MICROINCENTIVES FOR SUSTAINABLE MOBILITY IN EUROPE

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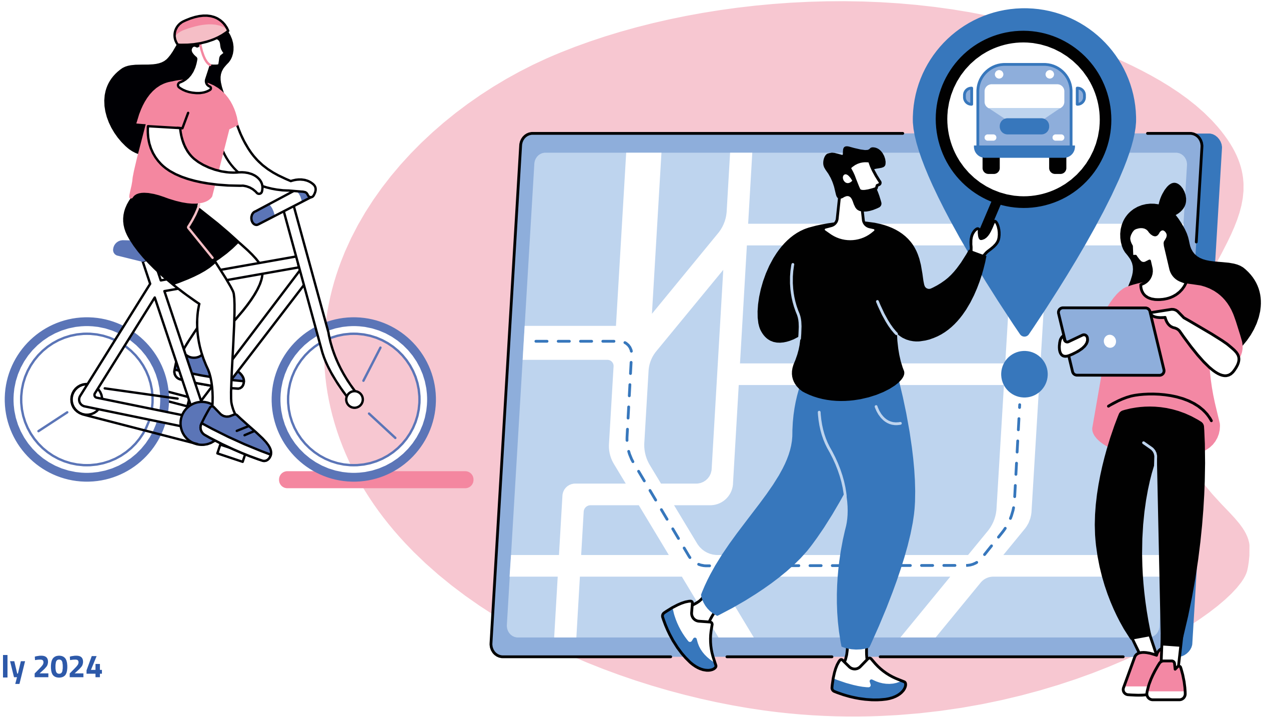

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Executive summary

Public transport relies on subsidies from public authorities and organisations in most cities and regions globally. Our analysis reveals that, on average, public subsidies constitute roughly half the yearly revenue for most Public Transport Authorities (PTAs) in Europe. These subsidies serve two key purposes:

- **Equity:** They ensure accessibility for specific societal groups, typically those with lower incomes.
- **Efficiency:** By making public transport more competitive, subsidies help reduce externalities associated with excessive private vehicle use, such as congestion, emissions, and safety concerns.

This study explores the potential for improvement in how public transport subsidies function. We propose a shift towards a more flexible, dynamic, and targeted approach, ultimately aiming to enhance the societal impact (both equity and efficiency) of subsidies and optimise their management for PTAs. We refer to this novel approach as microincentives. But what are they exactly?

Microincentives are essentially tailor-made reward schemes, either monetary or in-kind, designed based on flexible and dynamic criteria to maximise the impact of subsidies in achieving financial and societal goals. These criteria could include promoting specific transport modes at particular times, days, routes, or for designated user categories. Microincentives are envisioned to be highly granular, potentially allowing for individualised incentives for each journey.

The report explores two key use cases for microincentives:

- **Off-peak Travel Incentives:** Encourage public transport use during off-peak hours to smooth ridership patterns.
- **Sustainable Travel Incentives:** Motivate a switch from car journeys to more sustainable modes, including micromobility options, ride-hailing services for first/last-mile connections to public transport hubs, and carpooling.

This study incorporates four main components:

- **Qualitative Analysis of Current Subsidies:** Utilising data from the EMTA barometer 2022 (with data up to 2020), we assess the current state of subsidies.
- **Literature Review:** We examine the existing impact of transport subsidies on equity and externality reduction.

- **Expert Interviews:** Interviews have been conducted with PTAs (Barcelona, Madrid, Berlin, Oslo, Leuven) and mobility experts.
- **User Survey:** A user survey has been conducted across Barcelona, Madrid, Berlin, Oslo, and Lisbon, with a total sample of 2,250 respondents. This survey includes a stated-preference block to analyse user acceptance of microincentives for both car and public transport users.

Results suggest that:

- Subsidies could be more efficient and effective if targeted and combined with disincentives for car use, such as low emission zones or increased parking charges.
- Existing funding mechanisms for public transport are struggling to keep up with rising costs. Implicit subsidies for private transport further distort the market. Therefore, exploring new funding sources and optimising existing subsidies is critical.
- Users are receptive to price differentiation based on factors like distance or environmental impact, provided a seamless payment system across all mobility modes exists (similar to a Mobility as a Service (MaaS) scheme).
- Car users are sensitive to price and are willing to switch to alternative modes to save money compared to their car trip. This highlights the importance of service quality in modal shift (as different cities provide different quality levels), but also suggests that price incentives can still be effective. For example, in Barcelona, a 15% discount is sufficient for 20% of users to switch from a car trip with the same travel time, while in Lisbon this value grows to 31%. Notably, in Berlin and Oslo, no discount is even needed to achieve this shift, suggesting a higher baseline attractiveness of public transport in those cities.
- Similarly, public transport users who travel during peak hours are also willing to change their behaviour in exchange for incentives. However, they appear to be less sensitive to price changes compared to car users. The study suggests that higher discounts than those effective for off-peak travel or car users might be necessary to convince them to shift travel times by even a modest amount (e.g., 30 minutes before or after peak hours).

This initial analysis underscores the potential of microincentives to improve public transport ridership and achieve broader sustainability goals. The report delves deeper into these findings and explores the practical implementation of microincentives for PTAs.

1 Introduction

In 2021 we published a short article called ***"The beauty of microsubsidies, a new era in the management of public transport?"***[1] which argued that there is ample scope to enhance the management of subsidies in public transport. This includes improving their impact on the societal goals they aim to achieve and optimising the "limited" resources that transport authorities have at their disposal. In this article, we suggested that microsubsidies (or microincentives, as we will refer to them interchangeably throughout this report), understood as very targeted subsidies whose size could depend on certain features of the recipient, the mode of transport, the route, and the time of travel, etc., could be a much more efficient and equitable way to nudge users towards more sustainable mobility.

This report builds on the ideas presented in that article and aims to better understand how subsidies are currently being deployed by PTAs today. It analyses their effectiveness in facilitating access to mobility for certain groups of users, as well as their impact on making public transport more competitive compared to private cars. Lastly, and most importantly, we aim to gain an initial understanding of the potential that microsubsidies could have as a tool to make mobility more sustainable.

[1] Available at www.factual-consulting.com/the-beauty-of-micro-subsidies-a-new-era-in-the-management-of-urban-mobility

The goal of this report is not to provide conclusive answers but rather to present relevant insights regarding the potential implementation of microincentives. The major financial crisis of 2008, the COVID-19 pandemic, and the war in Ukraine have created a significant paradox for public transport and mobility in general: on the one hand, the crisis caused by the pandemic has reinforced the case for public transport as the core element of the mobility system, especially in urban areas; but on the other hand, the financing of public transport has been under considerable stress for the past 15 years due to increasingly demanding budgetary constraints.

The report is therefore very timely, as PTAs need to explore new funding schemes, and microsubsidies are undoubtedly a venue worth exploring. As the report shows, many European governments have implemented various free public transport schemes in response to the COVID-19 crisis. While these schemes may be justified on a temporary basis (essentially as a way to compensate users for lost income during the pandemic and for increased living costs due to the war in Ukraine as well as other, less obvious, motivations), their unlimited extension over time could have harmful effects on public transport (resulting in inevitable service deterioration) while having limited impact on incentivising users to reduce private car use.

The funding of public transport and mobility in general is thus currently an open question, and microsubsidies could be part of the answer. When analysing potential new ways to fund mobility, it is important to acknowledge certain contextual changes: firstly, technology is becoming increasingly available (at affordable costs) to design more targeted fares; secondly, the pay-per-use principle is gaining acceptance as a key policy principle; thirdly, the rapid deployment of shared mobility modes (which can provide a sustainable alternative to traditional modes) offers a powerful new option in urban mobility that needs to be acknowledged in policy design and subsidy frameworks. With all this in mind, the study aims to stimulate discussion on how to improve public transport and mobility funding and make this funding and its impact increasingly sustainable. Naturally, this is a lengthy and complex discussion, and this report modestly aims to contribute some interesting insights.

The study is structured into three main parts. Firstly, we present an overview of subsidies to public transport in Europe today, analysing both quantitative and qualitative aspects. Secondly, we focus on the current impact of subsidies and their capacity to facilitate access to public transport and contribute to more sustainable mobility. Thirdly, we discuss the potential for implementing microincentives by identifying specific use cases.

1.1 The conceptual framework

The underlying idea behind microsubsidies is simple and not new, as it replicates the concept of price discrimination widely used in mainstream economics, but in this case applied to subsidies in public transport.

In our 2021 article, we argued that the impact of subsidies and their cost to the Public Authority (PA) can vary significantly depending on how targeted they are, as illustrated in this very simplified graph (*Figure 1*):

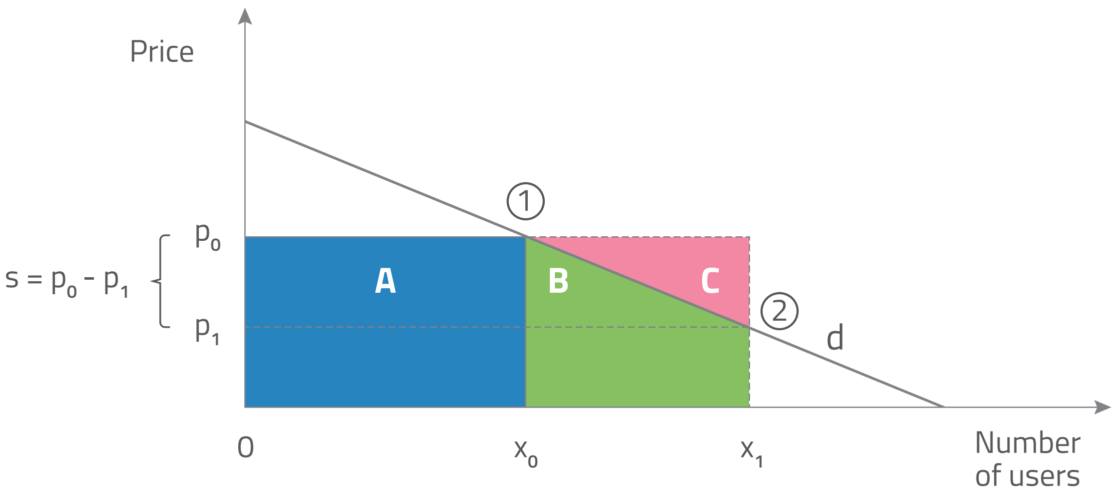


Figure 1: Uniform vs targeted subsidies (own elaboration)

Typically, subsidies are given to facilitate access to certain (often disadvantaged) groups or to enhance the competitiveness of public transport against private cars, thus increasing its demand.[2] In the *Figure 1* graph, d represents the demand curve for public transport and ① represents the combination of price (p_0) and quantity (x_0) - i.e., demand - without subsidies. With a subsidy (s), we move to ② where price is reduced to p_1, and demand increases to x_1. What is the total amount of subsidies that the PA needs to disburse? There are three possible scenarios:

[2] The increase in demand for public transport reduces the demand for trips by private car, thereby reducing the externalities it generates, such as damaging emissions to the environment (which affect climate change and air quality), congestion, injuries, and fatalities from road crashes, noise, and occupation of public space. The reduction of all these effects justifies the subsidy to public transport.

- In the first one, the PA gives a uniform subsidy (s) to all public transport users ($0\text{-}x_1$) and all of them pay the same price, p_1. So, the total amount of subsidies that the PA has to disburse is A+B+C. In this scenario, users $0\text{-}x_0$ receive a subsidy when they do not actually need one to access public transport;
- In the second scenario, the PA gives a uniform subsidy (s) only to the group of targeted users x_0- x_1. These users pay the price p_1; the rest of users ($0\text{-}x_0$) pay the price p_1. So, the total amount of subsidies to be disbursed by the PA is B+C;
- Finally, in the third scenario, users x_0- x_1 are the ones who receive the subsidy, but the subsidy is different for each user, that is, each user pays a different price and the PA complements with a different subsidy to each of these users to cover the costs of the operator. The rest of users ($0\text{-}x_0$) pay price p_0. So, the total amount of subsidies needed is only C. Conceptually, this third scenario is the one that corresponds to microsubsidies, i.e., the case where there is full discrimination of subsidies.

In the 2021 article, microsubsidies[3] were defined as:

"Targeted subsidies down to the level of very narrowly defined categories or even individual users that can be modulated according to categorical/personal characteristics (age, income, disability, socio- economical groups –like unemployed-, etc) and any relevant feature of the journey (like time, geolocation, mode of transport, type of motorisation of the vehicle, occupancy, etc)".

The article concluded, then:

"With microsubsidies the PTA has the capacity to decide how to best combine these criteria in order to ensure that everyone has access to transportation and to achieve other societal goals such as reducing emissions, reducing congestion or improving road safety. Microsubsidies are linked to the category/individual and their specific journey, and therefore need not be exclusively linked to them using a certain mode of transport operated by a public operator or a concessionaire as is the case with current subsidies. Surely, with microsubsidies a large bulk of subsidies will go to mass transit operators, but microsubsidies open the door to subsidising journeys made in other modes, even if they are privately operated, if this is deemed desirable because of equity or efficiency considerations. In the limit, and just to illustrate this point graphically, microsubsidies could subsidise people to walk or bike instead of using certain motorised modes of transport if this were justified from an environmental point of view, for example".

[3] Note that microsubsidies refer to the financial support given by PA to certain users to incentivise the use of public transport. In a broader sense, microincentives refer to financial or in kind support given by PAs or by private entities to incentivise certain users to use certain mobility modes.

1.2 A word of caution: microsubsidies in practice

Our previous analysis confirms a well-known fact among theorists and practitioners alike: subsidy discrimination, or its opposite, price differentiation, is a superior solution to flat subsidies or flat fares in terms of efficiency. This approach allows for achieving a similar impact with fewer public resources or a greater impact with the same amount of public resources.

In practice, however, things can become more complex, as there are other considerations that need to be taken into account (EMTA, 2016).

Among these considerations, the following seem especially relevant:

- **Simplicity:** PTAs seem to value simplicity as a key element in the design of the fare structure. Simplicity is valued from a management perspective (the cost of designing, explaining, and managing uniform fares is much lower) and also because it facilitates income forecasting for the PTA.
- **Fairness:** Mobility is a sensitive issue from a social standpoint, so equity considerations are crucial and need to be duly considered. Equity issues are relevant because changing the fare structure to make it more efficient may result in some groups paying higher prices and therefore opposing these changes. The question then arises of how these groups can be compensated, and there are likely instruments within the general tax system (notably income taxes) to provide this compensation without affecting their incentives to use different mobility modes.

Ultimately, the concept of microsubsidies and their potential application to public transport should be understood in a pragmatic manner. The idea is not that microsubsidies should imply a radical change in the design and development of subsidy policies in public transport. Subsidies already exist in public transport, and in some cases, they are more or less targeted. Microsubsidies open the door to a much more precise approach to subsidy policy with the aim of maximising its impact and optimising the use of public resources.

Therefore, microsubsidies can either refine existing subsidies or identify new cases - be it groups of individuals, types of journeys, moments in time, modes of transport, etc. - that authorities want to target in order to achieve the societal goals they have set with the minimum amount of public resources.

The potential implementation of microsubsidies should be seen more as a process than as a fixed state. In other words, when discussing microsubsidies, it is not a black or white issue but rather a matter of shades of grey. It is not a matter of essence but rather one of degree.

2 Subsidies to public transport in Europe today

In the following sections, we provide an overview of subsidies in a highly representative group of European cities. These cities include Amsterdam, Barcelona, Berlin, Budapest, Copenhagen, Frankfurt, Helsinki, London, Lyon, Madrid, Oslo, Paris, Prague, Stockholm, Vilnius, and Warsaw. We selected these cities based on the availability of complete data in the EMTA Barometer. For these cities, we analysed the period from 2013 to 2019, excluding the year 2020, to isolate the significant impact that the COVID-19 pandemic had on public transport ridership.

2.1 Quantitative analysis

Subsidies are a widespread reality in public transport in Europe today and they constitute a significant portion of PTAs' revenues. During the period 2013-2019, subsidies accounted for around one-third of total revenues, but there was a clear downward trend (see *Figure 2)*. In fact, their share decreased from 39.4% to 31.4% of total revenues. This reduction was offset by an increase in sales revenue (from 44.1% to 46.5%) and particularly from other sources of revenue (from 16.6% to 22.1%). Therefore, somewhat surprisingly, following the major financial crisis, revenue from fares gained prominence at the expense of subsidies in the financing of public transport.

2.1.1 Revenue structures across Europe

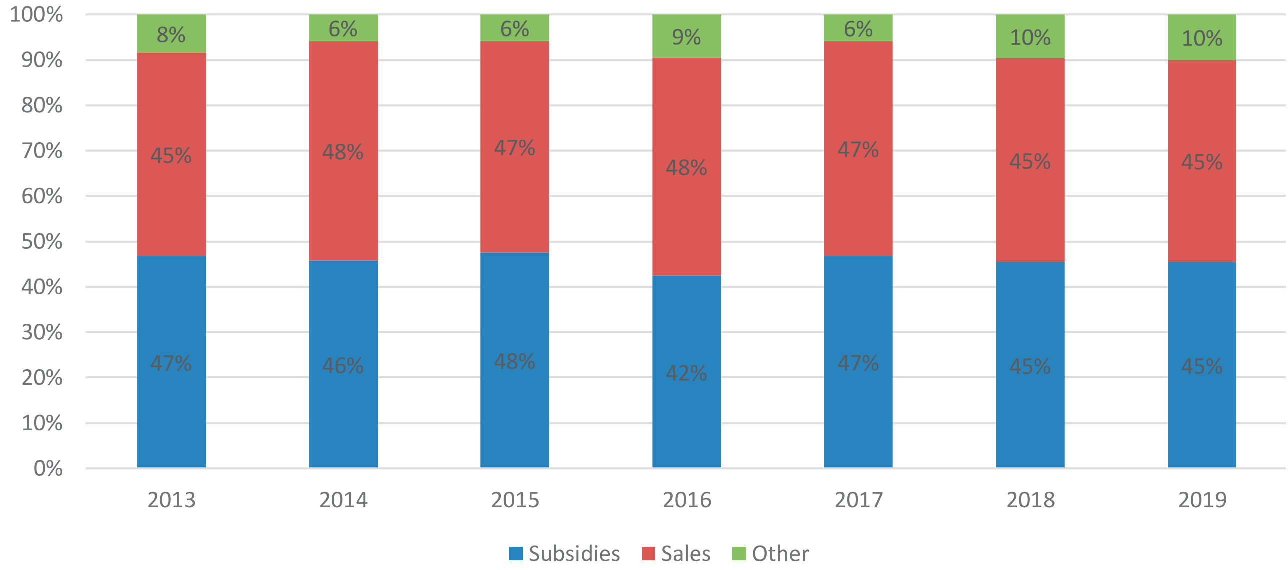


Figure 2: Revenue structure aggregated (2013-19)

The revenue structure varies significantly, however, across the cities considered (see *Figure 3)*. Basically, two groups can be distinguished: on the one hand, there are London, Paris, and Lyon where other revenue is very significant and subsidies account for the smallest share of total revenue; on the other hand, there are the rest of the cities where subsidies have an important weight, yet it varies significantly: from 34% (Amsterdam) to 80% (Prague).

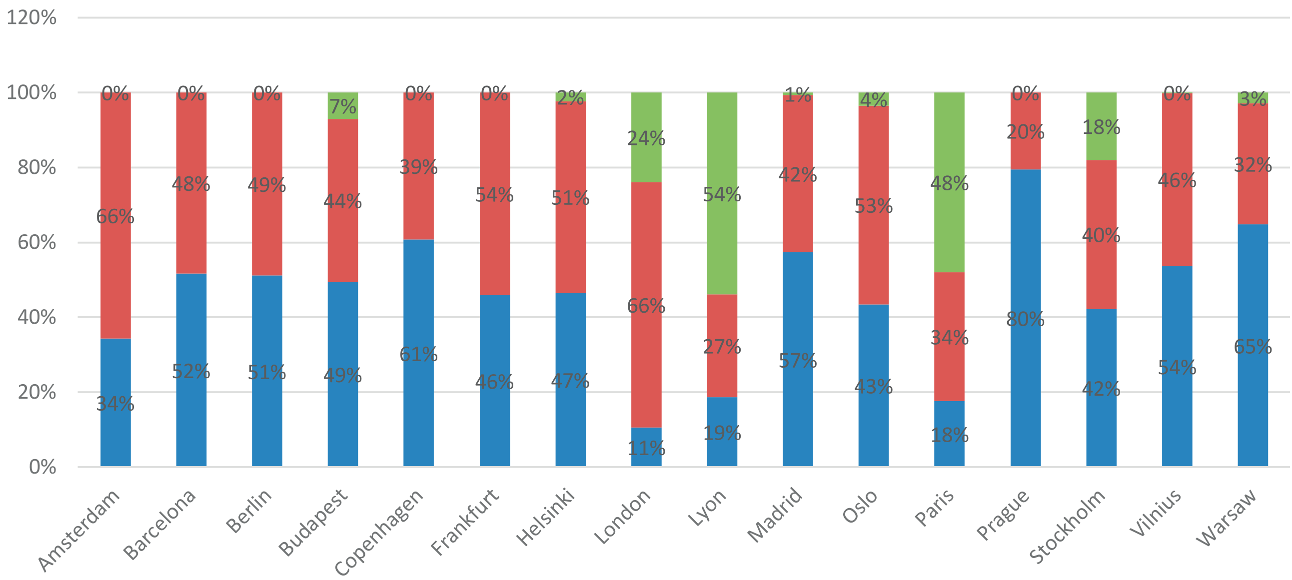


Figure 3: Revenue structure per PTA in 2019

The revenue structure not only differs significantly across cities in 2019, but its evolution since 2013 has also been markedly different (see *Figure 4*). In Amsterdam, Budapest, Helsinki, and Oslo, the share of subsidies decreased at the expense of an increase in the share of fare revenue. In contrast, in Barcelona, Berlin, Copenhagen, Frankfurt, Madrid, Prague, Vilnius, and Warsaw, the opposite occurred. Additionally, in London, Paris, and Lyon, other revenue increased; in London and Lyon, this increase was at the expense of subsidies, while in Paris, it was at the expense of fare revenue.

