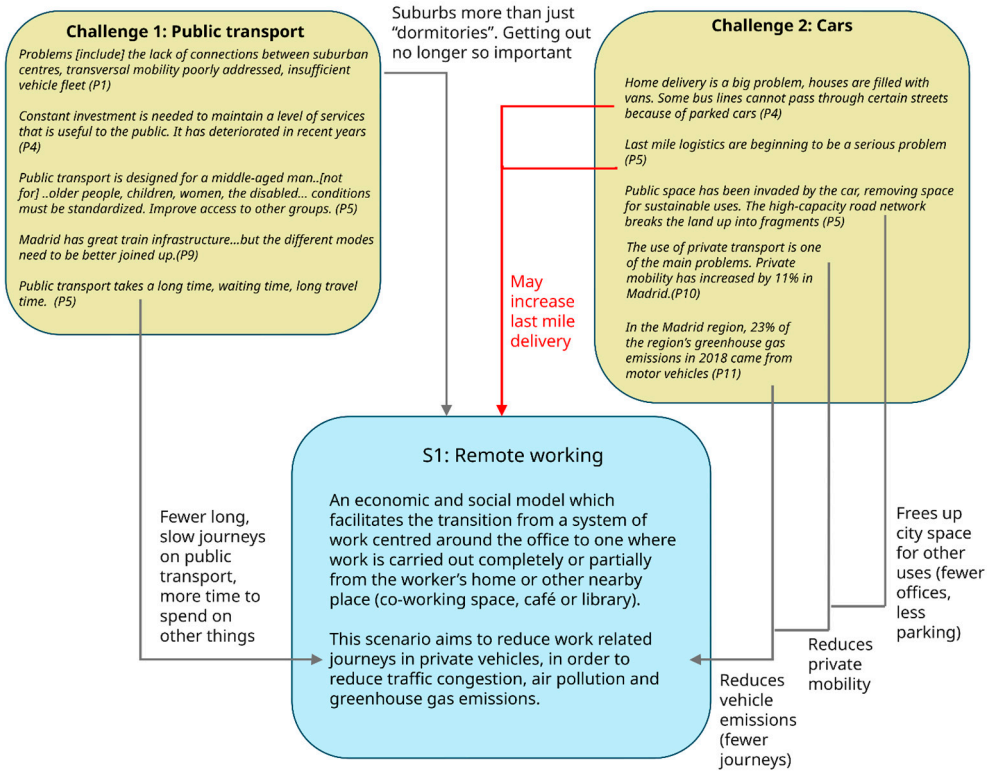



**Figure 3.** The scenario development approach unpacked: Scenario 1: Remote Working, as emergent from stakeholder discourse, using the NS approach. P4, P5 etc. denote participants, their discourse is presented verbatim though slightly simplified for reasons of presentation. Grey connectors indicate anticipated positive impacts from Remote Working, red connectors indicate negative aspects.

The four scenarios thus developed were not entirely exclusive, in the sense that some key themes mentioned by interviewees were common to more than one scenario (Figure 4).

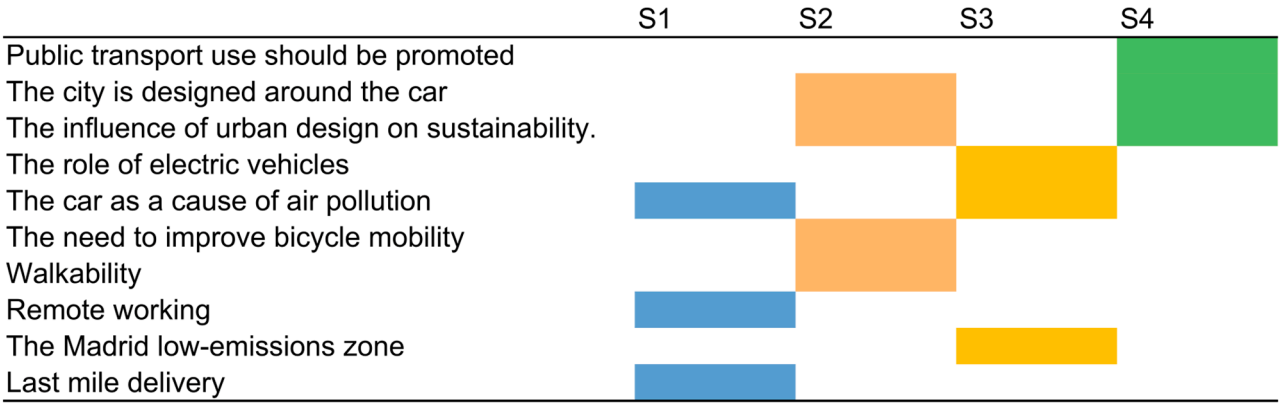



**Figure 4.** Common themes from participants' discourse in each scenario.

## 4. Discussion

### *4.1. Critical Discussion of Strengths, Weaknesses, Opportunities and Threats from Each Scenario*

The four scenarios that emerged are structured conceptualizations of what participants considered the most important challenges to sustainable transport in Madrid, together with what they identified as acceptable or possible solutions. In the final part of the participatory scenario development process, the four scenarios developed as described above were subjected to critical analysis by workshop participants using the SWOT framework.

#### 4.1.1. Remote Working

Under the Remote Working scenario, interviewees had emphasized the need to build dialogue between various social actors to enable a new model of work that is socially just as well as sustainable. The low level of participation of companies and trade unions in the remote working discourse following the widespread implementation during the COVID-19 pandemic was seen as a major problem—indeed, remote working following the pandemic has been largely discretionary, leading to concerns around unequal access to remote working and resulting inequitable distribution of its benefits [55]. It would also be necessary to solve the difficulty that many people have encountered in working from their own home, by creating or enabling remote work centers. If carried out successfully, this could help orient the city towards a more polycentric model, potentially shortening commuting distances and reducing pollution.

However, on the negative side, workshop participants considered remote working to be "overrated" as a solution to the problem of emissions and air pollution. They saw this scenario as unrealistic and felt that it would require a major process of restructuring of "productive activity". They viewed it as appropriate as a complement to other measures rather than a stand-alone solution. Participants noted that aspects of the remote working paradigm could be adopted separately, like allowing employees greater flexibility in their schedules. The completed SWOT analysis results for the Remote Working scenario are shown in Figure 5.