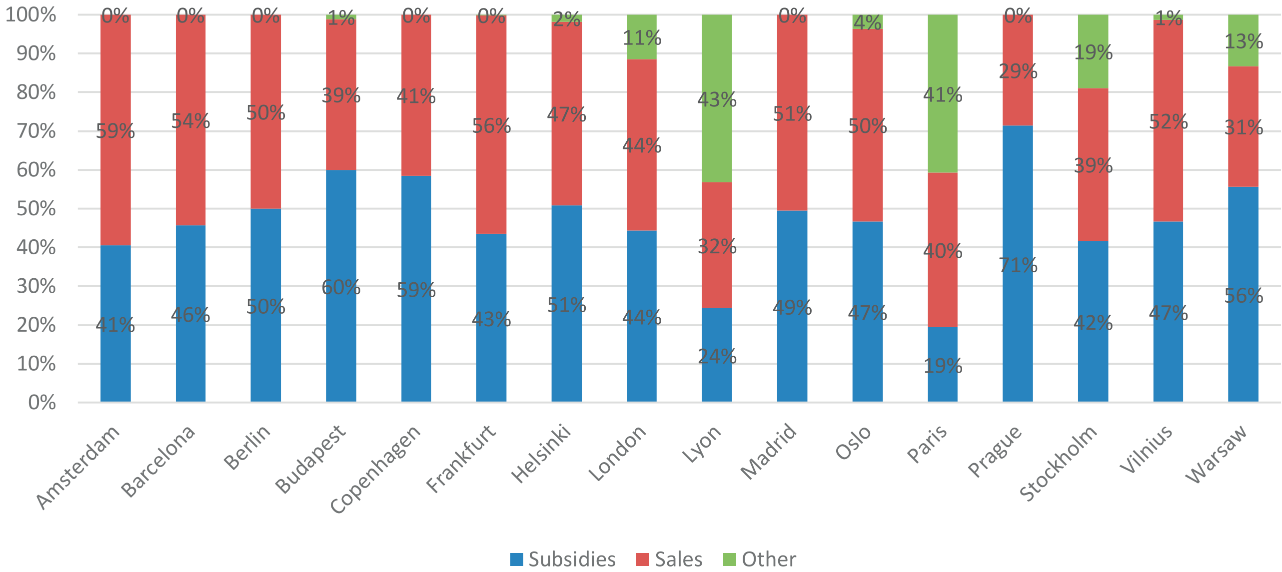


Figure 4: Revenue structure per PTA in 2013

2.1.2 Public transport trends across European cities

The lack of a common pattern in the evolution of the revenue structure of PTAs is confirmed when taking a broader look to also consider the evolution of demand, supply, and operational costs of public transport in the period 2013-2019. This is illustrated in *Table 1* following. On average, demand for public transport (measured in millions of boardings) increased by 12.7%, supply of public transport (measured in million vehicle-kilometres) by 15.5%, and operational costs by 15.8%. This implies that, on average, the occupancy ratio fell by around 3 percentage points (the difference in the rate of change between demand and supply), and the unit cost in nominal terms remained constant (as supply and total operational costs grew at the same rate).

However, this general trend is actually the outcome of very divergent trends at the city level. Demand grew strongly – at two-digit rates – in most cities except in Vilnius, Budapest, and most significantly in London, which has a very high weight on overall demand.

Supply exhibited more divergent patterns, with some cities showing very high rates of growth (such as Barcelona, Oslo, Prague), while others experienced a reduction in supply (like Budapest, Lyon, and Madrid, for example). Interestingly, the rate of change in operational costs appears to be more aligned with the evolution of demand than with that of supply.

	Trends in public transport across European cities [Percentage change in the period 2013/19]					
	Demand of public transport	Supply of public transport	Operational Cost	Subsidies	Sales	Other
Amsterdam	60%	-4%	19%	7,5%	40%	0%
Barcelona	35%	106%	34%	54%	22%	0%
Berlin	17%	6%	36%	33%	28%	0%
Budapest	2%	-8%	28%	3%	39%	692%
Copenhagen	44%	25%	6%	11%	2%	0%
Frankfurt	39%	5%	25%	32%	20%	-100%
Helsinki	13%	0%	29%	17%	38%	62%
London	4%	5%	0%	-81%	16%	65%
Lyon	13%	-9%	17%	15%	27%	87%
Madrid	17%	-4%	25%	42%	1%	0%
Oslo	15%	87%	28%	16%	33%	22%
Paris	11%	15%	15%	8%	3%	40%
Prague	12%	52%	42%	58%	1%	0%
Stockholm	14%	1%	16%	21%	20%	13%
Vilnius	-48%	28%	25%	37%	6%	-94%
Warsaw	17%	22%	14%	33%	18%	-75%
Average	13%	15%	16%	-13%	15%	45%

Table 1: Trends in public transport across European cities [Percentage change in the period 2013/19]

The evolution of subsidies, sales revenue and other mirrors what we saw in *Figures 2* and *3*. Overall, subsidies decreased by 12.9%, but this is exclusively due to the significant reduction of subsidies in London (-81.4%), as in the other cities considered, subsidies increased, albeit at very different rates, with Prague and Barcelona showing the highest rates of increase (57.8% and 54.2% respectively). Revenue from sales grew by an average of 15.1%, with varying growth rates (all positive) across cities. Interestingly, in six cities (Amsterdam, Budapest, Helsinki, London, and Lyon), sales grew faster than subsidies, while in Stockholm and Berlin, both variables grew at similar rates.

Finally, other revenue increased on average by 45.4%, with strong growth in Copenhagen, London, Helsinki, Lyon, and Paris. Interestingly, this significant growth in other revenue seems to be strongly correlated with low growth in subsidies. Therefore, some cities appear to be using revenue from other sources to reduce the relative weight of subsidies, but not of sales revenue.

2.1.3 Fares per trip

Actual fares per trip vary significantly across cities (see *Figures 5* and *6*), and they have changed very differently across cities in the period 2013-19 (refer to *Figure 7*). Fares per trip increased in eight cities but decreased in six cities during the period under consideration.

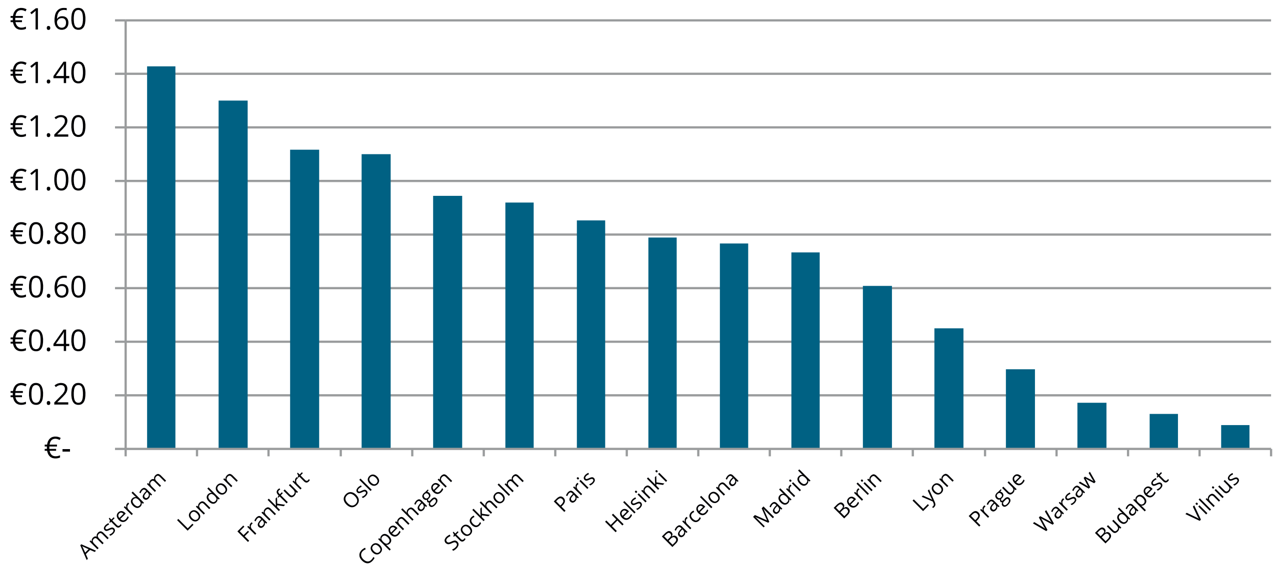


Figure 5: Fare per trip in 2013

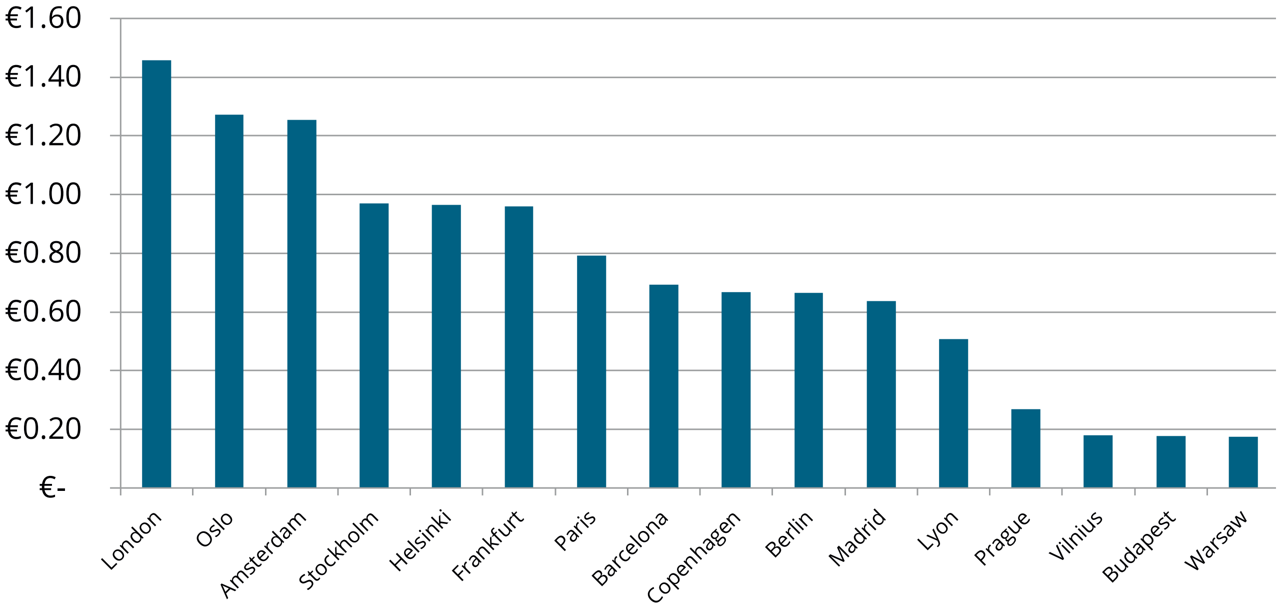


Figure 6: Fare per trip in 2019

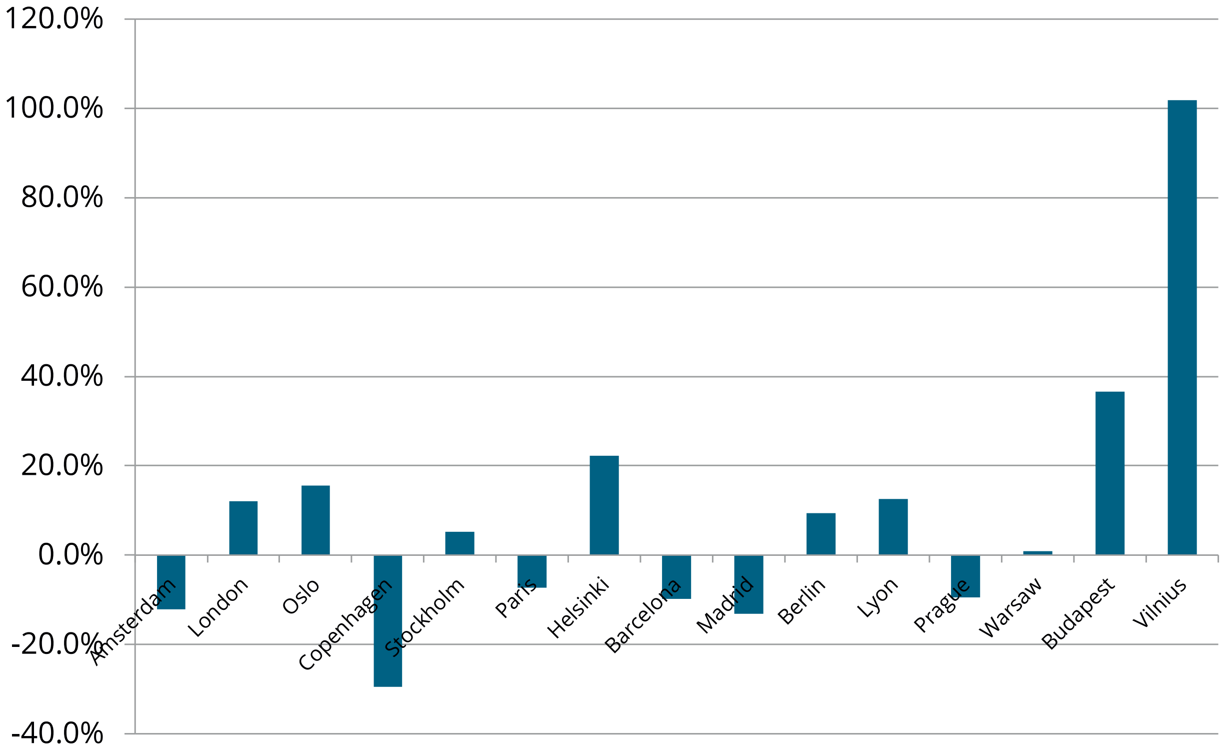


Figure 7: Percentage change in fare per trip (2013-19)

Surprisingly, however, the percentage changes observed in fares per trip do not correspond to the changes introduced by PTAs in their single tickets and monthly passes.

This is illustrated in *Table 2*:

	Fare per trip	Percentage change (2013-19) of single ticket		Percentage change (2013-19) of monthly pass	
City	% Change, 2013-19	Urban	PTA	Urban	PTA
Amsterdam	-12,1	121,6	78,6	122,2	116,7
Barcelona	-9,8	2,4	0,4	10	-54,7
Berlin	9,3	3,8	N/A	13,3	N/A
Budapest	36,5	-6	N/A	-6	N/A
Copenhagen	-29,4	17,9	N/A	0	450
Helsinki	22,2	28,4	9,7	12	-8,6
London	12	3	N/A	-2,3	N/A
Lyon	12,6	11,1	11,1	11,8	11,8
Madrid	-13,1	4,6	4,6	0	0
Oslo	15,6	-0,3	-1,2	3,7	0,6
Paris	-7,2	15,5	N/A	11,8	11,8
Prague	-9,4	-5,4	820,8	8,3	802,8
Stockholm	5,2	-1,6	-1,6	9,2	9,2
Vilnius	101,8	0,1	N/A	-35,6	N/A
Warsaw	9	-5,1	-11	-3,2	-3,3

Table 2: Change in fares. Where N/A (Not Applicable) is present, there is no difference between Urban and PTA area.

The differences are striking. In Amsterdam, Copenhagen, Paris, and Prague, for example, single ticket and/or monthly pass prices increased significantly, but the fare per trip dropped. The opposite occurred in Budapest or Vilnius. This discrepancy is significant and could be attributed to a more intense use of monthly passes, a change in the mix of trip types by users, or the fact that larger groups of users benefited from increased discounts (i.e., subsidies). Alternatively, it may be caused by a lack of quality in the available data.

2.1.4 Subsidies per trip, per inhabitant

Subsidies per inhabitant vary greatly across cities. In 2013, London had the highest subsidy, but this changed dramatically by 2019, when London had the second lowest subsidy per capita, just above Vilnius. This is illustrated in *Table 3*:

	Subsidies/Inhabitant		Subsidies/trip	
City	2013	2019	2013	2019
Amsterdam	136,5	137,3	0,97	0,66
Barcelona	115,4	159,5	0,65	0,74
Berlin	204,4	258,4	0,61	0,70
Budapest	166,3	169,2	0,20	0,20
Copenhagen	142,9	151,8	1,33	1,03
Frankfurt	119,2	153,0	0,86	0,81
Helsinki	252,1	261,8	0,85	0,88
London	575,3	100,4	1,31	0,23
Lyon	114,6	122,5	0,34	0,35
Madrid	151,3	209,0	0,72	0,87
Oslo	264,6	273,1	1,04	1,04
Paris	146,0	215,4	0,42	0,40
Prague	220,5	250,8	0,74	1,04
Stockholm	339,6	372,7	0,97	1,03
Vilnius	42,2	72,1	0,08	0,21
Warsaw	128,4	157,3	0,31	0,35
Average	216,7	187,6	0,72	0,56

Table 3: Subsidies per trip and inhabitant

2.2 Qualitative aspects: types of fares, management of fares and fare structure

This chapter presents the results of a questionnaire that was sent to four PTAs in different cities across Europe (Leuven, Madrid, Oslo, and Berlin) with the aim of gathering information on the types and management of fares and subsidies available in each city.

Over time, European cities have developed a complex system of fares and, implicitly, of subsidies. Several points are worth noting:

1. In general, PTAs focus on fares rather than subsidies. This is understandable, as fares are politically a highly sensitive issue. Fares are what public transport users see. However, this means that from a management point of view, subsidies are treated as a complement (together with other sources of income, as discussed in the previous section). This is important, because it means that more attention is paid to the impact of fares than to the cost structure of public transport.

2. Funding comes from local, regional and national governments; but there is a trend to pass responsibilities/competencies to local governments without corresponding funding (Bahl et al., 2013).

3. All PTAs have developed highly sophisticated schemes of special fares for specific groups of users. The number of cases is almost limitless. In general, there is a perception that these schemes may have gone too far as they are not easy to manage, and in many cases, users may be receiving a subsidy (too low a fare) when they do not need it. There is a lack of knowledge about the actual cost implications of these schemes, as often there is no information on the actual use that different groups make of public transport. Interestingly, the fare structure is not widely used in a targeted way to reduce the externalities of mobility and make it more sustainable. When determining fares, the key consideration is how they benefit different target groups, but very seldom are they determined taking into account other goals such as reducing congestion, pollution, or CO_2 emissions.

4. Fares (and implicitly subsidies) are determined politically. It is the board of PTAs, composed of political representatives, that decides the level of fares and the fare structure, and with it, the amount of subsidies to public transport. Of course, these political decisions are based on technical appraisals and proposals by the internal services of PTAs, but ultimately, the decision rests with the board of PTAs. Usually, the board follows the proposals of the technical services of the PTAs, but this is not always the case. In fact, some frustration can be detected in the technical services of some PTAs following the decision, following the pandemic, to substantially reduce or move towards free public transport. See more on this in the SPOTLIGHT in Chapter 3.

5. There is very little flexibility in changing fares. Fares are usually modified once a year (in some cases once every two years) and usually follow pre-set criteria, like the Consumer Price Index (CPI) or some other cost index.

6. In general, there is very little evaluation of the impact of the fare structure and how it serves to achieve distributional or sustainability goals.

Regarding the fare structure, *Table 4* below summarises our findings:

User group	Discounts for specific groups, with big differences in number of groups and conditions.
Off-peak discounts	Not widely used, apparently because of fairness reasons (low-income workers have less flexibility).
Distance	Flat fares with zones. Some scepticism on distance-based fares, apparently because of fairness reasons (low-income users are being kicked out from city centres).
Mode	Not much discrimination. Integration is seen as more convenient to user.
Operator	Only in concession contracts (awarded via tender). Some ongoing pilots in which shared micromobility or carpooling operators are subsidised to have their services integrated into public transport fares.
Special events	Some fares integrated with sports events, but no discount.
Updates	Mostly annual and with fixed rules (CPI, constant rate, etc)

Table 4: Insights on fare structure, from a questionnaire that was sent to Public Transport Authorities (PTAs) in Leuven, Madrid, Oslo and Berlin

3 Financing public transport

Beyond this quantitative and qualitative analysis of subsidies, it is useful to have a broader picture of the trends surrounding the financing of public transport, as this can help better assess the potential for microsubsidies.

The financing of public transport has come under increased stress during the past years (EMTA, 2017). As we have seen in previous sections, this is due to an increase in ridership and costs (although the data we have shown suggests that the real unit cost in the provision of public transport may have decreased significantly in recent years). Alongside increased costs, many cities have experienced significant revenue shortages, which can be attributed to the following four factors (Ardila-Gomez & Ortegon-Sanchez, 2015):

1. Limitations of existing financing mechanisms to generate sufficient revenue. This is an especially relevant constraint given the increasing budgetary difficulties faced by public administrations in general.

2. Inefficient pricing and economic distortions, favouring private transport (Medda, 2011); (Zegras, 2006); (Zhao et al., 2012). While public transport is in great need of investments, implicit subsidies are provided to the road network and private cars, which represent a minority of users.

3. Unbalance in investment responsibilities and financial capacity at the city level. Decentralisation has generally strengthened local administration, but while municipalities have been empowered in terms of their expenditure responsibilities, there has been little movement by national governments to implement a strategy that would give municipalities more budgetary self-sufficiency (Bahl et al., 2013).

4. Mismatch between the periodicity of revenue and expenditure. The nature of transport systems requires both large up-front capital investments and recurrent relatively smaller expenses for operation and maintenance.

The COVID-19 pandemic has contributed to putting public transport in the spotlight and making the discussion on its funding even more urgent:

- On the one hand, public transport has emerged as the main pillar for resilience and sustainability in cities, as it ensured access for all user groups and the reduction in private transport made people realise its impact on the quality of life in cities.
- The reaction of public authorities has been to increase funding for public transport. In some cases, political authorities have opted for significant reductions in the price of public transport or even making it free. However, the experience of these efforts and similar ones made in the past shows that these are unsustainable.

All in all, this leads to the need to rethink the funding of public transport and mobility in general. The challenge is to achieve high-quality and affordable public transport systems. In particular, the following approaches seem desirable:

- Seek new sources of funding: This is something that public authorities are constantly pursuing. See the following SPOTLIGHT for some examples.
- Optimise funding (i.e., subsidies to public transport): Both the distributional and efficiency effects of subsidies are not optimal (see *Chapter 4* and *5*), so there is significant scope to improve the management of subsidies to public transport. This is where microsubsidies have a role to play.
- Optimise funding for mobility: Developments over the last decade in many European cities, and especially during the COVID-19 pandemic, have shown the increasing relevance of transportation options like micromobility, ride-hailing, or carpooling in the mobility mix in European cities and their potential as useful ways to reduce private car dependency. This is leading public authorities to start exploring possibilities to support these modes of transport to make mobility more sustainable. More on this in the Case Studies chapter.

SPOTLIGHT: Innovative sources of funding for public transport

The balance to be struck between the different actors in the financing system is not a one-size-fits-all proposition. Each city must find its own mix of funding (Allaire, 2014). Over recent years, many different and innovative strategies have been adopted by various PTAs (EMTA & Rebel, 2017; Pons-Rigat et al., 2017), which can be grouped into four themes:

1

Generic Value Capture: Solutions capturing (part of) the economic benefits of improved public transport services accruing to the broader urban economy. Some examples include:

Enterprise Zone Northern Line Extension, London: An enterprise zone featuring specific business tax rates imposed on businesses located within the zone.