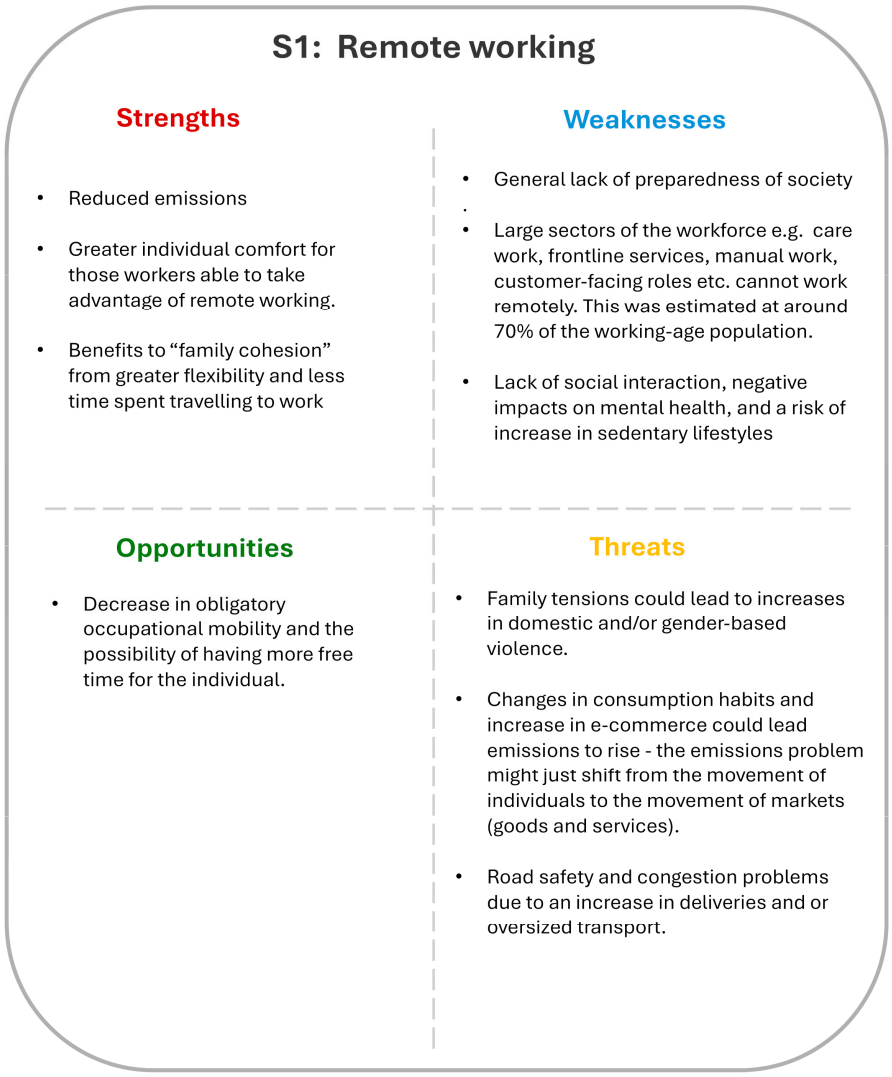



**Figure 5.** Strengths, weaknesses, opportunities and threats of Scenario 1: Remote Working.

#### 4.1.2. The 15-Minute City

The 15-Minute City scenario implies a radical departure from the current conception of the city. The use of the car would be severely restricted, for example, through low-traffic neighborhoods or "superblocks" and a strategic plan based around accessibility and dense concentrations of mixed-use developments (see, e.g., [56]). Interviewees felt that this would require a great mobilization of resources and a "master plan" for the city, guided and implemented by benevolent public administrations, dedicated to improving the well-being of citizens. Participants noted that this scenario would appear to demand a top-down reorganization of the city, which would require the participation of citizens. The city hall has a fundamental role in regulating zoning changes (or land use changes) and should include resident/constituent participation. Citizens may be very reluctant to countenance such severe changes in their mobility habits without major structural improvements, i.e., more and better public transport. It is an open question as to whether the various coalitions of interest that define public policy in the Spanish capital would have sufficient stability to be able to implement the measures necessary for the 15-min city in the face of possible citizen opposition. The completed SWOT analysis results for the 15-min city scenario are shown in Figure 6.

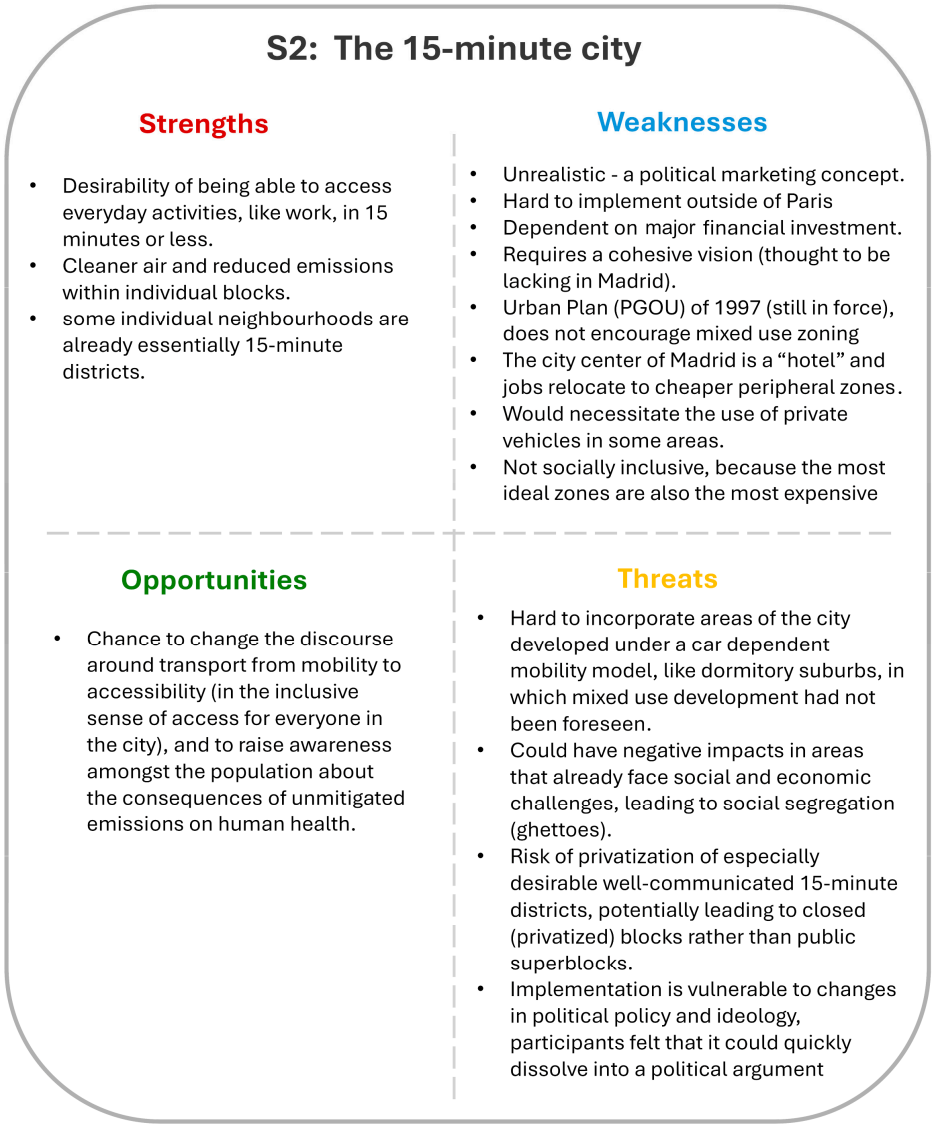



**Figure 6.** Strengths, weaknesses, opportunities and threats of Scenario 2: The 15-Minute City.

#### 4.1.3. Electric City

The Electric City scenario was focused on the electrification and decarbonization of both public and private transport. The scenario is heavily linked to digital infrastructure deployment and the "smart cities" concept. In this case, the state would make a large investment to electrify the Madrid public transport fleet, following the "entrepreneurial state" model of Mazzucato [57]. In this case, the state invests a large amount of money, aware that the investment is not only convenient but necessary. Public spending will be reversed in the long term by higher air quality and cheaper, more effective and efficient transport that improves the quality of life in the city for its inhabitants and visitors. Logically, this scenario presents great economic opportunities for the car industry and other private entities linked to the manufacture and supply of electric vehicles. Electric vehicle adoption is related to affordability, and subsidies have been shown to increase uptake (e.g., [58,59]). In this sense, the private sector could be considered a key beneficiary of policies implemented to realize this scenario. The completed SWOT analysis results for the electric city scenario are shown in Figure 7.