AMB Metropolitan Tax, Barcelona: A surcharge on land/property in its 18 municipalities in support of public transport services.

Earn-Back Model, Manchester: An agreed approach with the UK government, allowing Greater Manchester to retain a portion of additional tax revenue generated as a result of local investment in infrastructure.

2

Targeted Value Capture: Solutions specifically capturing (part of) the economic value generated by new residential areas, shopping malls, and other commercial properties. Some examples include:

Naming Rights Emirates Air Line, London: An arrangement where the cable car across the Thames is known as the Emirates Air Line, providing exposure and name recognition in exchange for covering a portion of establishment and operational costs.

Developer Levy, Barcelona: Requiring developers conducting mobility studies for new developments generating over 5,000 journeys/day to cover the operational deficit of transport services for 10 years.

3

Private-to-Public Value Capture: Solutions aimed at discouraging private car use to reduce congestion and environmental impact, with the incidental benefit of capturing funds to cover public transport expenditure. Some examples include:

Fuel Levy, Paris: A tax on the importation, production, or exportation of fuel products, with proceeds transferred to the PTA (up to €100m/year).

Congestion/Access Charges, Helsinki: A study on road pricing with proceeds earmarked for financing public transport.

Greek road pricing model: A study in Greece simulated how road pricing could work and its potential impact on public transport funding (Tsekeris & Voß, 2010).

Cordon-based charging: Cities like Stockholm and Gothenburg explored charging drivers entering specific zones (cordons) during peak hours, with revenue directed towards public transport (Börjesson & Kristoffersson, 2018).

Palermo parking experiment: It tested how adjusting parking pricing could influence car use and generate funds for public transport (Migliore et al., 2014a).

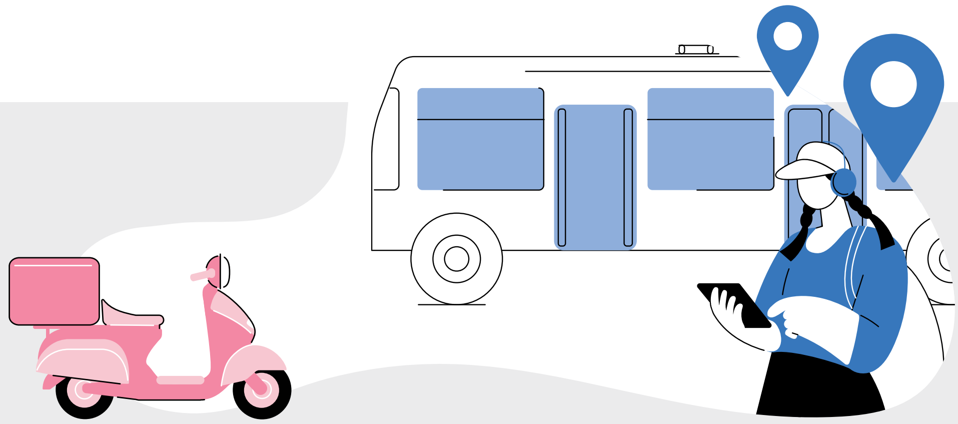
4

Other innovative solutions: Solutions exploring new opportunities, general tax charges, etc.

Revenue security enhancements, Budapest: Introduction of automated fare collection to raise the fare receipt base.

Revenue security enhancements, Paris/IdF: Legislation enabling strict enforcement of fare collection.

VAT reduction to go to public transport, Paris/IdF: A reduction from 10% to 5.5% in VAT on a public transport fare, with the reduction to be retained for the purposes of funding (solution not implemented).



4 Impact of subsidies

Transport, and road transport in particular, is widely acknowledged as a key factor contributing to the development of the economy and society at large. Facilitating access to road transport is essential to ensure equal opportunities for all citizens in education, health, work, training, and leisure, for example. Transport should be seen more as a means than an end. In this respect, road transport has an obvious equity dimension.

However, transport benefits often come with negative impacts whose cost is not borne by the users who generate them but is passed on to other users or society as a whole. These impacts are what economists call negative externalities and can be of diverse nature: congestion and associated waste of time, emissions contributing to climate change, reduced air quality, crashes causing fatalities and injuries, or increased occupation of public space, to name a few. All this demonstrates that road transport also has an important societal impact that is often identified as its efficiency dimension.

One way for public authorities to address the equity and efficiency dimensions of road transport is through the prices that users face when choosing among different modes of transport. In particular, through subsidies, authorities can lower the end price for certain users, making certain modes of transport accessible to them. Additionally, by using a combination of taxes and subsidies, they can alter the relative cost of alternative modes to make one more attractive or competitive for users compared to others, typically seen in the case of collective modes of transport versus private vehicles.

In this section, we review the literature on subsidies for public transport aimed at achieving equity and efficiency goals. It is important to note that, generally, the literature focuses mostly on prices/fares rather than on subsidies, but these can be seen as complementary concepts: generally, the higher the subsidy, the lower the necessary fare/price to cover costs; and vice versa. There are exceptions to this when other sources of income are available, but this is more the exception than the rule.

4.1 Distributional effects

4.1.1 Mixed evidence

Of the many studies on the issue, we will refer to four of them:

A study for Madrid (Cadena et al., 2016) shows that travel pass usage (which is heavily subsidised) depends negatively on income level, and the authors conclude that the travel pass in the city can be considered progressive since it effectively targets disadvantaged groups. This fact suggests that subsidies for public transport in Madrid tend to favour vertical equity. Other studies for Paris (Bureau & Glachant, 2011) and for the whole of Spain (Asensio et al., 2003) reach similar conclusions.

More recent studies, however, point in the opposite direction. For example, a study for Stockholm (Börjesson et al., 2020) shows that the average subsidy rate in public transport is 44%, but the variation across trips is large: while 34% of the trips are not subsidised at all and generate a profit, 16% of the trips have a subsidy rate higher than 2/3. The average subsidy per person is similar for all income groups, except for the top income quintile. This holds not only for the current flat-fare system but also for distance-based fares and fares with a constant subsidy rate. The authors conclude that public transport subsidies are hence not effective as a redistribution policy in Stockholm.

Therefore, the distributional impact of subsidies needs to be assessed on a case-by-case basis. Currently, subsidies may be effective at best, but they are not efficient: some groups may need larger subsidies to have access to public transport, while others are being subsidised unnecessarily.

4.1.2 Specific subsidies are better than lump sum subsidies to operators

This limited effectiveness of subsidies may be linked to the way in which subsidies are designed and managed. A study in several countries in Australasia (Starrs & Perrins, 1989) found that public transport subsidies offer only limited support to the objectives of income redistribution to low-income citizens and improved mobility for the transport disadvantaged. This study argues that targeting subsidies to particular user groups could be more successful in meeting societal objectives than general subsidies. Another study (Gomez-Lobo, 2009) showed that for the case of Santiago de Chile, subsidies to users are more progressive than subsidies to operators.

A similar conclusion is reached in another study on low- and middle-income countries (Estupiñan et al., 2007). The authors highlight the need to shift away from supply-side subsidies towards demand-side subsidies and integrate transport social concerns into wider poverty alleviation efforts. They go even further and propose the possibility of channelling subsidies through monetary transfer systems or other welfare instruments (such as food subsidies, health services, and education for the poor).

4.1.3 Providing access and quality

Some studies (Estupiñan et al., 2007; Gwilliam, 2002) take a broader view and argue that subsidies are only justified as a financing tool if society as a whole benefits from the accessibility provided by the transport system. This benefit is realised when the transport system offers good quality, extensive coverage, and inclusive accessibility. Therefore, the objective of public transport subsidies should not solely be to provide lower fares, especially if this comes at the expense of the quality and quantity of transport supply (Ardila-Gomez & Ortegon-Sanchez, 2015).

4.2 Efficiency effects

4.2.1 Measuring the negative externalities from private transport

Externalities abound and, from a policy point of view, what matters is knowing their magnitude and being able to quantify their cost. The negative externalities of road transport are significant, with most stemming from private transport. For example, a study (Jakob et al., 2006) conducted in Auckland (New Zealand) revealed that the external costs of transport equated to 2.23% of annual GDP. Of this, private transport generated 28 times more external cost than public transport. The internal cost assessment showed that total revenues collected did not even cover 50% of total transport cost, including negative externalities (sometimes referred to as unpaid costs). The study highlights that the external costs of vehicle transport are high and subsidised. Similar results are found in other studies (TMB, 2019).

4.2.2 Internalising these externalities

Put simply, the relative demand for public transport compared to private motorised transport depends:

- Negatively on relative cost
- Negatively on relative travel time
- Positively on relative comfort

Formally:

$$\frac{D_{PT}}{D_{PMT}} = f\left(\frac{cost_{PT}}{cost_{PMT}}, \frac{traveltime_{PT}}{traveltime_{PMT}}, \frac{comfort_{PT}}{comfort_{PMT}}\right)$$

Equation 1: Relative demand for public transport with respect to private motorised transport , expressed as a function of their cost, travel time and comfort

Here, PT and PMT stand for public transport and private motorised transport respectively, with cost and travel time contributing negatively, while comfort contributes positively to the demand ratio.

What does the literature say on the influence of each of these factors?

4.2.2.1 Relative cost

These negative externalities can be internalised through "optimal prices" achieved with the introduction of taxes and subsidies. The literature on optimal pricing in transport is vast. In short, it focuses on altering the relative cost of public transport versus the private car to shift demand towards the former. This can be achieved by increasing road pricing or decreasing public transport fares. These strategies are considered interchangeable or can be applied simultaneously.

The required charges on private transport to achieve optimal outcomes are highly dependent on the case, but research generally shows that increasing the cost of private transport (through tolls/ congestion charges), especially during peak hours, or increasing the cost of parking at destinations (Migliore et al., 2014) can be effective tools for transferring users from cars to public transport. Interestingly, the literature also indicates that user sensitivity (i.e., elasticity) tends to decrease as charging levels increase within a metropolitan area. This is likely because the most price-sensitive traffic is priced out with the introduction of congestion charges (Börjesson & Kristoffersson, 2018). Similar to losing weight, shedding the first kilos is relatively easy; afterwards, it becomes more challenging.

These effects on modal shift can be reinforced when revenue from congestion charging is used to subsidise public transport. In fact, such revenue can, in some cases, cover a large part of the optimal subsidies needed for public transport (Ljungberg, 2016). In this case, road pricing and public transport pricing (which is the inverse of public transport subsidies) are substitutes. However, in other cases, road pricing and public transport pricing can be complementary, especially if implemented during peak times when higher fares can help flatten the demand curve for public transport (Kilani et al., 2014).

4.2.2.2 Relative travel time

Beyond the relative cost between private cars and public transport, the transfer of users from the former to the latter also depends on relative travel times. Some studies (Basso et al., 2011) find that dedicated bus lanes, for instance, are a better stand-alone policy than public transport subsidies or congestion pricing, to the extent that establishing dedicated bus lanes or implementing congestion pricing renders subsidies unnecessary for high demand levels. Unsurprisingly, this study notes that both subsidisation and dedicated bus lanes would receive public support, while congestion pricing would likely encounter opposition. It estimates that the optimal proportion of road capacity that should be allocated to bus traffic is approximately one-third.

4.2.2.3 Relative comfort

Finally, there is the matter of the qualitative attributes of public transport that can entice car users. Qualitative attributes encompass a wide range of features, including comfort (access to seats, noise levels, air conditioning, amongst others), safety (road safety and personal security), convenience (simplicity in using the service), and aesthetics (appeal of vehicles, stations, and waiting areas). There is not a great deal of literature on this, but some authors (Redman et al., 2013) assert that the attributes most effective in attracting car users are largely emotive and linked to individual perceptions, motivations, and contexts. Reduced fare promotions and other habit-interrupting transport policy measures can succeed in encouraging car users to try public transport services initially. However, qualitative attributes that are perceived by the target market as important service attributes must then be provided if the shift is to be sustained in the longer term.

4.3 Free public transport

Another option is to reduce public transport fares, even making it fare-free, with the corresponding administration bearing the entire cost. This option has gained traction recently, mainly due to the conflict between Ukraine and Russia and the resulting increase in fuel prices. Apart from lowering the cost of transport for its citizens, the aim of these policies is to influence their preferences, so that they opt for public transport as their usual mode of transport, reducing journeys by private vehicle.

Several countries have adopted such measures to promote the use of public transport. Spain, for example, has reduced the cost of public transport by offering free train passes, starting in September 2022, or Germany, which introduced a one-month ticket that for €9 allowed passengers unlimited use of public transport during the summer of 2022.

Photo by Alexander Bagno on Unsplash

Meanwhile, Luxembourg made public transport completely free in 2020. But, while Luxembourgers generally express a positive attitude towards the free public transport policy, there is little evidence yet that it has reduced the number of cars on the road. In May 2022, congestion on Luxembourg's roads was (depending on location) largely equivalent to or higher than levels in May 2019, before the free public transport policy was introduced (O'Sullivan, 2022).

In most cases, these policies have not proven very effective in achieving their goals. Studies have shown that making public transport free does not in itself lure people away from their cars. While removing fees may prove an incentive, it will not compensate for other possible disadvantages, such as overcrowded, delayed or cancelled trains, or an inability to compete with the convenience of door-to-door travel. Data from other fare-free public transport programmes suggests that making travel free enticed those who, due to limited income, would have otherwise walked, cycled, or foregone the trip entirely (O'Sullivan, 2022).

The story was similar in Santiago, Chile, where researchers randomly assigned free two-week public transport passes to residents between 2016 and 2017. Those receiving the free passes took 12% more trips overall, but they did not drive less (Bull et al., 2021).

In Estonia's capital, Tallinn, a similar outcome was observed. The National Audit Office of Estonia has been investigating the implementation of free public transport in Tallinn since 2013, which includes complimentary bus and tram travel for locally registered residents. The analysis focused on examining whether the decision to eliminate user payments considered both economic feasibility and the mobility requirements of the populace.

The findings from Tallinn's initiative revealed that the objective of reducing car usage was not met by the introduction of free public transport. Although there has been an increase in the use of public transportation, more than half of the commutes to work are still undertaken by car. Additionally, the National Audit Office discovered disparities in the allocation of funds for public transport services across Estonian counties, and there has been a significant rapid increase in state spending on funding public transport (Köllinger, 2021).

On the other hand, in Frýdek-Místek, Czech Republic, the FFPT (fare-free public transport) scheme was introduced in March 2011 and was gradually extended, reaching the residents of a total of 19 municipalities. Free access to the public transport network is subject to the purchase of an annual coupon for 1 Kč (circa 0.04€ in October 2023), which is carried on a personal smart card. The implementation of the FFPT scheme was combined with an increase in fleet capacity, from 24 buses to 46. The first year saw an increase of 22% of passengers compared with 2010, with an average of 13.5% additional passengers per year in the following years. The increased availability of unused parking spaces in the city centre during working days and off-peak hours was seen as evidence that car use was reduced during the same period (UITP, 2020).

More and more cities around the world are following suit and now offer free fares on all or part of their public transport network. Nonetheless, as we have seen, the effectiveness of free public transport to reach sustainability objectives depends largely on the initial local context and the accompanying measures put in place. There is no clear evidence that this policy alone is enough to bring about modal shift, social inclusion, and economic development to a city. Successful free public transport schemes combine several push and pull measures, aimed at improving the public transport network and prioritising sustainable transport modes. Affordability of public transport is an important objective, linked to social concerns about accessibility and equity. However, this policy is a blunt instrument to address this. More targeted measures may be both more effective and manageable within the budget limitations faced by many public authorities. Finally, and perhaps most importantly, a full free fare scheme has a cost that will have to be borne by the government, taxpayers and/or third-party funding in a way that does not jeopardise public transport's financial sustainability. The long-term costs and consequences of free public transport must be fully considered and planned for, bearing in mind that reversal is always a difficult political decision.

4.4 Universal travel passes

In a similar vein to free public transport, some public authorities are considering implementing highly convenient travel passes that offer access to public transport across an entire country or region. A prominent example is the 49-Euro ticket, or as it is known locally, the Deutschlandticket, which was launched in 2023 by the German government as a follow-up to the 9-Euro ticket trial held the previous summer. The scheme enables passengers to travel by train across Germany for just €49 per month, making it an affordable option for many people. The 49-Euro ticket has been praised as a positive step towards achieving sustainable mobility, but it is not without its challenges.

There are several negatives to highlight. One of the main issues with the 49-Euro ticket is that it is heavily subsidised by the government, with taxpayers footing the bill. According to a study by the German Institute for Economic Research (DIW Berlin), the total value of the 49-Euro ticket system is estimated at around €1.2 billion per year, which is a significant amount, especially considering Germany's economic challenges due to the COVID-19 pandemic. There are also concerns about the effectiveness of the 49-Euro ticket in reducing greenhouse gases. A study by the Technical University of Munich (TUM) suggests that the 49-Euro ticket system may not be as successful in reducing carbon emissions as initially thought, although it increased the number of people travelling by train, it did not reduce the number of cars on the road. The policy was found to have only a modest impact on overall transport emissions (TUM, 2023). Furthermore, there is concern that the 49-Euro ticket may have unintended consequences. For example, it can lead to overcrowding on trains, which can compromise passenger safety and comfort.

4.5 Commuting allowances

Commuting allowance programmes are becoming increasingly popular in European countries as governments and businesses aim to incentivise sustainable transport through corporate mobility schemes.

However, currently many fiscal systems in Europe continue to promote commuting by car. Across most countries, the tax advantages associated with providing employees a company car for personal use artificially incentivise car usage, creating a disadvantage for other, more sustainable and health-friendly modes of transportation. Consequently, company cars hold a substantial share in new car registrations in Europe, comprising approximately 50% in the EU overall and exceeding 63% in Germany as of 2020 (Transport & Environment, 2021). While some countries, such as Belgium and the Netherlands, offer favourable tax treatment for active modes of transport, initiatives like cycling mileage allowances for home-work travel are met with resistance in other nations. Unfortunately, these instances of resistance often stem from a narrow focus on immediate budgetary costs, neglecting the significant public health benefits associated with such measures (ECF, 2014).

On the contrary some positive examples of countries include (ECF, 2014):

- France is one of the countries that has implemented a successful policy implementation cycle. Called the "Forfait Mobilites Durables" or Sustainable Mobility Package, the scheme provides tax-free funding for employees who cycle, walk or use public transport to work. The scheme, up to €400 a year, can be used to buy a bike, repair appliances or pay for public transport.
- Cycling is already a popular mode of transportation in the Netherlands, and the government has implemented several policies to push cycling further. One of the most successful schemes is the "Fietsplan", which provides employees with tax-free income to buy a bicycle or new e-bike. The scheme costs €750 and can be used every three years.
- Belgium has also implemented a wheel-to-work system, called "Fietsvergoeding". The scheme provides tax-free incentives for workers who cycle to work, paying €0.24 per kilometer travelled. The scheme costs €240 a year and is available to all employees who cycle to work.

5 Potential for Microincentives

5.1 The PTAs' perspective

We asked several Public Transport Authorities (Berlin, Oslo, Leuven, Madrid and Barcelona) about their views on the appropriateness of implementing more targeted fares or microincentives, as well as the feasibility of certain use cases. The attributes we asked them to evaluate included granularity, or the degree to which incentives can be tailored to individual use cases; integration, which refers to the extent to which the incentive is integrated into the overall transport system; modularity, which refers to the ability to easily add up components of the incentive; flexibility, which refers to the ability to adapt the incentive to different contexts and circumstances; and communication, or how well the incentives are communicated to users. Moreover, we asked them to identify the main obstacles to the introduction of this scheme. The outcome proved how PTAs shared diverse perspectives on the feasibility and impact of implementing more targeted fares and subsidies.

5.1.1 Feasibility and impact of microincentives

Granularity of fare structure

Regarding the granularity of fare/subsidy structures, PTAs expressed the potential to enhance sustainable mobility but acknowledged challenges in implementation. The discrimination based on specific groups, individuals, time, space/zones, and sustainability conditions was considered to have potential, though the difficulty of implementation was acknowledged.

Flexibility

Flexibility, or the ability to adjust fares promptly in response to changing circumstances, was viewed as having a modest impact but with a high implementation difficulty.

Integration of fares across different modes and providers

Integration of fares across different modes and providers was seen as impactful but faced challenges in implementation, primarily due to political implications related to subsidising privately owned operators.

Modularity

A modular system of fares, allowing users to benefit from multiple subsidies simultaneously, was perceived as having a positive impact on increasing ridership but was deemed difficult to implement.

Communication

Effective communication of new incentives was unanimously seen as a potential catalyst for adoption and sustainability improvement, with relatively low perceived difficulty in implementation.

Obstacles

PTAs also identified various obstacles to implementing targeted fares or incentives. The main obstacles recognised are similar to the ones that MaaS faces in cities across Europe and are of regulatory and legal nature. The creation of Mobility Data Spaces for the sharing of data across public and private providers is something that most PTA have not tackled yet. Technology and cost are seen as less important obstacles, although not unimportant. In some PTAs, the development of such system would require a standardisation of ticket validation equipment across different operators, which is both a technical and costly issue. Finally user acceptance was not considered to be an issue, although stress was put on the fact that this change needs to be communicated effectively and that simplicity is a key value when it comes to fares creation.

5.1.2 Potential applications

Mobility as a Service (MaaS)

When asked if the implementation of MaaS should be used as an opportunity to also push for new targeted fares and incentives PTAs acknowledged this opportunity. Nonetheless, the "enthusiasm" is very dependent on how far the PTA is into the development of MaaS. For example, PTAs that have not reached level 1 MaaS (integration of information) do not consider this as a priority. While others, where MaaS is already more advanced, are considering such initiatives as potentially beneficial.

Use Cases

PTAs identified use cases with potential impact on sustainable mobility, emphasising integration of shared mobility and public transport to improve accessibility in 'transit deserts', that is, areas with limited public transport supply. Some of the cities interviewed have already piloted or tested schemes to incentivise the use of shared mobility as first- and last mile connections to the public transport network. However they generally complain that it is difficult to understand whether the incentives to shared mobility were used as intended or if they might have even been used in spite of public transport. In this sense, they see potential in providing targeted incentives, in order to avoid over incentivising unnecessary trips and also to target less serviced areas.

Another use case that was seen as potentially impactful is the creation of corporate mobility schemes, incentivising employees to commute sustainably. This is especially true in countries like Germany or France where similar initiatives are already in place.

Germany deserves a special mention, after the implementation of the Deutschland Ticket not much focus is being put on public transport fares anymore and the topic of microincentives, despite being interesting to most PTAs, is not part of any discussion at the moment.

5.2 The perspective of the experts

Experts provided qualitative insights into microincentives, through a series of interviews and questionnaires. This chapter provides an overview of the most relevant ones.

5.2.1 Feasibility and impact of microincentives

Granularity of fare structure

According to the interviewed experts, the perceived impact varies, but it can be especially positive in terms of equity for less affluent families. They also stress that the effectiveness of microincentives can be very different depending on the city and especially on what PTAs can offer in terms of alternatives to cars. They also suggest that incentivising alternatives without disincentivising cars can be ineffective. They suggest that congestion charges or increasing parking prices should be implemented into the scheme. Finally they identify difficulties in identifying users, routes, and privacy concerns which make implementation challenging.