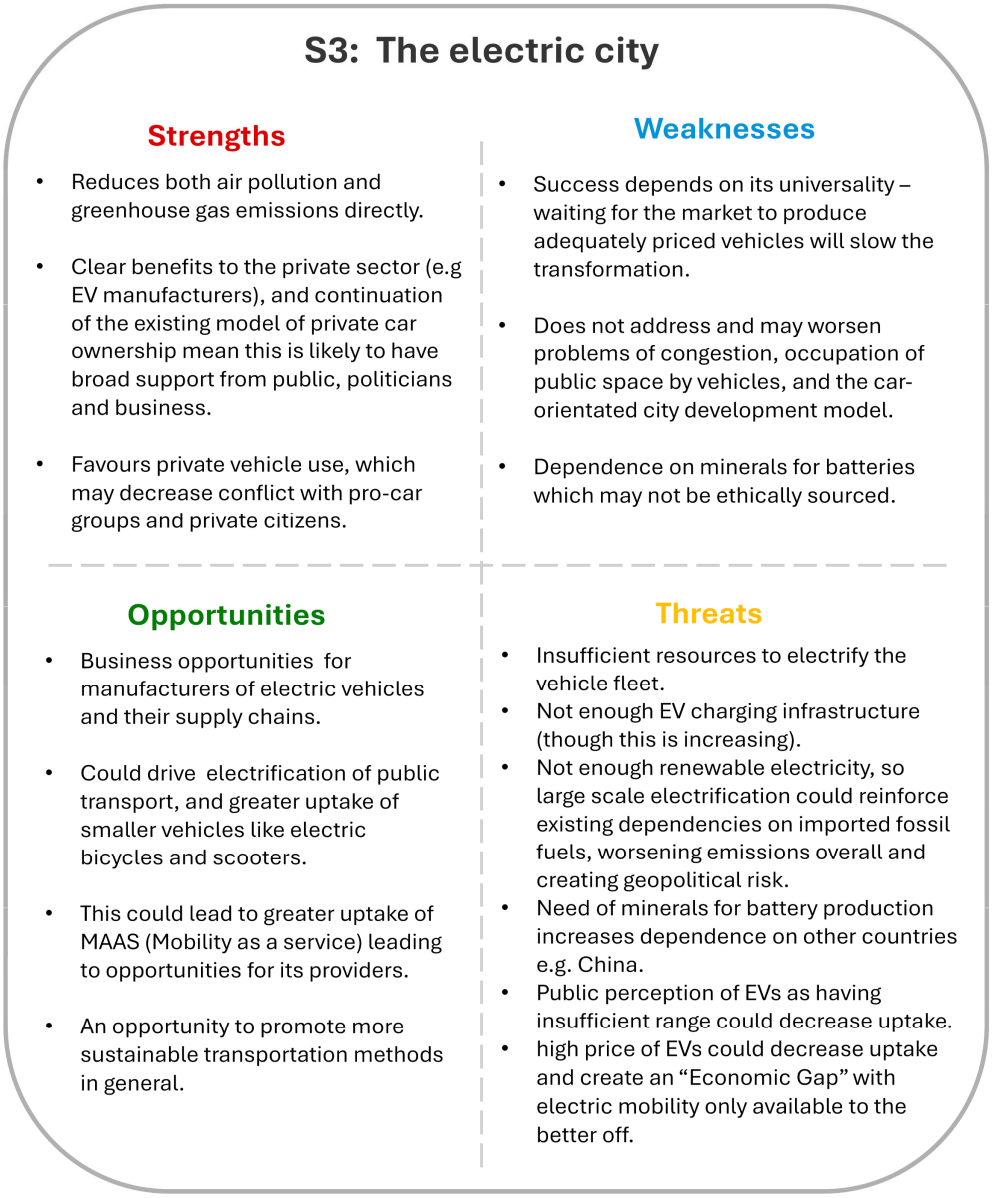



**Figure 7.** Strengths, weaknesses, opportunities and threats of Scenario 3: Electric City.

#### 4.1.4. Public City

The Public City scenario requires significant involvement of public institutions, although not necessarily major institutional changes, megaprojects or non-repayable investment. Under this scenario, the transition to sustainable mobility has more ambitious objectives than simple reduction in emissions. Specifically, it aims to improve public health and build a more equitable society through a focus on social justice. Public transport provision is expanded with the aim of ensuring access for all, including lower-income areas which are typically less well served than wealthier districts (see, e.g., [60]). This scenario is explicitly citizen-driven, such that public authorities actively work to facilitate community initiatives and listen to citizens' mobility demands. In the public city, public authorities work hard to facilitate the participation of the most disadvantaged sectors of society, who, by definition, tend to participate less in civic discourse than more affluent citizens. Participants proposed an alternative name for this scenario: *the caring city*. This was the only one of the four scenarios that met with widespread approval among participants who suggested it should be used as a guiding principle for enacting specific changes defined in

the other three scenarios. The completed SWOT analysis results for the public city scenario are shown in Figure 8.