Flexibility

Experts see a potential in this, especially for what concerns trying to reduce congestion during high pollution events or during large events. However, they advocate caution because regulation allowing authorities to change fares could go both ways. They claim that there needs to be boundaries to the flexibility, and this could be politically challenging.

Integration of fares across different modes and providers

Integration of fares across different modes and providers was seen as impactful but faced challenges in implementation, primarily due to political implications related to subsidising privately owned operators. The main benefit of integration is seen in the fact that it might help some car users to use public transport, for example by subsidising parking at train stations. As the car has the highest perceived reliability, integration with similar modes, such as ride hailing can be the most impactful to reduce car use, but also very costly.

Modularity

A modular system of fares, allowing users to benefit from multiple subsidies simultaneously, was perceived as having a positive impact on increasing ridership and was deemed very easy to implement. Moreover, this allows to fill some equity issues that could arise. One notable example is the off-peak incentives, as low-income workers usually have less flexibility in their commute and usually travel during peak hours, they would have to pay more. With a modular system where one can receive an incentive not only based on the time of the day but also based on their income status, this conflict could be solved.

Communication

Effective communication of new incentives was unanimously seen as a potential catalyst for adoption and sustainability improvement, with relatively low perceived difficulty in implementation.

Obstacles

The main obstacles pinpointed by the experts include user acceptance as one of the most important. Many users value simplicity as an important factor when it comes to fares and not easily knowing how much a trip could cost is could be a barrier for many, especially for older generations. In general, communication is key to overcome these obstacles. Not only for the less tech-savvy, but for everyone.

5.3 The survey

In order to assess the potential for the implementation of microincentives, we conducted a series of surveys among mobility users in different cities to understand how the availability of different microincentives would affect their behaviour when deciding what modes of transport to use or at what time to travel. The metropolitan areas where the online survey took place are the following: Barcelona, Madrid, Lisbon, Berlin and Oslo. For each city a pool of 450 people were interviewed, for a total of 2250 interviewees across all of them. The samples are representative of people living in all parts of the metropolitan area and using different modes of transport.

In particular, we assessed the potential of microincentives in two use cases:

1. The case of people who currently travel by car but could be incentivised to use public transport and/or shared mobility modes (or a combination of them).
2. The case of public transport users at peak hours to see how big an incentive they would need to travel off-peak.

Respondents were, early into the survey, divided into two categories:

- Car users
- Public transport users

and asked to respond to different sets of questions on their last car trip or their last public transport trip during peak hours, respectively. Then, these two cases were assessed using the stated preference methodology. Two distinct stated preference blocks of questions were presented to these two categories of respondents.

This approach allows to explore the decision-making responses to specific attributes or changes within a given choice context. The theoretical background of Stated Preference Studies can be traced back to Lancaster's consumer theory, emphasising the role of utility and the multidimensional nature of goods and services. By employing surveys and hypothetical scenarios, we can gauge how individuals weigh and trade-off different attributes when making choices, providing valuable insights into their preferences. The data collected is then used to create logit models, which can estimate the probability of users choosing one option over the others based on which values are assigned to the different attributes associated with the options. More information on the stated preference study is available in the following chapter.

Additionally, we used the survey to ask some more general questions on user's behaviour and preference to allow us to better assess the potential for the application of microincentives.

In the following sections, we analyse first the results of these general questions and then we show the results of the stated preferences exercises.

5.3.1 Overview of car ownership and usage

As can be seen in *Table 5*, car ownership is higher in Lisbon and Madrid than in Berlin and Oslo, with Barcelona holding an intermediate position. In Lisbon and Madrid, the average number of cars is 1.4 and 1.3 respectively, while in Oslo and Berlin it is 1.1 and 1.0. Conversely, the number of respondents that do not own a car is higher in Berlin and Oslo than in Lisbon and Madrid. In all cases, Barcelona is in an intermediate position.

Metropolitan Area	Number of respondents	Average number of cars in the household	Household does not own a car (Used public transport in their previous journey)	Household owns at least a car	
				Drove a car in their previous journey	Used public transport in their previous journey
Barcelona	461	1.2	64	235	162
Madrid	453	1.3	46	226	181
Lisbon	453	1.4	42	226	185
Berlin	455	1	91	228	136
Oslo	450	1.1	80	225	145

Table 5: Overview of car ownership and mode preference patterns across the study areas

These results are important as they may suggest that the potential to switch modes from the car to public transport (or other sustainable modes) may be higher in cities with higher car ownership and/or usage.

5.3.2 General questions

We present here the answers to the general questions in the five cities surveyed. As the graphs are quite self-explanatory, we just make a brief comment at the end of each question.

5.3.2.1 Reasons for not owning a car

In this sub-chapter we present an overview of the answers to the question: "Please rate the following reasons based on how relevant they are for you in the decision of not having a car in your household". Interviewees were asked to rate a list of 5 reasons from 1 to 5, with 5 indicating an extremely high importance in their decision process and 1 indicating an extremely low one. This question was only asked to those who claimed earlier in the survey that their household do not own any cars.

Barcelona

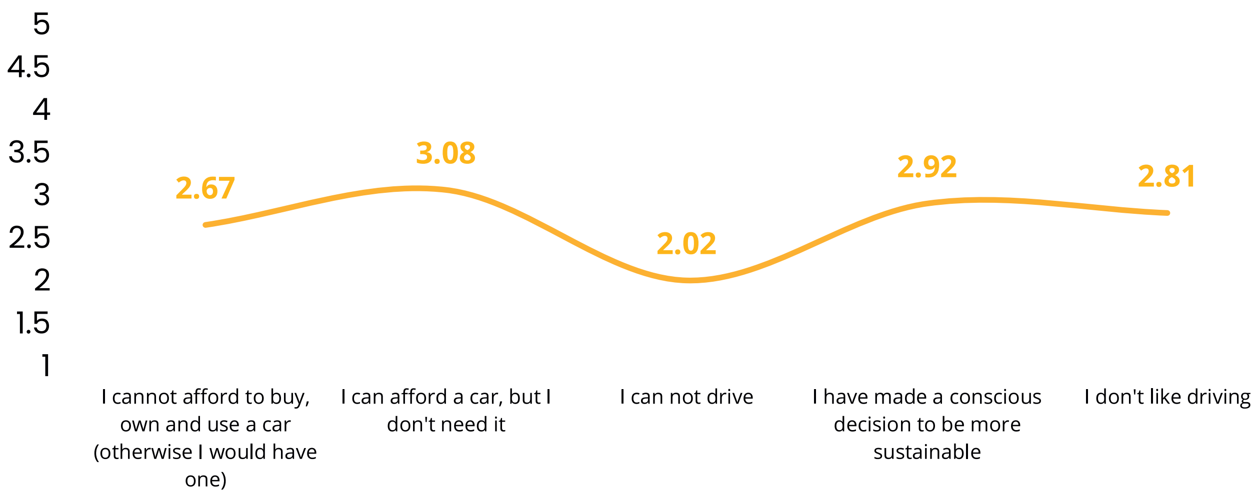


Figure 8: Reasons for not owning a car in the Metropolitan Area of Barcelona

Madrid

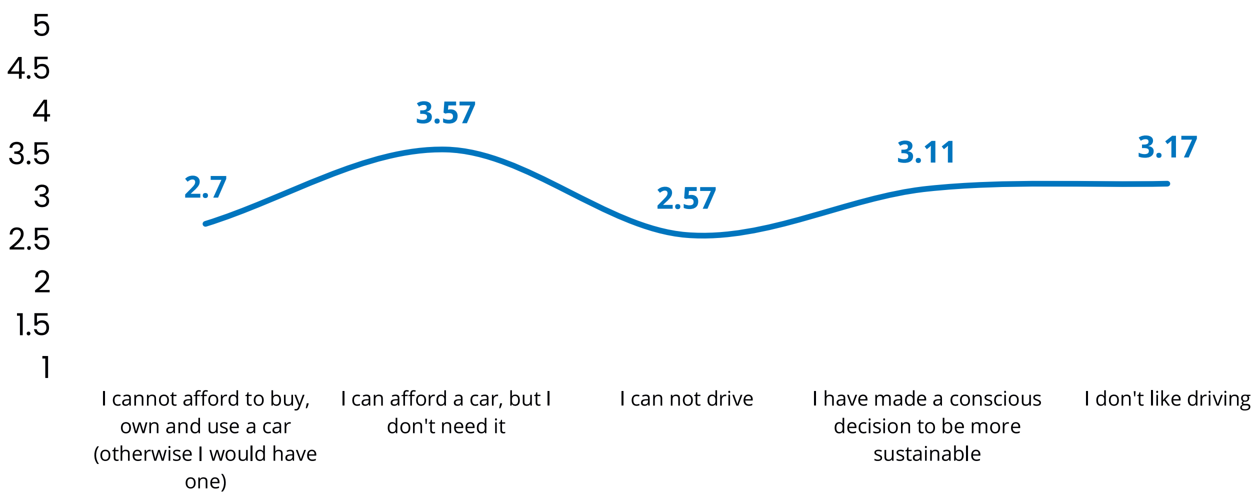


Figure 9: Reasons for not owning a car in the Metropolitan Area of Madrid

Lisbon

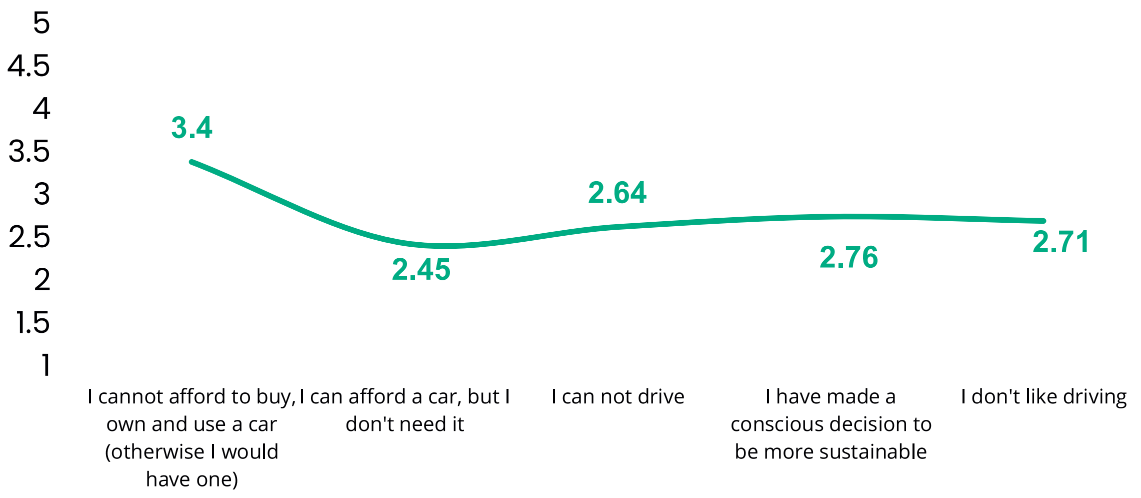


Figure 10: Reasons for not owning a car in the Metropolitan Area of Lisbon

Berlin

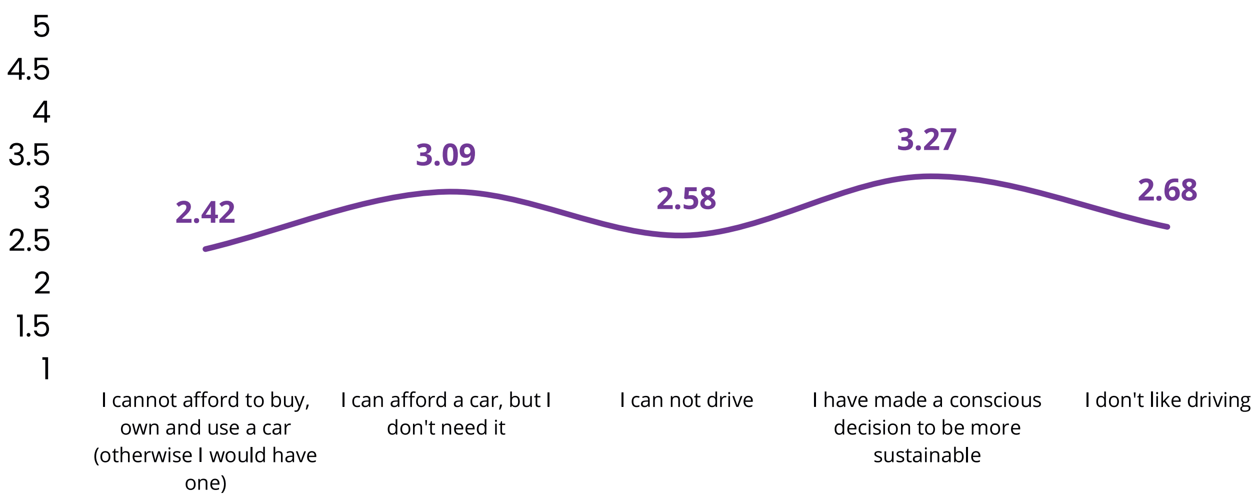


Figure 11: Reasons for not owning a car in the Metropolitan Area of Berlin

Oslo

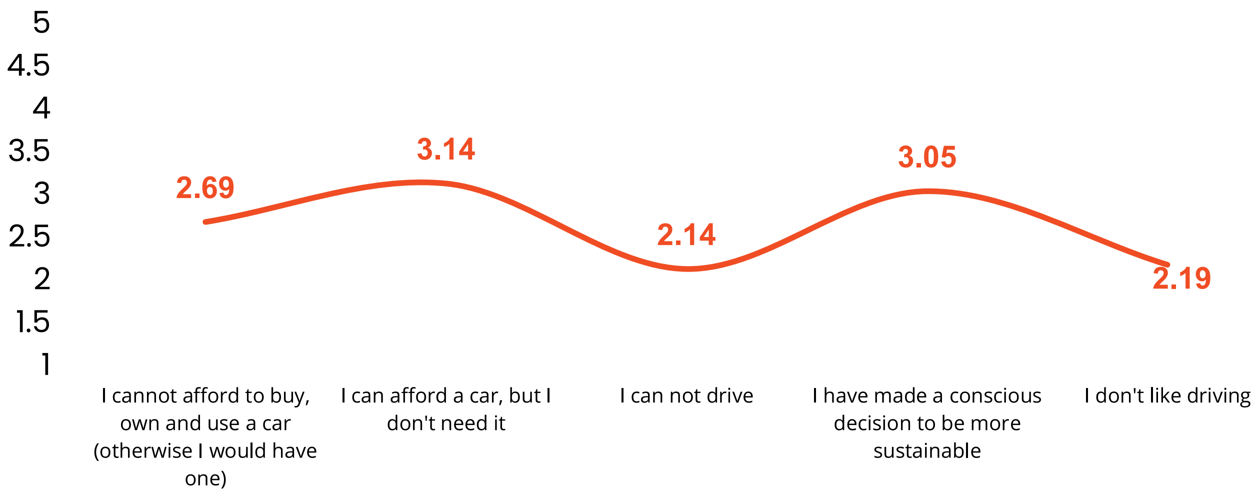


Figure 12: Reasons for not owning a car in the Metropolitan Area of Oslo

Interestingly, when asked about the reasons for not owning a car, the answers are very convergent in almost all cases: the strongest reasons relate to the fact that respondents feel that they do not need a car or that they have made the conscious decision not to own a car. Cost issues or the inability to drive rank lower in the answer from the interviews. The only Metropolitan Area where this does not apply is Lisbon, where high costs represent the main reason for not owning a car.

5.3.2.2 Reasons for preferring car over public transport

In this sub-chapter we present an overview of the results from the question: ¨Keeping this journey in mind... Please rate the following reasons based on how relevant they are for you in the decision of taking a car and NOT taking public transport on your last journey¨. Interviewees were asked to rate a list of 10 reasons from 1 to 5, with 5 indicating a very high importance in their decision process and 1 indicating a very low one.

Barcelona

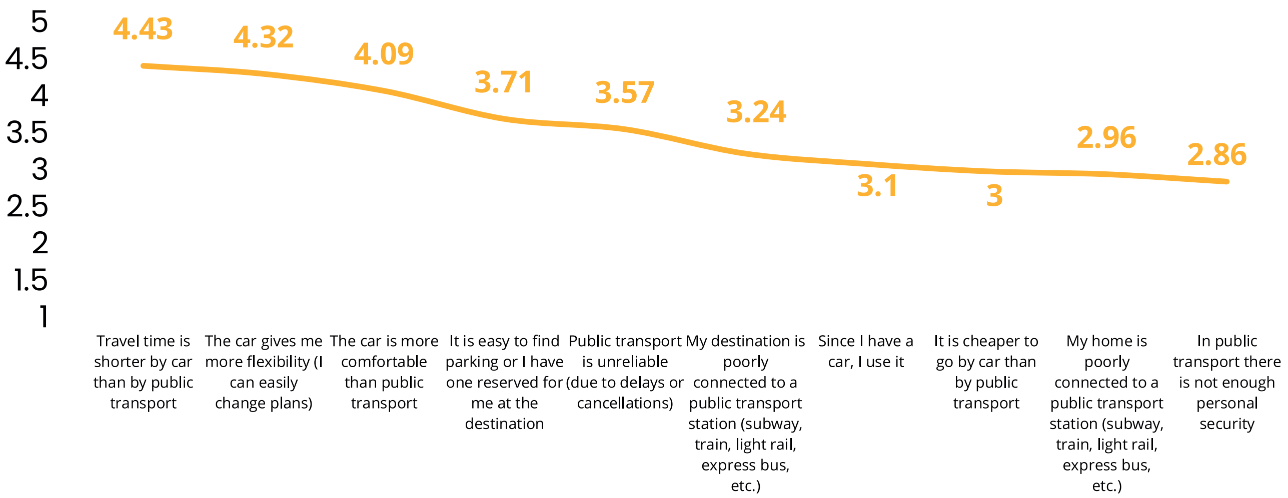


Figure 13: Reasons for driving a car instead of taking public transport in the Metropolitan Area of Barcelona

Madrid

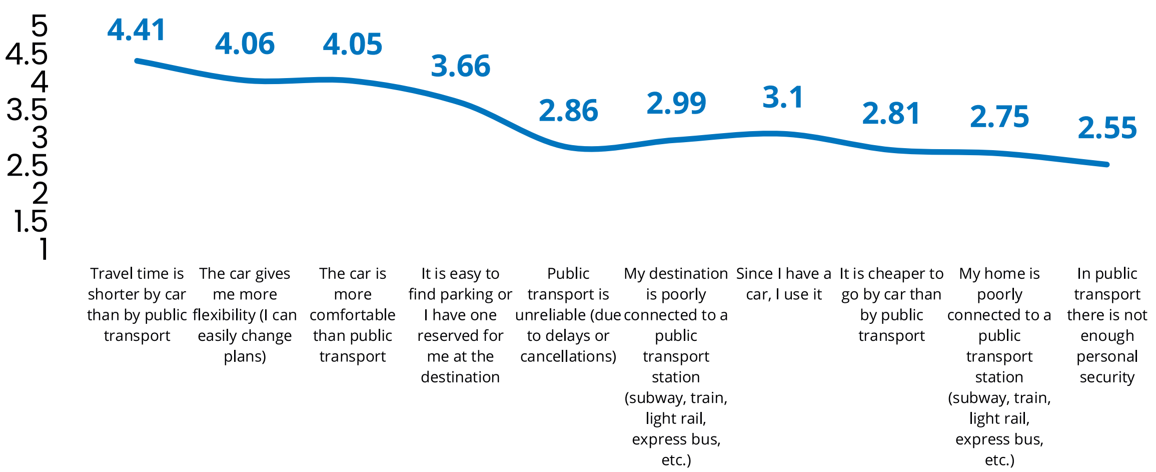


Figure 14: Reasons for driving a car instead of taking public transport in the Metropolitan Area of Madrid

Lisbon

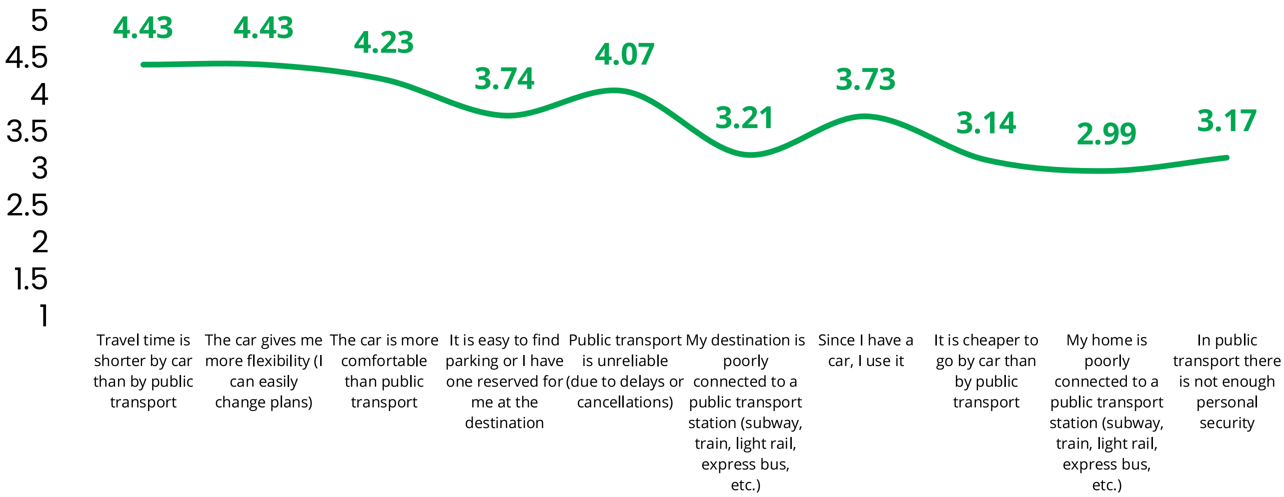


Figure 15: Reasons for driving a car instead of taking public transport in the Metropolitan Area of Lisbon

Berlin

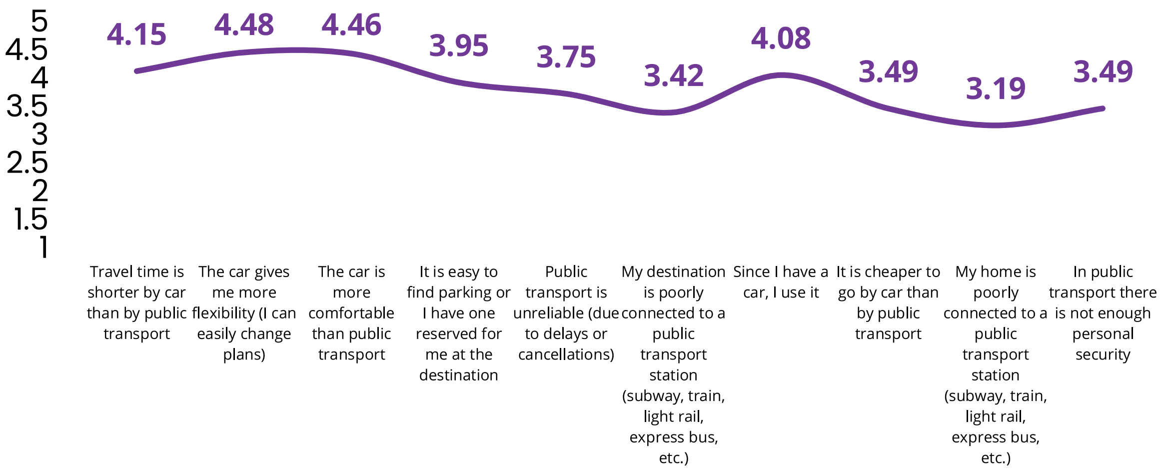


Figure 16: Reasons for driving a car instead of taking public transport in the Metropolitan Area of Berlin

Oslo

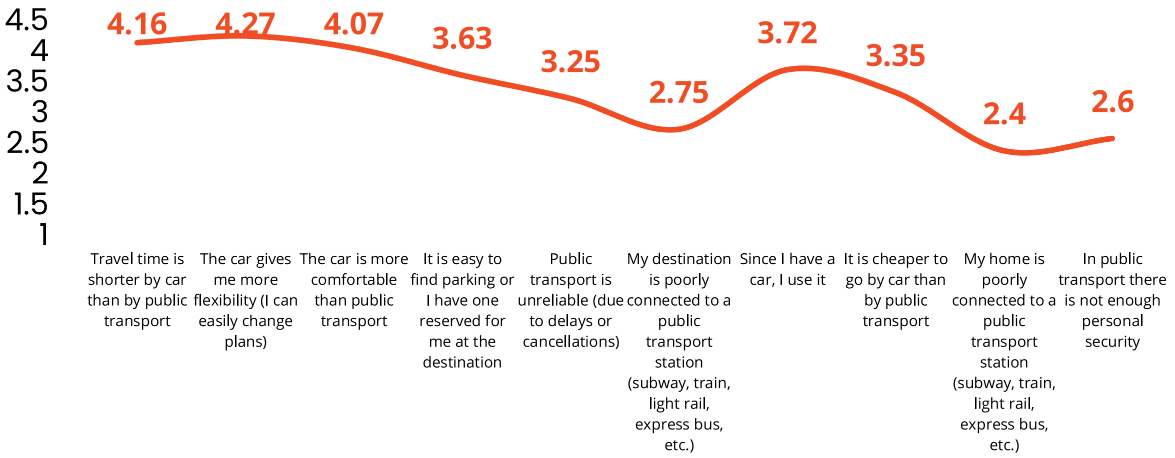


Figure 17: Reasons for driving a car instead of taking public transport in the Metropolitan Area of Oslo

When asked why they use the car, time, cost and convenience come first. This is so in all cases and is very much in line with the results of the literature review we did in previous sections. Interestingly, in Lisbon, there seems to be an issue with the reliability of public transport, suggesting that public transport is clearly not competitive in terms of quality with the private car. In the case of Berlin and Oslo, it can be somewhat surprising that many respondents seem to use the car just because they have it. This may suggest that there is room to make drivers more conscious on the need to move towards a more sustainable mobility or to increase the relative cost of the private car versus public transport.

5.3.2.3 Reasons why car owners prefer public transport over car

In this sub-chapter we present an overview of the results from the question: ¨Keeping this journey in mind… Please rate the following reasons based on how relevant they are for you in the decision of taking public transport and NOT drive a car on your last journey¨. Interviewees were asked to rate a list of 10 reasons from 1 to 5, with 5 indicating a very high importance in their decision process and 1 indicating a very low one.

Barcelona

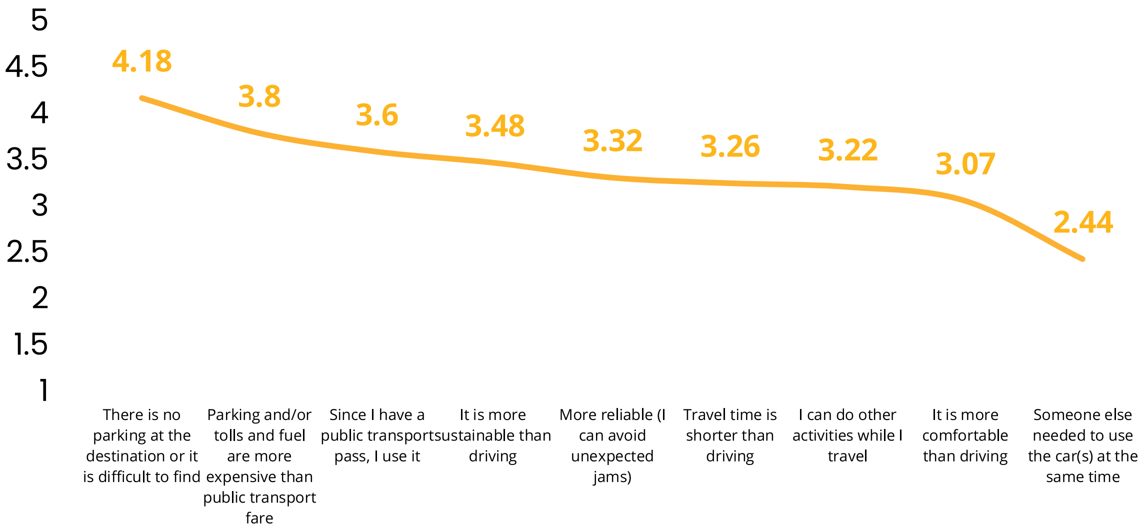


Figure 18: Reasons for taking public transport instead of driving a car in the Metropolitan Area of Barcelona (directed to car owners)

Madrid

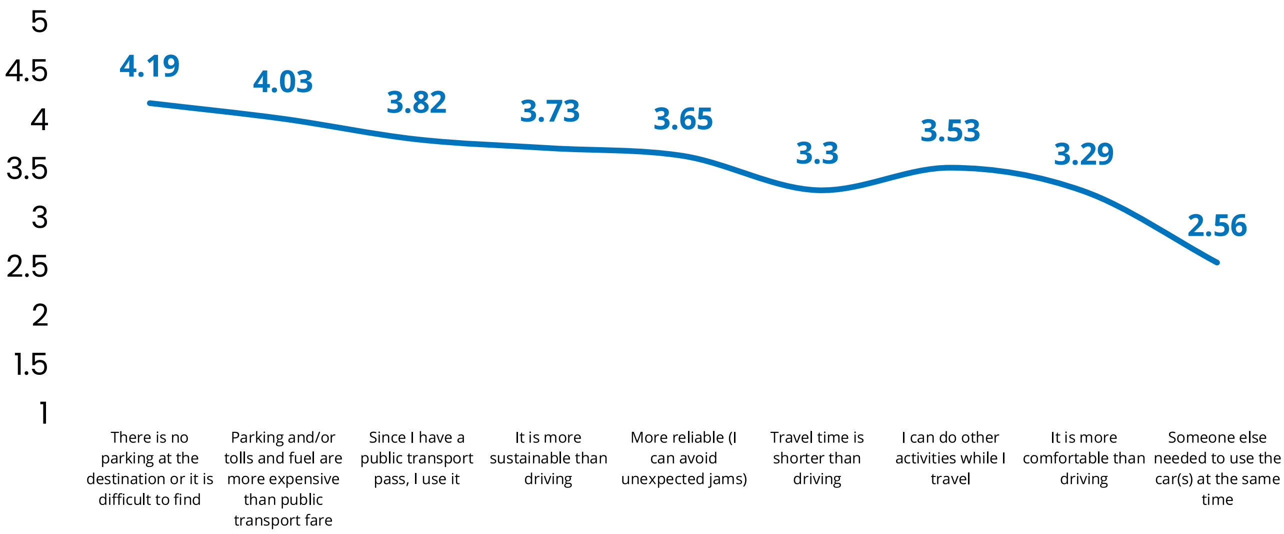


Figure 19: Reasons for taking public transport instead of driving a car in the Metropolitan Area of Madrid (directed to car owners)

Lisbon

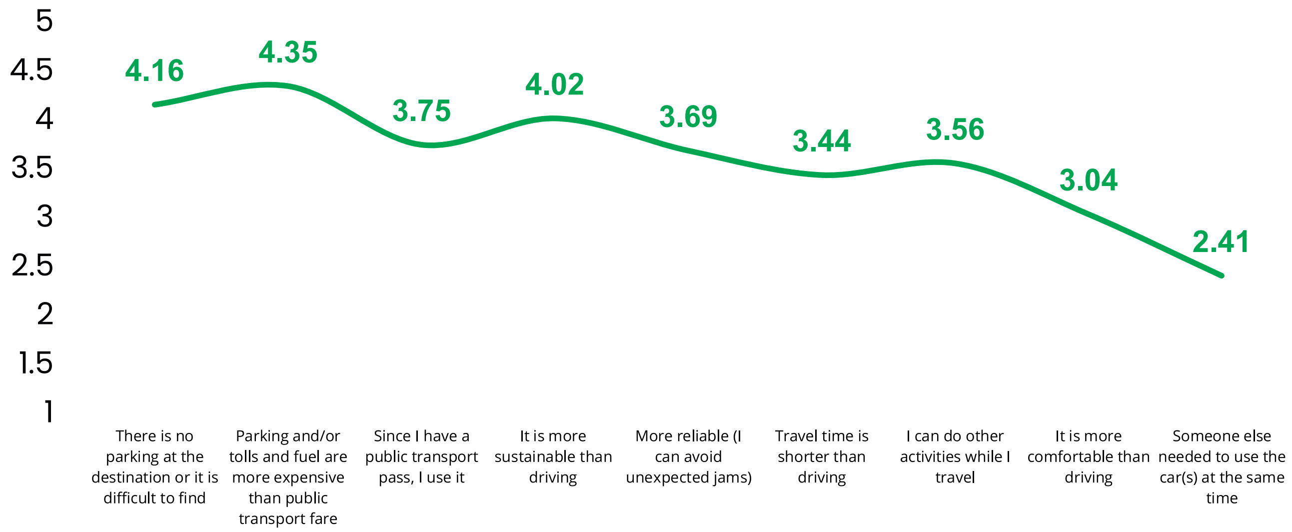


Figure 20: Reasons for taking public transport instead of driving a car in the Metropolitan Area of Lisbon (directed to car owners)

Berlin

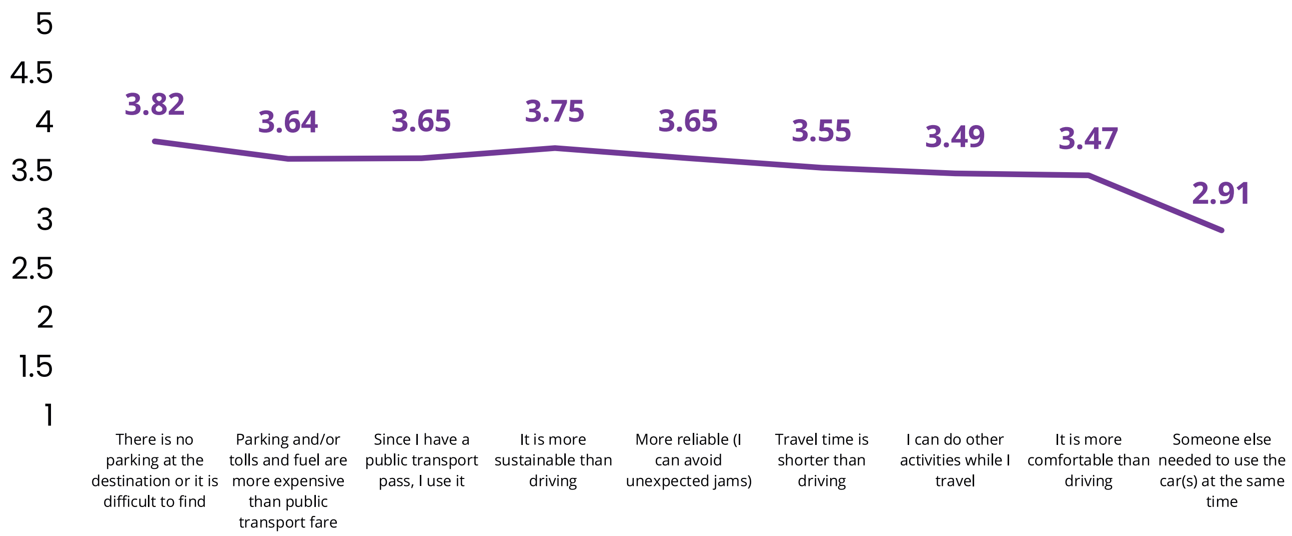


Figure 21: Reasons for taking public transport instead of driving a car in the Metropolitan Area of Berlin (directed to car owners)

Oslo

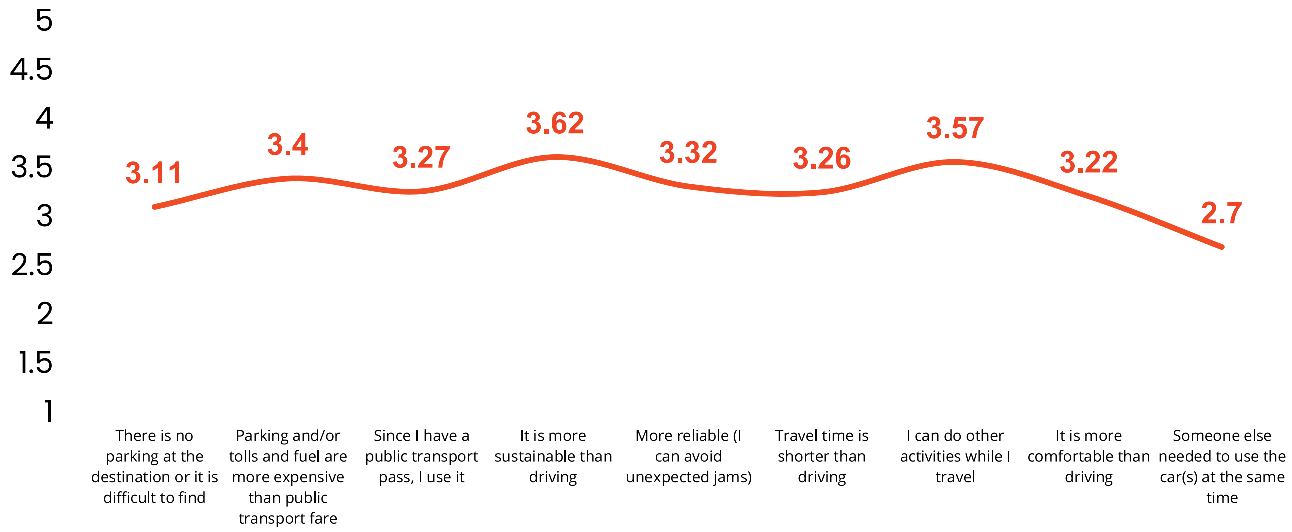


Figure 22: Reasons for taking public transport instead of driving a car in the Metropolitan Area of Oslo (directed to car owners)

When car owners are asked why they use public transport, there appears to be a clear difference between Barcelona, Madrid and Lisbon, on the one hand, and Berlin and Oslo on the other. In the first case, the curve shows a downward trend, with lack of parking and cost (tolls, fuel, etc) as the main reason for opting for public transport. In Berlin and Oslo the curve is flatter, with reasons like comfort or sustainability showing as relevant factors in the decision to opt for public transport.

5.3.2.4 Public opinion on public transport fare structure

In this sub-chapter we present an overview of the results from the question: ¨In this paragraph, we will ask you some questions about mobility fees and payment systems. Please evaluate on a scale from 1 (Completely disagree) to 5 (Completely agree) how much you agree with the following statements:

- There should be a single card that allows payments for all mobility services, public, shared and private.
- The price of each trip should depend on the real distance traveled (and not only on the number of areas crossed).
- The price of each trip should depend on socio-demographic characteristics of the user (such as age, income level and occupation).
- The price of each trip should change in case of special events (large sports event, high pollution day).
- The price of each trip should depend on the sustainability of the means of transport used (in order to encourage active modes or carpooling, for example).
- Privately operated modes (such as shared motorcycles or carpooling) should be subsidised if they contribute to making mobility more sustainable.
- The price of each trip should depend on the time of day or day of the week to encourage off-peak travel.
- There should be a post-payment system for mobility, as there is for electricity or internet.

Barcelona

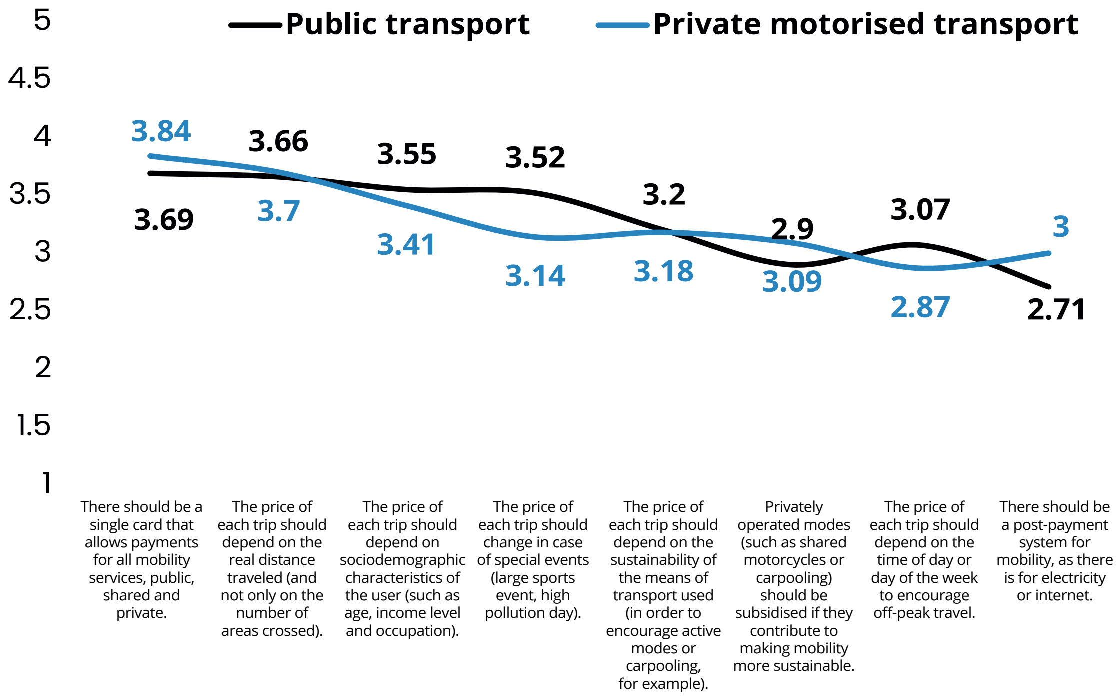


Figure 23: How public and private motorised transport users of the Metropolitan Area of Barcelona view changes in the current fare system

Madrid

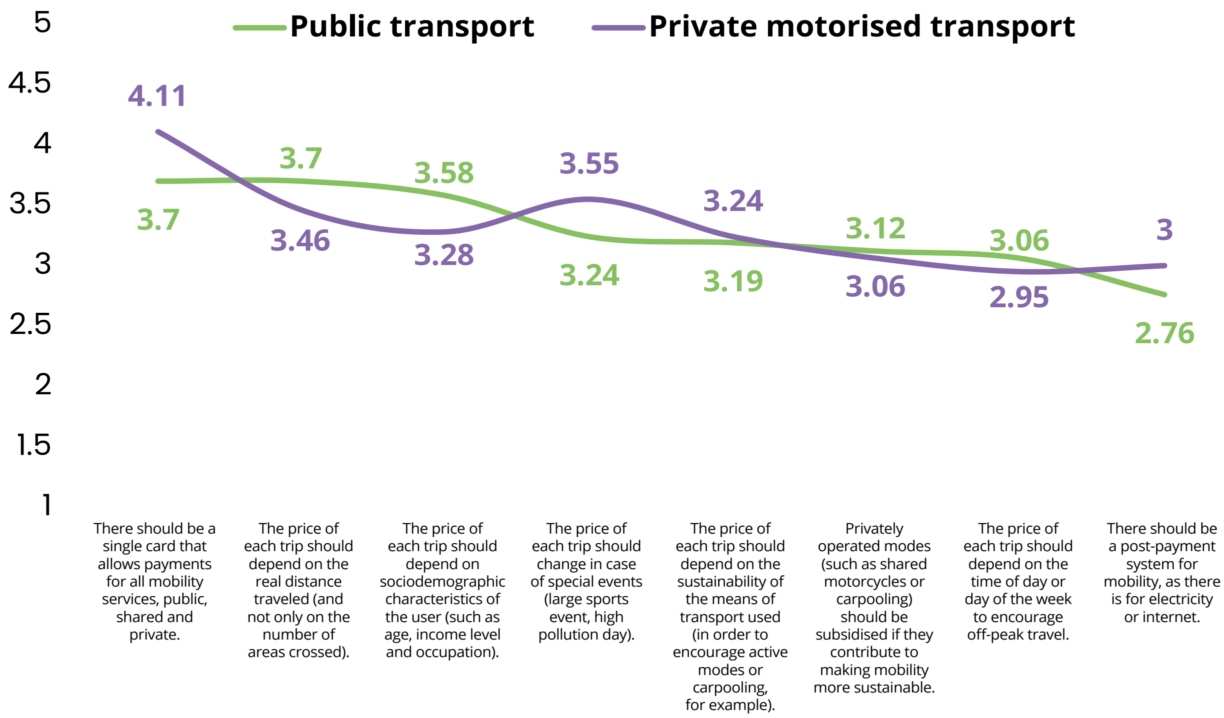


Figure 24: How public and private motorised transport users of the Metropolitan Area of Madrid view changes in the current fare system

Lisbon

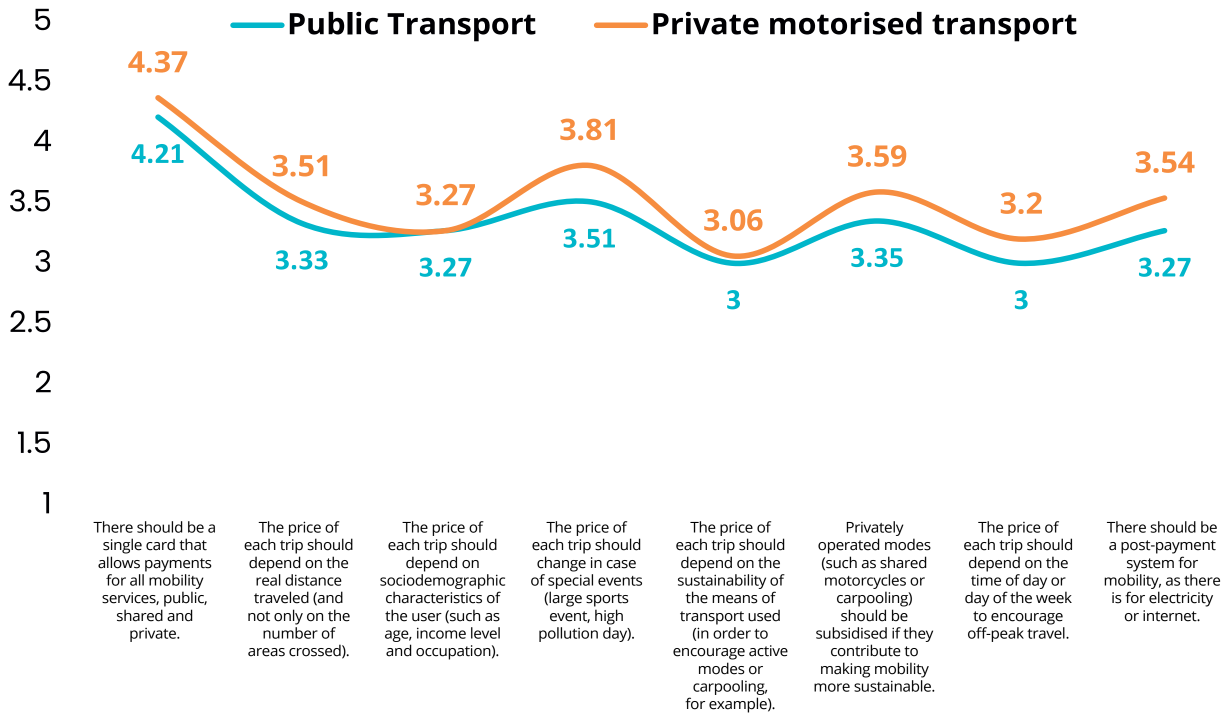


Figure 25: How public and private motorised transport users of the Metropolitan Area of Lisbon view changes in the current fare system