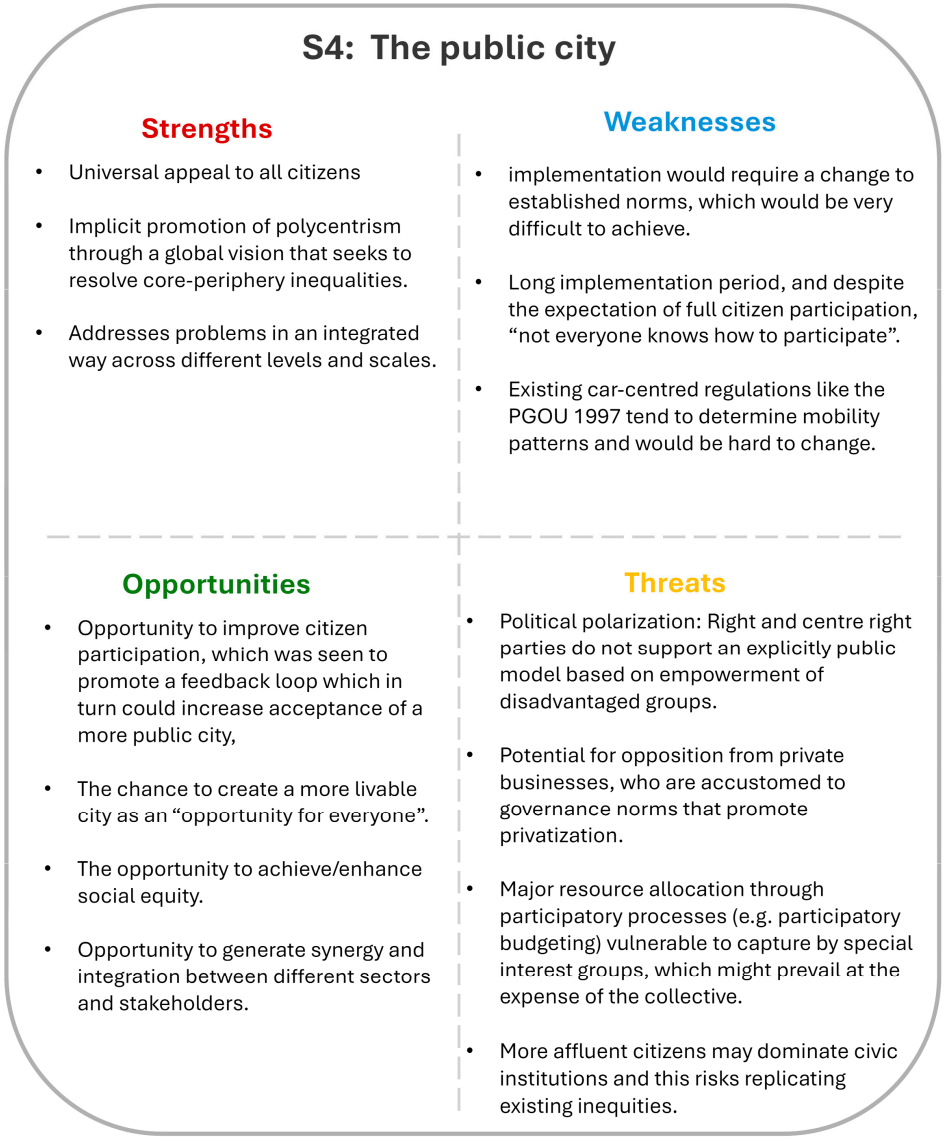



**Figure 8.** Strengths, weaknesses, opportunities and threats of Scenario 4: Public City.

### *4.2. Applicability and International Transferability of Results*

Though the conflicted nature of sustainable mobility and urban design in Madrid makes the city a natural choice for the kind of detailed examination offered in this paper, many of the key points that emerge are likely to be applicable more widely. We discuss the implications of our results for other cities as follows.

A key weakness identified in the Remote Working scenario was that many people are not able to work remotely, for example, anyone engaged in physical handling of products (i.e., industrial, manufacture, building, etc.) or direct contact with others (health and social care). Cities with large scientific, administrative or financial service sectors, such as are found in Europe and North America, might benefit significantly from the adoption of a remote working model, while cities with strong manufacturing or industrial bases, e.g., in China, India or elsewhere in the Global South, would benefit far less. Since larger and capital cities tend to have higher concentrations of employees in the civil service, information technology or finance, there is also a risk of exacerbating inequality between

these and second-tier cities, which may have higher concentrations of industry, services or manufacturing.

Among the participants' major concerns, which featured in all of the scenarios, was that transformation projects might not be socially inclusive or would work to perpetuate existing inequities. However, transformative transport infrastructure projects with benefits for social equity have been undertaken elsewhere. In Colombia, for example, Bogotá's TransMilenio Bus Rapid Transit system [61] and Medellin's Metrocable service [62], which connects poor districts by cable car, are both widely acknowledged successes. These and other experiences might offer useful points of comparison for the implementation of more equitable transportation systems, particularly under the 15-Minute City and Public City scenarios.

Less positively, our participants felt strongly that both the 15-min city and public city models are associated with the political left, leading potentially to rejection by the political right and the business community. This is, unfortunately, a highly relevant observation that is very widely applicable elsewhere. Libertarian, right-leaning politicians routinely oppose cycling infrastructure (e.g., in Toronto, ON, Canada) or low-emissions zones (e.g., in London, UK) and tend to be skeptical of major public investment. In the US, for example, cities with successful public transport systems are often in progressive or left-leaning places, such as Portland, Oregon or Boston, Massachusetts.

### *4.3. Limitations of the Study*

The four scenarios proposed in this paper emerged from the discourse of stakeholders representing academia, business, public administration and civil society, obtained through semi-structured interviews between 2020 and 2021. Some of the same stakeholders attended the workshop in 2022 and evaluated the utility, feasibility and relevance of the scenarios to solving the problem of transport-related emissions. The views obtained are therefore a snapshot of the views of the individual stakeholders involved and clearly not completely representative of wider opinion. They should also be seen in the context of the time the interviews were carried out, shortly after the first wave of COVID-19 infections and related lockdowns, and during a period of public alarm which lasted over 2 years. The workshop was held shortly after the Russian invasion of Ukraine, an event that was in the minds of both participants and facilitators. These two events account for, in the first case, the importance given to remote working as a scenario in itself and, in the second, the concerns about supply chains and energy dependency expressed within the Electric City scenario.