Berlin

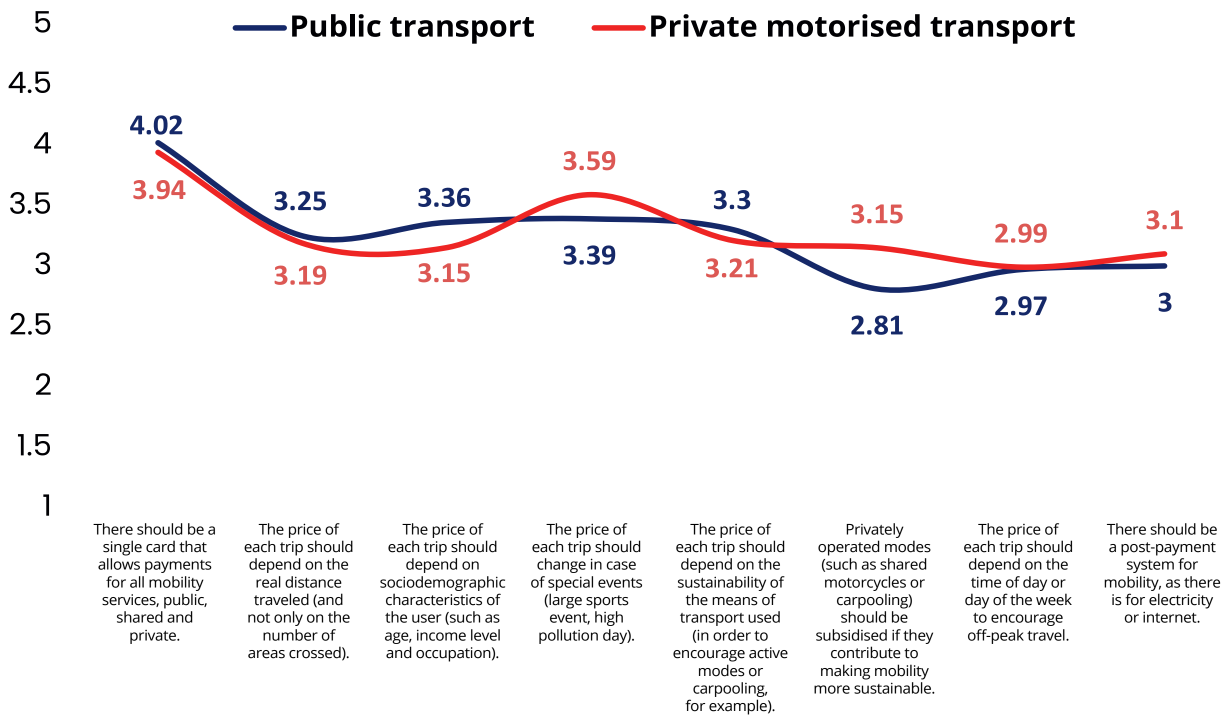


Figure 26: How public and private motorised transport users of the Metropolitan Area of Berlin view changes in the current fare system

Oslo

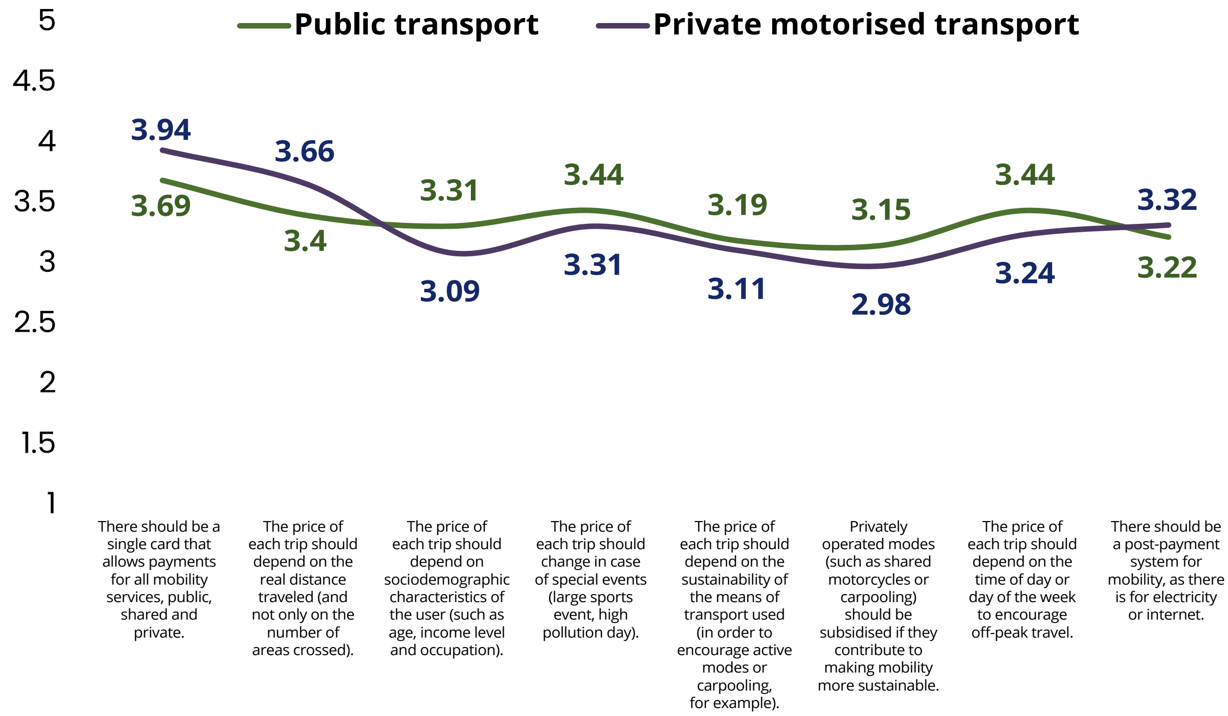


Figure 27: How public and private motorised transport users of the Metropolitan Area of Oslo view changes in the current fare system

Two interesting patterns appeared from the analysis of these answers:

- There is very strong support in all cases to have a single card allowing payments for all mobility modes, both public and private. In all cities, support for this option is higher than 4 (out of 5).
- There seems to be significant support in all five cities for the possibility to increase price differentiation following different criteria (distance, special events, sustainability of mode of transport, etc). In all cases, support is above three in the five cities surveyed.

5.3.3 Stated-preference study

5.3.3.1 Stated preference block to car users

The stated preference block of the survey that is tailored to car users aimed to assess the willingness of respondents to replace their car trips with alternative modes of transport, such as public transport, shared mobility, carpooling, or ride-hailing/taxi, in the context of a new fare system that assigns different prices to each trip based on several parameters.

The structure of the stated preference block consists of fourteen different scenarios, in which respondents must choose between re-doing the same car trip at an increased cost, or taking an alternative route at an incentivised cost. For each scenario, the alternative route will vary in terms of travel time, mode, and cost (see ANNEX Stated preference study).

5.3.3.2 Stated preference block to public transport users

On the other hand, public transport users are presented with different scenarios where they must choose between traveling during peak times at a certain cost, or traveling before or after peak times at a lower cost, the survey aimed to gather data on the trade-offs that respondents are willing to make in terms of cost and time in order to reduce overcrowding in public transport at peak times (see ANNEX Stated preference study).

5.3.3.3 Insights from the stated-preference study

The results of the stated-preference study are shown in this chapter, both concerning the survey directed to car users and the one to public transport users. Probability functions for accepting the incentivised trip are presented. The probability (expressed in percentages) is always on the y-axis, while the x-axis represents the cost ratio between the incentivised cost and the base option.

5.3.3.4 Probability of accepting the incentivised multimodal trip

In this chapter, we provide an overview into the results of the stated-preference study tailored to car users. The different coloured curves represent scenarios in which:

- Travel time is 10 minutes shorter than in the base option (blue).
- Travel time is the same as in the base option (red).
- Travel time is 10 minutes longer than in the base option (green).

The interpretation of the results presented in this section is quite straightforward:

- The steeper the slope of the curve, the higher the sensitivity of users to cost. In other words, the steeper the curve, the more likely they will be to switch to a multimodal trip for a given discount.
- The bigger the distance between the curves, the more sensitive users are towards time. In other words, the bigger the distance, the more likely they will be to switch to a multimodal trip for a given discount.

Barcelona

In *Figure 28*, we can see the probability of car users in the Metropolitan Area of Barcelona to accept the incentivised multimodal trip. The curves have a rather steep slope, denoting that the discount ratio is an important decisional factor. It is interesting to see that for travel time 10 minutes shorter and a discount ratio of 50%, the probability that a car user would take public transport is a higher than the probability that they drive.

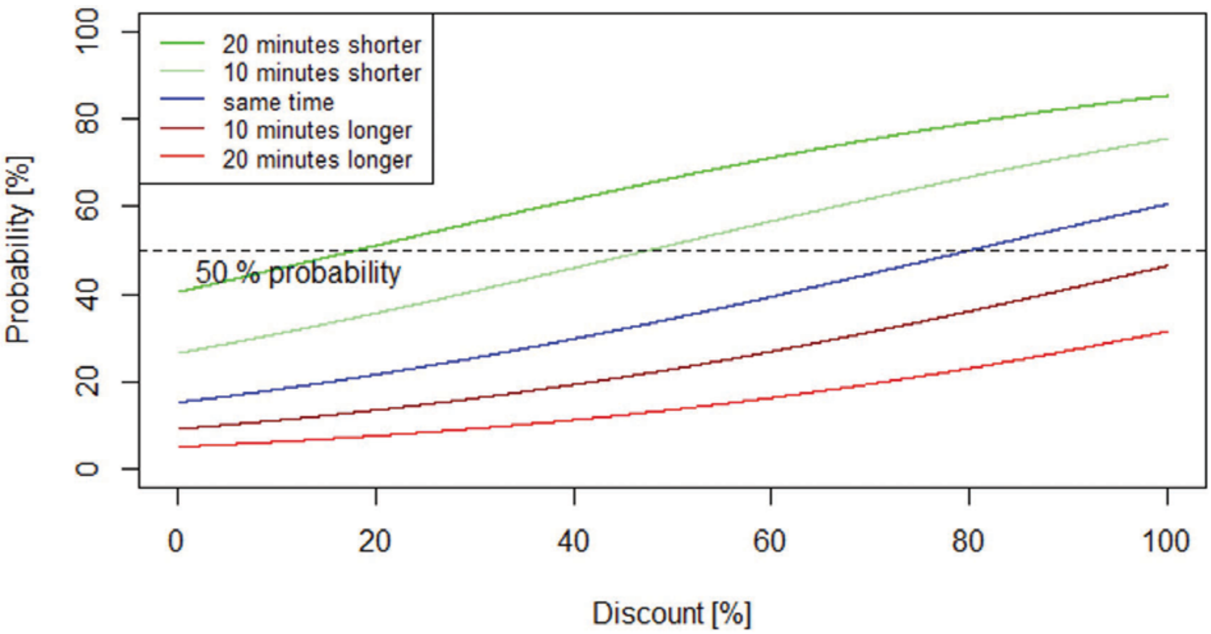


Figure 28: Probability of accepting the incentivised multimodal trip in the Metropolitan Area of Barcelona

Madrid

In Madrid, the probabilities of accepting the incentivised trip are generally higher than in Barcelona. The probability of using public transport for a half price discount is almost the same as driving, even for the same travel time.

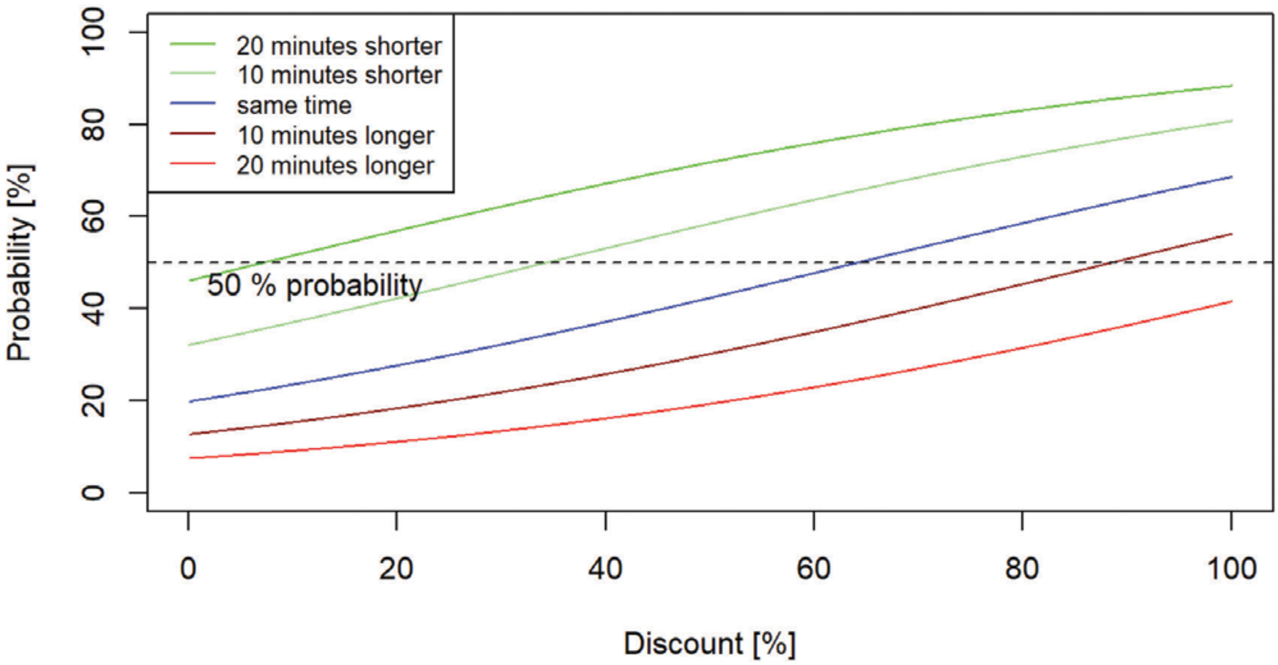


Figure 29: Probability of accepting the incentivised multimodal trip in the Metropolitan Area of Madrid

Lisbon

In *Figure 30*, one can immediately notice that for what concerns the Metropolitan Area of Lisbon, the same curves seen for Barcelona and Madrid are much steeper. This means that to achieve a similar modal shift effect, a higher discount is needed. To achieve a 50% probability in a same travel time scenario, the incentivised trip must have a cost that is 78% lower than driving a car. Conversely, a price that is half of what driving and parking a car costs, will yield a probability of 30% that someone would decide to accept the incentivised trip.

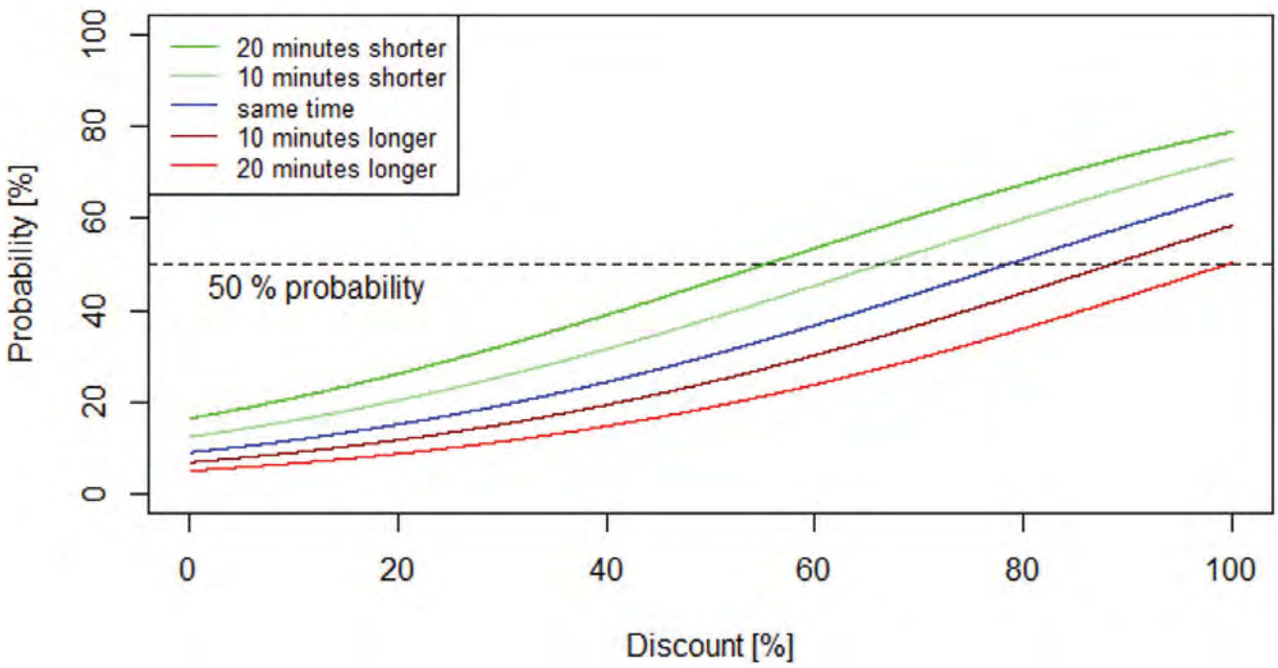


Figure 30: Probability of accepting the incentivised multimodal trip in the Metropolitan Area of Lisbon

Berlin

In the Metropolitan Area of Berlin, the curves have a much flatter slope, as can be seen in *Figure 31*. This shows that even for costs similar to the ones of driving, the probability a user decides to use an incentivised mode is not null. Interestingly, the curves do not start from the origin. Meaning that, even for a 20-minute detour and no discount, there is still a significant probability that the car user would switch to an incentivised mode. To be exact, the probability values for no discount are:

- 22% if the incentivised journey takes 20 minutes longer than going by car
- 28% if the incentivised journey takes 10 minutes longer than going by car
- 33% if the incentivised journey takes the same time as going by car
- 41% if the incentivised journey takes 10 minutes less than going by car
- 48% if the incentivised journey takes 20 minutes less than going by car

This shows that not only monetary discounts, but also availability of alternatives and other non-measurable attributes (such as comfort, ability to do other things while travelling, etc.) have a strong influence on mode choice (as well as, of course, travel time).

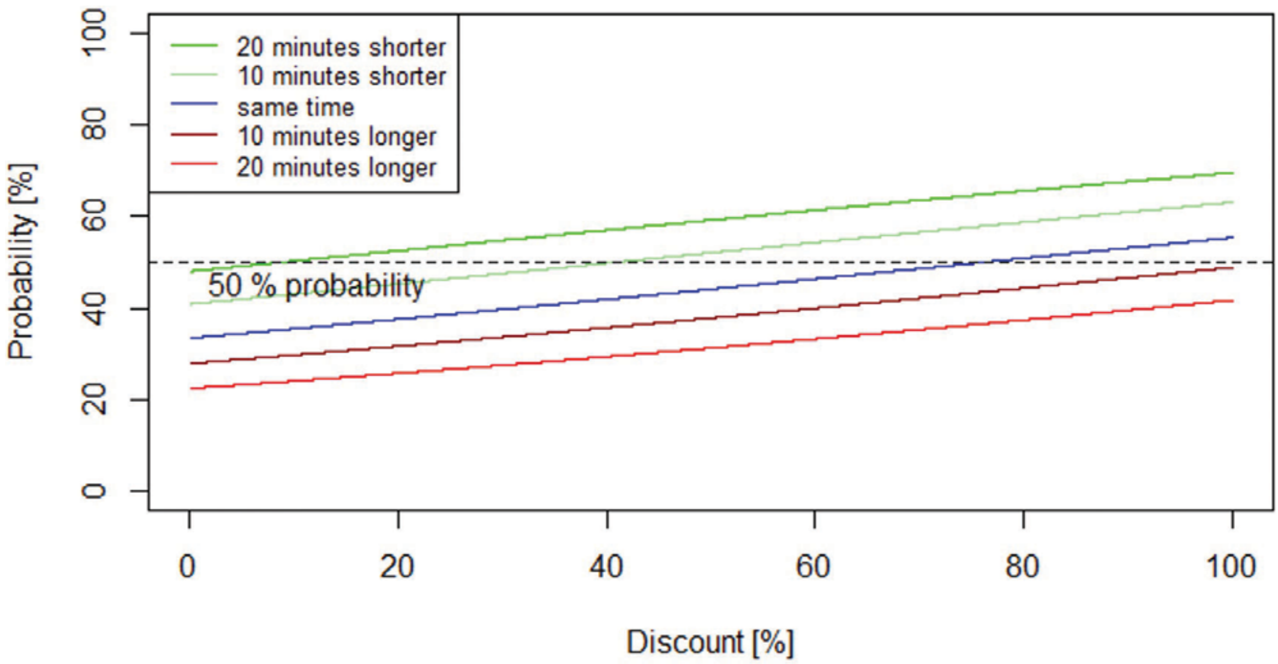


Figure 31: Probability of accepting the incentivised multimodal trip in the Metropolitan Area of Berlin

The price difference thresholds after which it becomes more likely that one chooses the incentivised mode over driving a car (probability above 50%) are the following:

- Never if the incentivised journey takes 10 minutes longer or more than going by car
- 76% if the incentivised journey takes the same time as going by car
- 41% if the incentivised journey takes 10 minutes less than going by car
- 9% if the incentivised journey takes 20 minutes less than going by car

Oslo

What just said about Berlin, also applies to Oslo as here as well the curves do not start from 0 but from probability values within 21% and 32%. Very differently from Berlin though, the curves appear to be quite steep. This means that respondents in Oslo were much more price-sensitive compared to their fellows in Berlin. The 50%-probability threshold is passed for the following price reduction percentages:

- 53% if the incentivised journey takes 20 minutes longer than going by car
- 48% if the incentivised journey takes 10 minutes longer than going by car
- 43% if the incentivised journey takes the same time as going by car
- 37% if the incentivised journey takes 10 minutes less than going by car
- 31% if the incentivised journey takes 20 minutes less than going by car

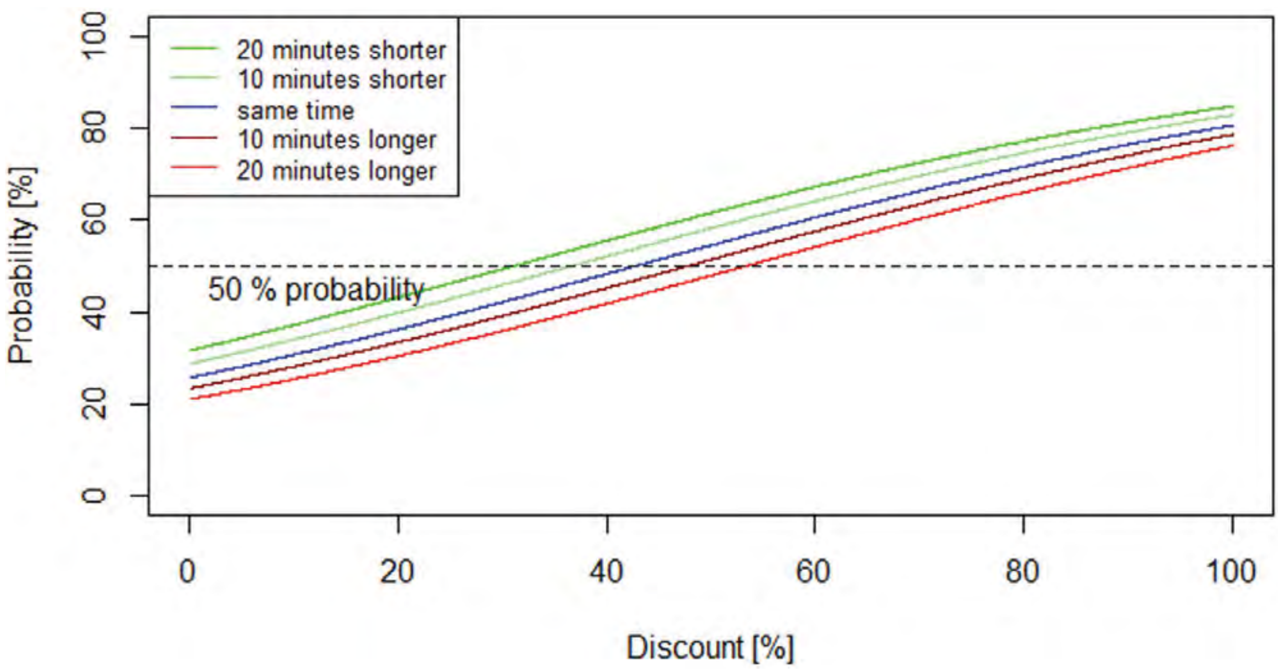


Figure 32: Probability of accepting the incentivised multimodal trip in the Metropolitan Area of Oslo

It is evident that respondents in Oslo do not seem to be very sensitive to travel time differences, when compared to respondents from other cities.

The tables below summarise the results of the stated preference exercise for the five cities. They show which minimum discount is needed to achieve a 50% and a 20% probability that the user would switch to the incentivised mode.

Travel time	Barcelona	Madrid	Lisbon	Berlin	Oslo
20 minutes longer	Never	Never	Never	Never	53%
10 minutes longer	Never	88%	89%	Never	48%
Same	80%	64%	79%	76%	43%
10 minutes faster	48%	34%	66%	41%	37%
20 minutes faster	18%	7%	55%	9%	31%

Table 6: Minimum discount (approximately) needed to have a 50% (or higher) probability of accepting a multimodal trip

Travel time	Barcelona	Madrid	Lisbon	Berlin	Oslo
20 minutes longer	72%	52%	52%	Always	Always
10 minutes longer	42%	25%	41%	Always	Always
Same	15%	1%	31%	Always	Always
10 minutes faster	Always	Always	19%	Always	Always
20 minutes faster	Always	Always	8%	Always	Always

Table 7: Minimum discount (approximately) needed to have a 20% (or higher) probability of accepting a multimodal trip

These results suggest that there may be ample scope for policy action to incentivise the switch from the private car to multimodal trips:

- For all cities (except Lisbon) an approximate discount of 50% or less would be needed for users to make the switch (with a 50%+ likelihood) to multimodal trips 10 minutes faster (or more) than with the private car.
- Oslo seems to be the city where users are more willing to make the switch: a discount of approximately 50% would suffice for users to abandon the private car (with a 50%+ likelihood).
- In Barcelona and Madrid, the trade-off between time and cost is quite pronounced, as the necessary discount to make the switch (with a 50%+ likelihood) decreases very rapidly as the time saved increases.
- If we lower the probability to just 20%, then the necessary discount is much lower. In fact, no discount would be needed in Berlin and Oslo for any kind of trip and this would be the case also in Barcelona and Madrid for faster trips.

5.3.3.5 Probability of accepting the incentivised off-peak trip

In this chapter, we provide an overview into the results of the stated-preference study tailored to public transport users. The different coloured curves represent scenarios in which:

- Users were asked to start their trip 10 minutes earlier or later than they normally do (blue).
- Users were asked to start their trip 30 minutes earlier or later than they normally do (red).
- Users were asked to start their trip 1 hour earlier or later than they normally do (green).

Here again, the interpretation of the results presented in this section is quite straightforward:

- The steeper the slope of the curve, the higher the sensitivity of users to cost. In other words, the steeper the curve, the more likely they will be to accept the incentivised off-peak trip for a given discount.
- The bigger the distance between the curves, the more sensitive users are towards time. In other words, the bigger the distance, the more likely they will be to to accept the incentivised off-peak trip for a given discount.

Barcelona

Figure 33 shows the results of the Metropolitan Area of Barcelona. We can notice that the discount ratios needed to achieve similar behaviour change results as in the previous chapter are significantly higher. A discount ratio of 50% only achieves a probability of accepting the incentivised trip of 30% (in the best case scenario).

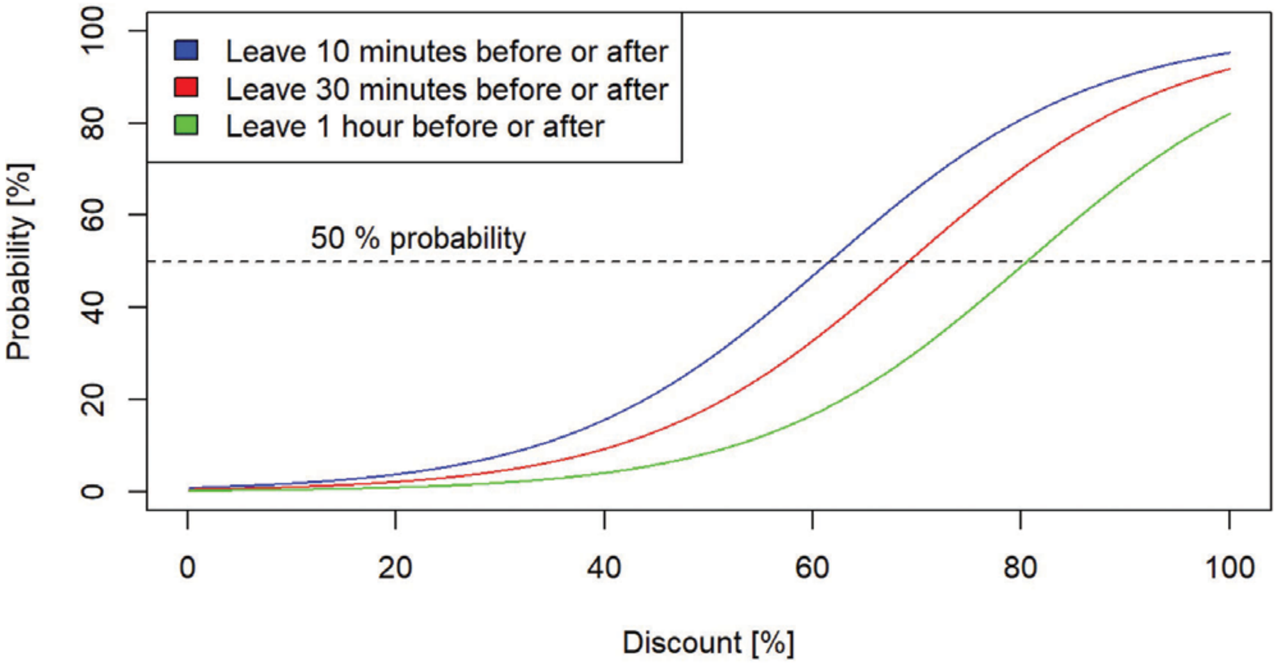


Figure 33: Probability of accepting the incentivised off-peak trip in the Metropolitan Area of Barcelona

Madrid

Figure 34 shows that the results of the Metropolitan Area of Madrid also follow a similar trend, nonetheless the probabilities are generally lower than for Barcelona. Moreover, the probabilities decrease faster with decreasing discount ratios.

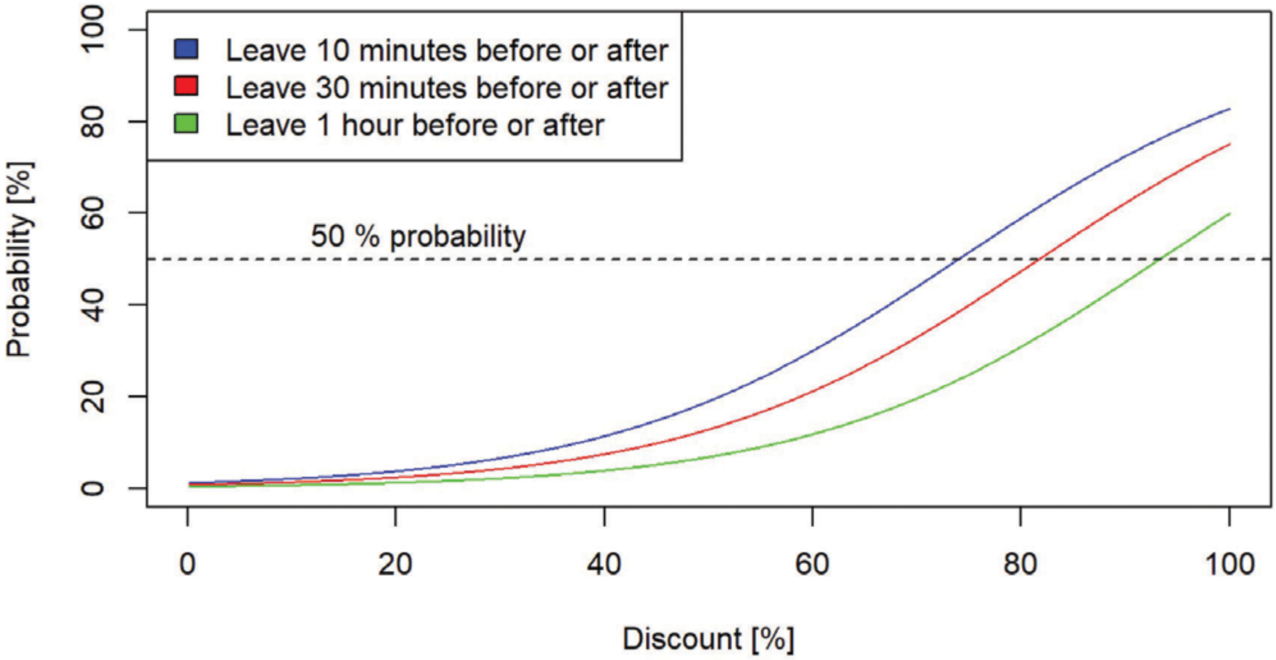


Figure 34: Probability of accepting the incentivised off-peak trip in the Metropolitan Area of Madrid

Lisbon

Figure 35 shows that the results of the Metropolitan Area of Lisbon highlight a higher overall probability of travelling off-peak even at higher discount ratios. Moreover, the probabilities decrease faster with decreasing discount ratios.

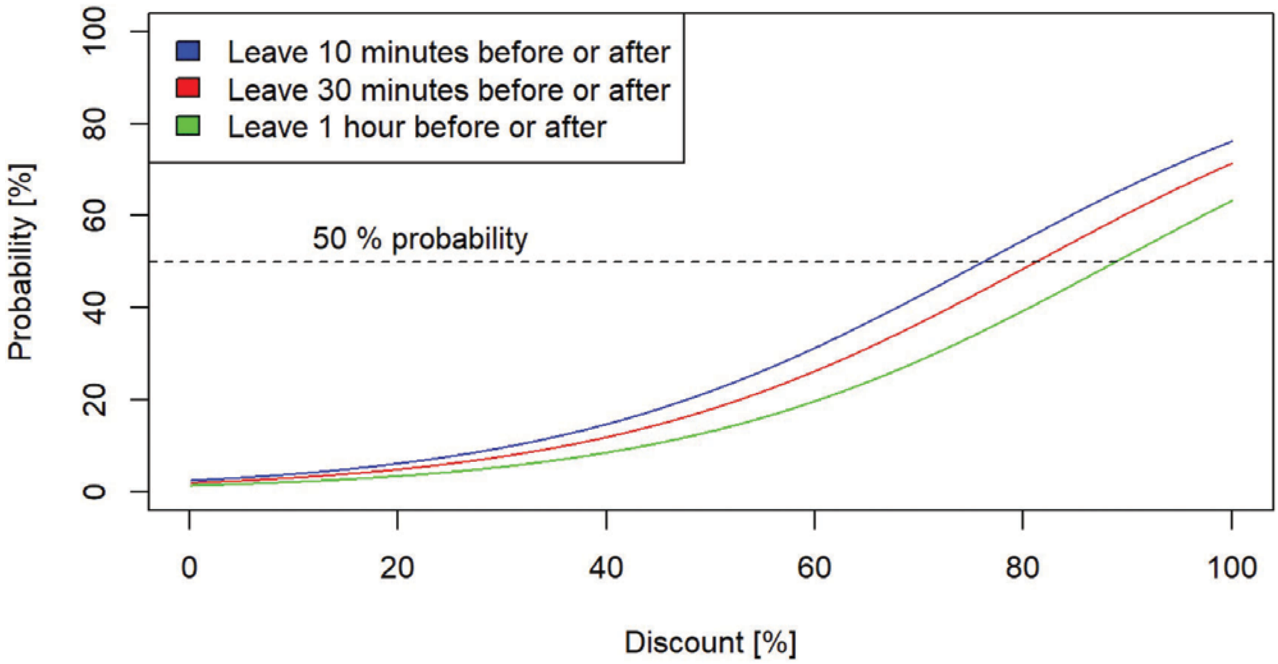


Figure 35: Probability of accepting the incentivised off-peak trip in the Metropolitan Area of Lisbon

Berlin

In the case of the Metropolitan Area of Berlin, the curves have a visibly flatter slope, meaning that Berliners show a less sensitive reaction to an increase in the discount ratio. This can be appreciated in *Figure 36* below.

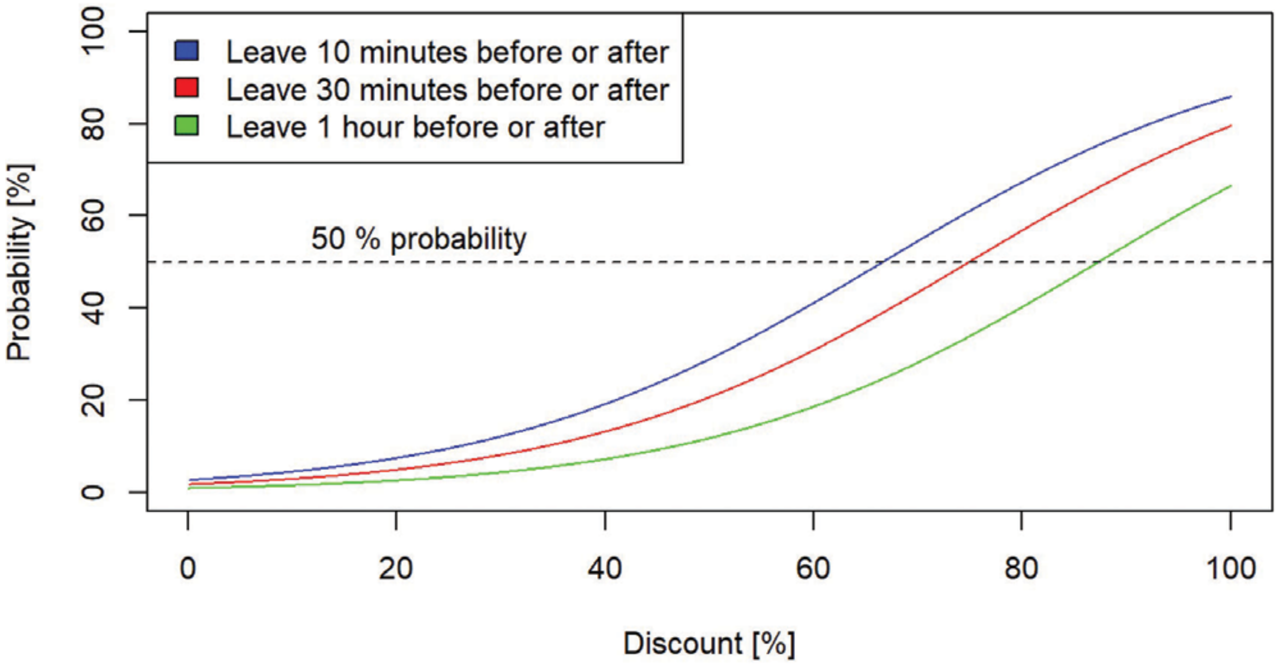


Figure 36: Probability of accepting the incentivised off-peak trip in the Metropolitan Area of Berlin

Oslo

In *Figure 37*, we can see that the results for the Metropolitan Area of Oslo show that interviewees there do not seem to be much time-detour sensitive, as all the curves are close to each other.

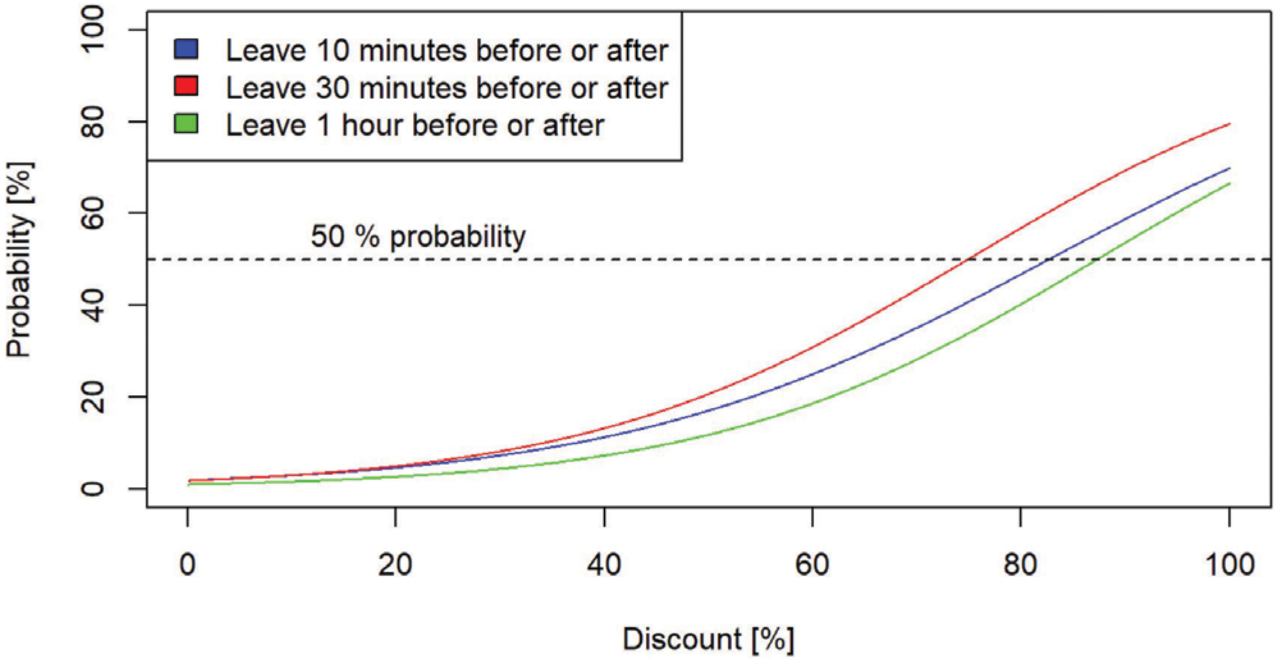


Figure 37: Probability of accepting the incentivised off-peak trip in the Metropolitan Area of Oslo

The tables below summarise the results of the stated preference exercise for the five cities. They show which minimum discount is needed to achieve a 50% and a 20% probability that the user would switch to the off-peak traveling.

Leave	Barcelona	Madrid	Lisbon	Berlin	Oslo
10 minutes before or after	61%	74%	76%	67%	80%
30 minutes before or after	69%	81%	81%	75%	84%
1 hour before or after	81%	93%	89%	87%	90%

Table 8: Minimum discount (approximately) needed to have a 50% (or higher) probability of accepting an incentivised off-peak trip.

Leave	Barcelona	Madrid	Lisbon	Berlin	Oslo
10 minutes before or after	44%	51%	48%	41%	52%
30 minutes before or after	51%	59%	53%	49%	56%
1 hour before or after	63%	70%	60%	62%	62%

Table 9: Minimum discount (approximately) needed to have a 20% (or higher) probability of accepting an incentivised off-peak trip.

These results suggest that users are quite inflexible when it comes to accepting changing the time of their trip at peak hours. Discounts between 60%-85% would be needed for users to accept (with a 50% likelihood) to switch to a trip leaving 10-30 minutes before or after peak time. But these discounts would be between 40%-60% for a 20% likelihood.

Also, it is worth noting that the trade-off between time and cost is not very pronounced in none of the 5 cities: even for leaving just 10 minutes before or after the preferred time, the discount needed (approximately) would be higher than 50% in all cases. This may explain why PTAs are not offering discounts to incentivise such trips.

It should be noted, however, congestion of public transport is very time sensitive and that small changes in time can help very much reduce overcrowding. This means that it might be worth exploring giving discounts that may switch the demand even if only by 10 mins as this may help flatten peaks of demand in a significant way.

6 Use cases

This chapter explores a collection of case studies that highlight diverse approaches aimed at incentivising sustainable modes. From collaborative carpooling initiatives to the integration of microsubsidies, these cases offer valuable insights into this evolving landscape.

Karos pilots in Toulouse and Paris

Karos, a French start-up founded in 2014, has been conducting over the past few years two projects on carpooling in Toulouse and Paris with promising results in terms of reducing the environmental impact and improving the quality of life for residents and employees. These projects can provide very interesting insights for the application of microincentives.

Karos in Toulouse

The Toulouse Metropolitan Area has seen a 77% increase in public transport usage between 2006 and 2016, with a goal of reaching 500,000 additional daily collective and shared mode trips by 2025. However, 74% of work commutes are currently made by car, leading to congestion and increased travel time during peak hours. In response, four major employers in the area, Airbus, ATR, the Toulouse-Blagnac Airport, and Safran, partnered with Toulouse Métropole and Tisséo Collectivités to address these issues through the COMMUTE project.[4] This project aims to experiment with a collaborative public-private governance model for urban mobility "from X to Y" where X indicates the start date of the project, and Y is +36 months.