It is useful to consider to what extent these limitations affect the generalizability of our conclusions to other study areas and timeframes. In the first case (the importance given to remote working as a result of participants' experiences during the COVID-19 pandemic) it is clear from the SWOT analysis results that workshop participants were already skeptical of the value of remote working as a solution to the problem of transport-related emissions by June 2022 (~26 months after the initial outbreak and subsequent lockdowns in Spain). Participants' views are reflected by many studies. For example, Cerqueira et al. [63] found that non-work trips accounted for a higher proportion of travel than commuting than usually imagined and that remote workers often traveled further overall since they tended to live further away from their workplaces. Stefaniec et al. [64] report that pre-COVID studies tend to emphasize emissions reduction effects from reduced work travel and lower office use, while post-COVID research "generally indicates modest emissions savings from telecommuting, with diminishing long-term benefits" [64]. In this sense, the pattern observed in the literature was reflected in our participatory process, with interviews carried out during the pandemic emphasizing positive effects and workshops, carried out subsequently, offering a more pessimistic view. This serves to highlight the

value of our two-stage process, in which co-constructed knowledge from interviews is put to the test by later workshops. In sum, it seems that, while remote working may offer some benefits in terms of reduced emissions in specific circumstances, this is not a certainty. Policies to encourage remote working need to account for specific patterns of work and travel in individual cities, as well as other factors like energy use both at home and at work.

With respect to the second limitation, the emphasis given by participants to the question of supply chains (for rare minerals in electric battery production) and energy sovereignty in Europe following Russia's invasion of Ukraine, subsequent geopolitical events suggest that these questions are more relevant than previously thought, rather than less. Initially, it appeared that widespread concerns about European dependence on fossil fuels from Russia would accelerate a Europe-wide energy transition leading to widespread electrification from clean energy sources [65]. However, the subsequent US trade war with China [66] and the EU's imposition of tariffs on Chinese electric vehicles [67] are likely to lead to lower levels of electric vehicle uptake than would otherwise be the case in US and European cities, delaying the transition and prolonging the causes and consequences of urban air pollution in these areas.

We note, however, that no participatory process is ever entirely disconnected from global events, and no stakeholder is ever completely impartial. Indeed, our aim has not been to coldly examine possible solutions to sustainable transport in Madrid but to draw out trajectories seen by key public and private sector stakeholders as possible, likely or feasible. In this sense, our work serves to identify pathways and barriers to solutions typically proposed in public discourse and to provide a platform for future studies, e.g., around citizens' preferences according to age or political affiliation.

Finally, while it might be suggested that scenarios should be entirely non-overlapping, this seemed to us not to be necessary as long as the main focus of each scenario was clearly distinct from the others. For example, while Public City clearly contains elements of the 15-Minute City, the latter is narrowly focused on a specific outcome around time-related accessibility, while the former looks to integrate low-carbon mobility into a broader vision of the city oriented around social inclusion and citizens' welfare.

### *4.4. Policy Recommendations*

In the following section, we draw out the weaknesses and threats identified by our participants and offer some recommendations as to how these problems could be mitigated at the policy implementation stage. We also suggest specific actions (policy tools, funding mechanisms and governance reforms) that could be taken to address these concerns.

#### 4.4.1. Social Justice/Equity

In 2020, Madrid city council commissioned a detailed study of grassroots initiatives in energy [68]. The study identified five guiding principles for ensuring social justice in energy transition contexts: 1. democratic governance; 2. civil empowerment and capacity building; 3. human rights approach; 4. diversity of actors; 5. sustainability. These principles, described in detail in [68], could be used to evaluate sustainable transport initiatives of various kinds.

#### 4.4.2. Difficulty of Structural Change, in Particular, Multi-Use Zoning

This issue stems from the restrictive nature of the most recent urban plan, the PGOU 1997. Fortunately, a new urban plan is currently in preparation. The new urban plan can, and should, incorporate solutions to the key problems identified in this piece, especially in the 15-Minute City scenario. This important planning reform would permit much more radical transformation of the city.

#### 4.4.3. Political Polarization

A number of specific steps can be taken to try to mitigate this problem. First, focused information gathering is very important. A detailed search for successful sustainable transport initiatives implemented under right-leaning administrations would be a good starting point. Further, policymakers should try to identify areas of overlap between apparently opposed ideologies, and in this, our scenarios may help. For example, the Electric City scenario appeals to business by offering direct benefits to the private sector, e.g., to car manufacturers and their supply chains, and is less likely to be rejected by citizens who oppose controls on the private car. But it also offers opportunities for large-scale electrification of public transport and could lead to a more sustainable transport model overall, while not appearing politically divisive. At the same time, while the 15-Minute City is strongly associated with the political left and in particular the socialist administration of Mayor Anne Hidalgo in Paris, the objectives behind the concept (less obligatory mobility, closer services and cleaner, safer streets) are likely to appeal to a wide range of groups. For example, environmentalists, who tend to be on the left, would support motor vehicle access restrictions based on arguments about sustainability, while conservative-minded citizens might be convinced by arguments about cleanliness and safety. The lesson here is to remove the politically divisive branding and concentrate on the specific measures.

#### 4.4.4. Implementation

In line with our stated aim to move beyond the state of the art in the literature on participatory scenario development, we can identify a number of weaknesses and threats identified that relate to challenges in policy implementation. Table 3 (below) highlights these implementation barriers and suggests policy pathways that may help mitigate them.

**Table 3.** Barriers and policy pathways for sustainable mobility in Madrid.

| Scenario | Implementation Barrier | Policy Pathway |
| --- | --- | --- |
| Remote Working | Lack of preparedness of society | Consultation with employers and worker's representatives would be a prerequisite for systematic implementation. |
| 15-Minute City | Associated with the political left | Focus on specific initiatives likely to receive cross-party support and raise public awareness [1] through non-partisan information campaigns |
| | City plan (PGOU 1997) does not permit multi-use zoning | Include multi-use zoning in new city plan |
| Electric City | Success depends on widespread adoption of EVs | Subsidize EV purchases, incentivize manufacturing (tax breaks) [2], use public procurement to ensure transition of public vehicle fleets |
| Public City | Opposition from business sector and right-wing parties | Raise public awareness [1] about incremental privatization of public spaces, use new city plan to limit private development encroachment on public land |

[1.] Public awareness is a key research gap in the sustainable cities literature. The systematic review by Wu et al. [69] provides a good point of access to this important topic. [2.] Specific funding mechanisms vary widely and may be directed at individual citizens, at employers or at local government. For promoting low-carbon travel they may include, for example, low-emissions travel to work schemes, e.g., salary complements or employer-subsidized vehicles; vehicle scrappage initiatives (payments to exchange old cars for new).

## 5. Conclusions

Stakeholders in Madrid engaged deeply and critically with modern tendencies in sustainable urban mobility, leading to four clear discourses which were used to form the scenarios. Remote working (S1) was not seen as a solution in itself to the serious problems of greenhouse gas emissions from the transport sector and associated severe air pollution, due to the risk of an increase in e-commerce and, consequently, more deliveries, congestion and emissions. In addition, around 70% of the workforce would be unable to work remotely. The 15-min city concept (S2) was largely viewed as an unattainable utopia or an exercise in branding, thought to be difficult to apply to cities beyond the original model (Paris). The wholesale electrification of transport (S3) was understood to be useful as a direct and

currently available tool that would certainly reduce emissions. But there was concern that it did not address mobility in an integrated way and, in particular, did nothing to reduce car dependence or challenge the status quo and that electric vehicles continue to be expensive relative to combustion-engine models. The public city concept (S4) was strongly favored over the other scenarios. However, stakeholders also felt that such a strongly public vision, in which structural social inequalities would be explicitly targeted, would be politically divisive. This is because the current right-leaning administration of both the city of Madrid and the regional assembly tends to reject interventionist approaches and view privatization as a force for civic freedom, while attempts to seriously address environmental impacts and social inequity through policy have become associated with the political left.

One possible way out of this quandary would be to develop public mechanisms for supporting social innovations in sustainable mobility at the level of the individual neighborhood or district but without specifying or prescribing the kinds of solutions developed. Segales et al. [68] have shown what such a process might look like for the case of clean energy. As these authors have noted, the social innovation framing may allow political differences to be put aside—promising initiatives could be selected for public funding through best practice competitions (see, e.g., [70]), but these could be business–entrepreneurial focused (appealing to libertarian capitalists) or community-based social enterprises (appealing to redistributive socialists). Small-state private sector enthusiasts would presumably not object to receiving public funds, and it does not really matter whether social innovators view themselves as entrepreneurs or as a "community of makers".

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## Appendix A




**Figure A1.** Workshop Program 21 June 2022.

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