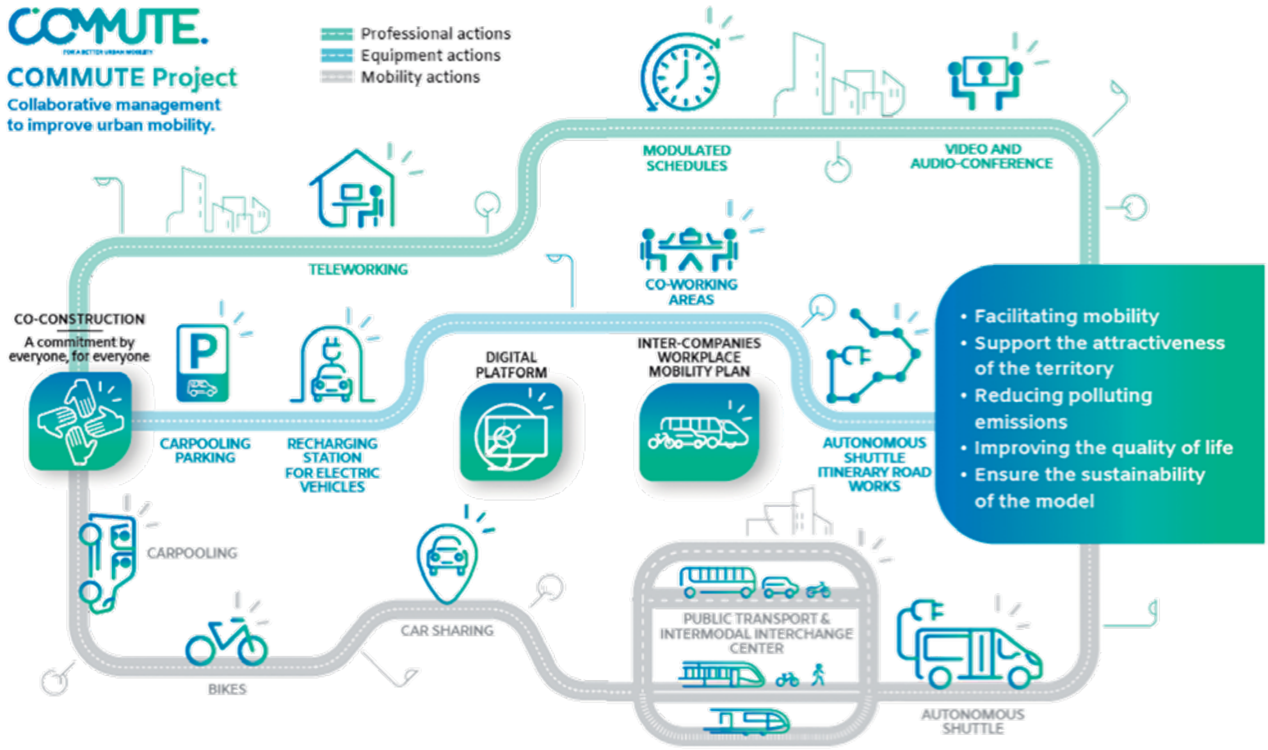


Figure 38: The COMMUTE project framework

One solution being implemented as part of the COMMUTE project is the deployment of a carpooling platform provided by Karos. Karos creates dynamic carpooling networks by utilising the empty seats in vehicles belonging to its community of drivers and combines these networks with key public transport lines to offer door-to-door intermodal trips to passengers. The platform also integrates other shared mobility options, such as bike and scooter sharing, and offers incentives and rewards for choosing sustainable modes of transport.

[4] https://www.projetcommute.fr/en/

Initial results from the pilot study show that Karos has been successful in reducing single occupancy vehicle use and increasing the use of sustainable modes. Over 6% of employees at participating companies have signed up for the platform, with 61% of registered users carpooling at least once and 33% using it regularly. The platform has also been well received by employees, with a satisfaction rate of 4.5 out of 5.

Overall, the COMMUTE project and the implementation of the Karos carpooling platform in Toulouse demonstrate the potential for innovative approaches to address issues of congestion and promote sustainable mobility in urban areas. The success of the pilot study suggests that similar solutions could be effective in other European cities.

Karos in Paris

Similarly to the case of Toulouse, the deployment of Karos in the Île-de-France region has had a significant impact on the transport landscape. The region already had a dense network of public transport, including 9 tram lines, 13 regional and RER train lines, 14 metro lines with 302 stations, and 1,519 bus lines. However, despite these resources, 46.5% of the budget of the region is dedicated to transport and mobility, with a focus on renewing or renovating trains, launching the Tramway 10 between Antony and Clamart, and extending the RER E to the west.

To address these challenges, Karos introduced a groundbreaking solution by "integrating" carpooling into the public transport fare system. The STIF (Syndicat des transports d'Île-de-France) allowed Karos to offer two free carpooling trips per day to Navigo pass holders. Karos also developed a first version of an intermodal calculator that integrates open data from the region's structured public transportation network (RER, Transilien, metro, and tram lines) to offer optimised door-to-door journeys combining carpooling and heavy modes.

The company also launched its own experiment, funded by its own resources, which made carpooling a true part of the public transport network with intermodal options, as well as integrated into its pricing system. This allowed users to access seamless, optimised mobility solutions in suburban and rural areas within their public transport fares. As the experiment progressed, Karos provided regular reports to IDF Mobilités showing the relevance of this approach for the region.

Finally, the Île-de-France region launched an ambitious 13-month experiment, in which IDF Mobilités funded carpooling trips at a rate of 2 euros per journey. This model, which Karos had been testing on its own funds for a year, was made permanent with funding from the AOM (Agence de l'Île-de-France).

Overall, this series of steps has resulted in the completion of over 4,240,000 carpooling trips in the Île-de-France region by the end of 2022.

The deployment of Karos in the Île-de-France region has been a successful experiment in transforming personal vehicles into a collective transport network. There are four key ingredients to this success: the use of artificial intelligence to adapt carpooling to short trips, the physical integration of carpooling into the existing transportation network through intermodality with structured lines, the alignment of carpooling fares with those of public transport, and the integration of ticketing systems to validate carpooling trips.

The use of artificial intelligence has allowed Karos to analyse and predict the mobility needs of its users with a high degree of accuracy, enabling the creation of reliable and flexible carpooling options for daily commuting. The physical integration of carpooling into the transportation network through intermodality with structured lines has made it possible to offer door-to-door solutions that combine carpooling and public transport. Aligning carpooling fares with those of public transport has provided a strong incentive for users, and the integration of ticketing systems has allowed for the validation of carpooling trips.

Overall, the deployment of Karos in the Île-de-France region has demonstrated the potential for carpooling to play a significant role in the collective transport network, improving mobility and reducing the environmental impact of transport (COMMUTE, 2022).

Bridging Urban Mobility Gaps: Dott's Shared Services Trial in Brussels with Rideal

Affordable housing tends to be concentrated in areas with inadequate public transport, leading to increased car dependence among economically disadvantaged communities. This not only strains household budgets but also exacerbates urban congestion and pollution. Dott, a leading shared micromobility service and Keita Mobility Factory, developers of Rideal, a digital tool to manage multiple mobility incentive programmes, recognised this issue and conducted a trial in Brussels in collaboration with the European Union Agency for Space Programme (EUSPA) project *MOLIERE*.[5]

RIDEAL

[5] https://moliere-project.eu/

They aimed to bridge this gap by connecting riders seamlessly to existing public transport services. With over 58% of Dott riders already integrating their trips with public transport, the potential for synergy between shared micromobility and transit systems became evident.

The trial in Brussels spanned twelve weeks during the summer of 2023, offering discounted access to Dott's shared e-bikes and e-scooters in targeted low-income neighborhoods. The initiative sought to improve transport accessibility for economically disadvantaged communities while reducing carbon emissions in city centers.

Discounted trips, ranging from 30% to 70% off regular fares, were provided to residents in selected neighborhoods. Results showed a notable increase of up to 10% in the overall volume of rides within the targeted areas compared to control areas. This demonstrated that financial incentives for lower-income communities could accelerate the shift towards more sustainable transport.

The trial's success underscored the importance of inclusive approaches to urban mobility solutions. Targeted microincentives for specific local communities can expedite the transition to sustainable transport. Shared micromobility services, like those offered by Dott, play a vital role in filling gaps in public transport services, offering a compelling alternative to all residents and reducing car dependence in city centers (Improving Transport Links in Lower Income Areas - Dott, 2022).

Innovating Public Transport Fare Systems: FAIRTIQ's Loyalty Program Trial with HAVAG

Public transport companies frequently employ bonus models and loyalty/reward programs to increase ridership. These models offer discounted fares once users complete a pre-defined number of journeys, with variations in structures such as immediate reductions, cashback, monthly or weekly rewards, and flat or variable discount rates. However, despite their popularity, there is limited reliable data on their effectiveness and whether the increase in ridership offsets their costs.

In an effort to address this gap, Hallesche Verkehrs-AG (HAVAG), a German public transport provider, collaborated with FAIRTIQ to conduct a trial of a loyalty program. FAIRTIQ's flexible infrastructure allowed simultaneous testing of different bonus models against a control group, providing valuable insights into the financial viability of such reward programs.

HAVAG's decision to trial a loyalty program was driven by the need to understand whether the benefits of these programs, such as increased ridership and revenue, outweighed the associated costs. The trial aimed to determine whether the introduction of reward programs makes financial sense for public transport providers.

The trial coincided with the introduction of the 'Deutschlandticket' in Germany, allowing unlimited travel on local and regional transport services for a fixed monthly fee. While this option was attractive to regular users, it left a significant portion of the population, who use public transport occasionally or rarely, without a suitable pricing system. Addressing this gap was crucial for the long-term development of public transport and sustainable growth in passenger numbers.

HAVAG, operating in the Leipzig-Halle area, commenced the trial in early 2023. They had already been using FAIRTIQ's app for digital ticket purchases since November 2019 and had experimented with an innovative distance-based fare in September 2022. The loyalty program trial involved testing two reward models alongside the Deutschlandticket introduction.

The trial setup included two test groups with varying discount structures, rates, and timing of rewards, alongside a control group. Using the 'FTQ Lab' app, HAVAG and FAIRTIQ aimed to identify which model had the most significant impact on public transport use. The rewards were applied based on a predetermined number of journeys, with a sliding scale of three thresholds and increasing discount rates.

Results from the trial revealed that both immediate and delayed reward models incentivised greater public transport use. The immediate reward model led to a substantial increase in passenger spending, with the test group spending approximately 20% more than the control group. The return on investment was positive, indicating that the additional expenditure justified the costs of operating the reward program.

While the results for the delayed reward model were more ambiguous, the overall findings demonstrated the profitability of reward models in increasing company revenue. The success of the trial showcased the advantages of FAIRTIQ's flexible infrastructure, allowing for precise testing, direct communication with users via the app, and the potential for developing innovative fare models (HAVAG Proved That Rewarding Passengers Immediately Increased Revenue the Most - by 20%, 2023).

Meep and Ciclogreen: Driving Sustainable Mobility at eCity Seville

The eCity Seville[6] project aims to revolutionise urban mobility in the Isla de la Cartuja area through sustainability and digitalisation efforts. As part of this initiative, Meep and Ciclogreen, in collaboration with participating companies, have joined forces to promote eco-friendly transport solutions within the Seville Technology Park. With the goal of making Cartuja Science and Technology Park a decarbonised, sustainable, and innovative environment by 2025, the project addresses longstanding mobility challenges prevalent in the area. Recognising the urgent need for improvement, the initiative was reintroduced in 2022 following its successful implementation the previous year. Central to the initiative is the II MaaS eCitySevilla Challenge, designed to encourage sustainable commuting practices among individuals. Participants earn "Cycles" for every kilometre travelled using eco-friendly transportation modes, with the opportunity to redeem these points for prizes. This marks a significant departure from the prevalent use of private cars within the Seville Technology Park. Meep, Ciclogreen, and participating companies collaborate closely to facilitate sustainable mobility solutions for partners arriving and departing from Isla de la Cartuja. By promoting alternatives to traditional transport methods, the initiative contributes to the broader goal of reducing carbon emissions and fostering a culture of sustainability. The microincentives-driven approach has yielded promising results, including increased adoption of eco-friendly transport modes and a reduction in carbon emissions. The initiative has also enhanced community engagement and contributed to the creation of a more sustainable urban environment (eCity Seville Project: An Example of Sustainability, 2022).

[6] https://ecitysevilla.com/

Introducing UPPER Measures: Driving Incentives for Sustainable Urban Mobility

In addition to the innovative case studies presented, the UPPER (Unleashing the Potential of Public Transport in Europe) project[7] has been spearheading 84 push and pull measures aimed at promoting sustainable urban mobility across different European cities. Of these, 5 measures leverage microincentives to promote the use of public transport, green mobility options, and multimodal transportation solutions. As leaders of the task related to incentivisation, Factual is closely following, supporting and monitoring the development of the following 5 measures:

[7] https://www.upperprojecteu.eu/

To incentivise the use of public transport for commuters in the Île-de-France region using mobility credits

This measure focuses on incentivising the use of public transport and green mobility among commuters in the Île-de-France region in the Paris Metropolitan Area. By allowing employers to provide Forfait de Mobilité Durable (FMD), or mobility credits, to their employees, this measure aims to reduce car dependency and encourage the adoption of eco-friendly transport modes. Employers can distribute FMD through a dedicated B2B application developed by Instant Systems, facilitating the use of micromobility services and other sustainable transport options for home-to-workplace trips.

Mobility for all by optimising the use of financial incentives to increase the share of Public Transport users in Leuven

This measure aims to enhance the efficacy of existing financial incentives for public transport in Leuven, Belgium. By analysing the impact and effectiveness of current incentives and developing a more coherent approach, Transport & Mobility Leuven seeks to increase the attractiveness and accessibility of public transport. Through targeted financial incentives integrated with Mobility as a Service (MaaS) applications, the uptake of public transport among specific social groups is expected to rise, contributing to a reduction in car usage and improved urban mobility.

Incentive packages to support multimodality in Rome

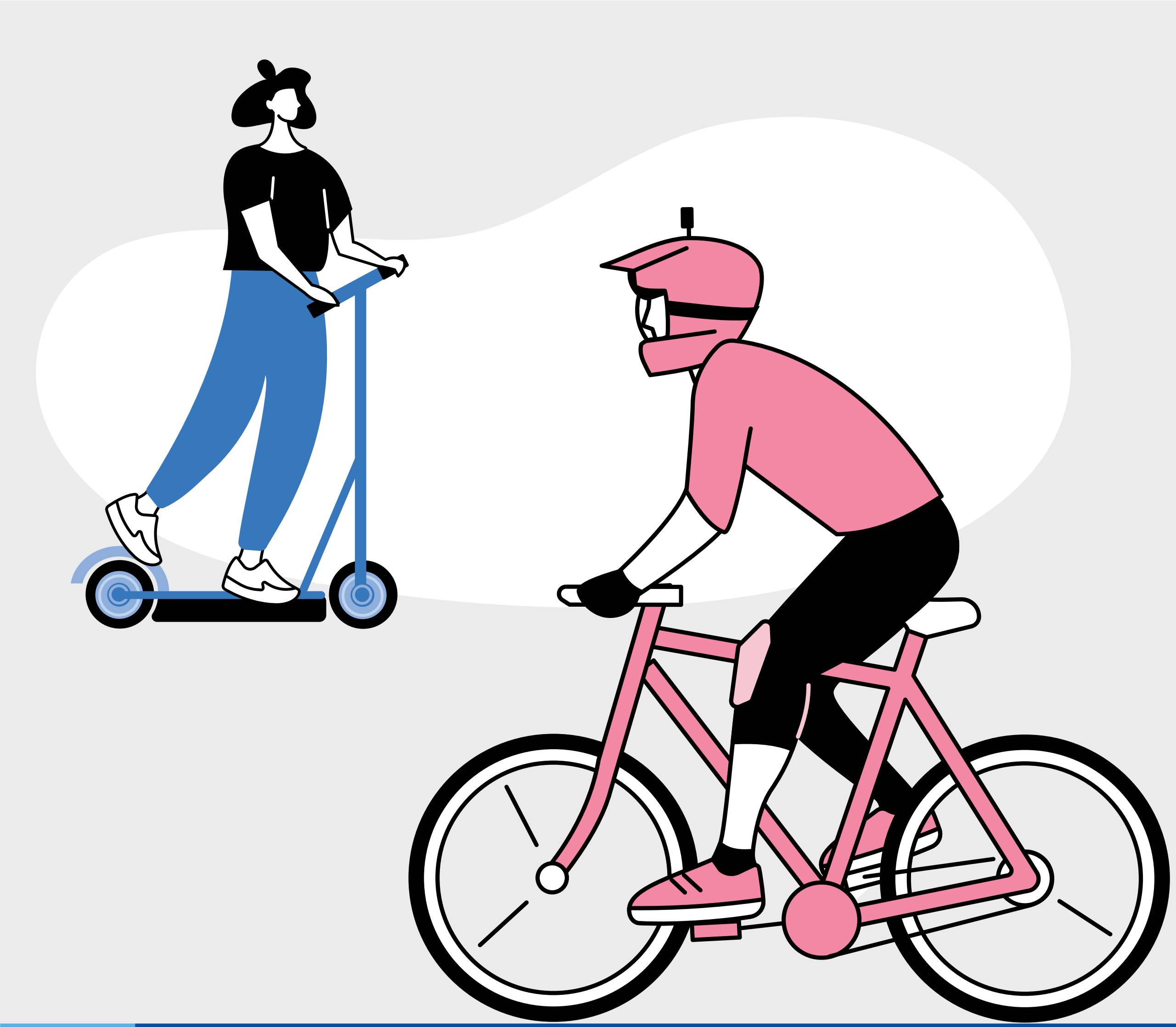
In Rome, Italy, Roma Servizi per la Mobilità is working on a measure to promote sustainable mobility behaviours through a network of local mobility managers. By engaging mobility managers in institutions, companies, and schools, this measure aims to encourage multimodal trips, carpooling, cycling, and the use of public transport among employees, teachers, and students. By leveraging the influence of mobility managers and implementing targeted incentives, the measure seeks to shift travel behaviours towards more sustainable modes and reduce the carbon footprint in the Metropolitan Area of Rome.

Incentivise the use of public transport in combination with active modes in Thessaloniki

This measure focuses on increasing the attractiveness of public transport in Thessaloniki through incentives. By offering passengers the ability to exchange their tickets for vouchers to be used in local shops, CERTH aims to promote the use of public transport in combination with active modes in the Greek city. A stated preference survey and algorithm development will support the implementation of tailored incentive packages, encouraging multimodal trips, car-sharing, cycling, and reducing car usage.

Reduce dependency on car ownership in Oslo

Lastly, in Oslo, Norway, Ruter, a PTO, is exploring models for cooperation between public transport operators, landowners, and mobility service providers to reduce car ownership dependency. By creating scalable combined mobility offers and reducing minimum requirements for private car parking, this measure aims to incentivise the use of public transport and shared modes. Through innovative pricing/payment models and service offerings, residents can access seamless mobility solutions, contributing to a more sustainable urban transport ecosystem. These new models includes offering residents of selected housing facilities pre-paid packages of minutes to be used on several shared mobility platforms available in Oslo. This pilot program will serve as a test for a wider implementation of incentives in the Norwegian capital.



7 Incentive management platforms

There are several incentive management platforms currently available on the market, each with different features.

The following table attempts to sum up and briefly describe the main ones:

Corporate mobility apps:

Platform	Description
	Pave Commute Helps employers manage employee commuting and incentivises sustainable modes of transport. **https://pavecommute.app/**
	Ciclogreen Corporate mobile app where employees win prizes for recording their sustainable commute to work by participating in fun challenges. It promotes all sustainable modes of transport, from cycling to carpooling, as well as healthy habits such as running and active mobility to combat sedentary lifestyles. **https://www.ciclogreen.com/**
	Liight Corporate app to track sustainable behaviour of employees, including the use of public, shared and active modes and recycling. It promotes such choices thanks to a gamified design and a ranking system. **https://www.liight.es/**
	highQ (mytraQ) In the App mytraQ, employees are shown different ways of working that are tailored to their individual needs. They can choose between connections by public transport, bicycle routes, car or carpooling. This makes the comparison easy and motivates employees to change. **https://www.highq.de/mobilitaetsloesungen/effizienztools/mytraq**

Account-based ticketing:

Platform	Description
FAIRTIQ	**FAIRTIQ** Mobile ticketing system that allows users to easily check-in and check-out rather than buying a ticket from the driver, at a ticket vending machine or a booking office and charges them the lowest possible price for the actual journey undertaken, whether it is single or multi-leg, or involving more than one operator. **https://fairtiq.com/en/**
masabi	**Masabi** Provides ticketing and mobile payments for public transport services. **https://www.masabi.com/**

Nudging mobility

Platform	Description
	Nivel Their Digital Regulator Tool analyses real-time position data from the micromobility vehicles with dynamic algorithms, allows to define zones and policies and regulate parking by fees or subsidisation. **https://www.nivel.no/**
MOTIONTAG	**MotionTag** App that informs and engages users about their daily CO_2 and use gamification to gain additional user interest and encourage behaviour change through leaderboards, challenges, rewards, and promotions. **https://motion-tag.com/**
pin bike	**Pin Bike** Anti-fraud system that allows a municipality, a company or a school to provide economic incentives to people who use their bicycles or e-scooters for their daily commuting. **https://www.pin.bike/**

SaaS for rewards, gamification or mobility budget

Platform	Description
BetterPoints	**BetterPoints** This mobile app combines tracking, motion sensing and user interaction with sophisticated server side algorithms that verify activities and characteristics. This information is then linked to different types and levels of incentives that are awarded to people when they meet certain behavioural goals, such as exercising, completing an activity or trying something new. **https://www.betterpoints.app/**
RIDEAL	**RIDEAL** Offers an incentive management solution to create and manage operator-agnostic incentive programmes that are based on geo-location, time and individual parameters The RIDEAL platform enables the following: 1. Flexible definition of an incentive-budget with an alert-function when the limit will be reached. 2. Easy and independent management of incentive rules and criteria to granularly target any person, circumstance, need and/or transport provider available in order to maximise financial and societal goals. 3. Real-time reporting and data analytics of all essential KPIs to track and monitor the impact and performance of each program, helping to continuously improve incentive-programs.
VELOCIA	**Velocia** Software as a Service (SaaS) mobility rewards platform designed to incentivise and reward people for their daily commutes. Velocia uses rewards to encourage people to get out of single occupant vehicles, and into any other form of public transport – with a mission to improve the way people get around in their cities. Velocia has experience working with public transport agencies, MaaS operators and municipalities. **https://velocia.io/**

8 Conclusions

8.1 Subsidies today

- Subsidies to public transport are a ubiquitous reality in Europe today. Their importance in the revenue structure of public transport varies significantly across cities, however. Before the COVID-19 pandemic, on average, the accounted for around 1/3 of the revenue of PTAs, but with big differences: in Stockholm, they accounted for almost 80% of total revenue, while in London that percentage was barely 10%.

  Interestingly, before COVID-19, and in the aftermath of the 2008 financial crisis, the evolution of subsidies was strikingly different, with London standing out as the city that changed more profoundly the revenue structure of its public transport, increasing revenue from sales and other sources and reducing subsidies from approximately 44% of its total revenue to just 10%. In contrast, many cities increased the weight of subsidies as a source of revenue between 2013 and 2019.

- During COVID-19, the weight of subsidies increased significantly in all cities, as PTAs opted not to reduce supply so as to keep public transport as the key mode to ensure mobility for everyone. But as ridership fell dramatically with the successive lockdowns, sales revenue decreased very significantly, and this missing revenue was covered mostly through subsidies.
- To soften the inflationary effects of the war in Ukraine that has eroded the purchasing power of many citizens, some governments have opted to reduce the price of public transport, bringing it close to zero. These moves have an equity dimension (compensate for the erosion of income in real terms) but also their goal is to further incentivise the use of public transport and reduce dependency on the private car. But experience shows that free (or almost free) public transport results mostly in increased ridership and in much smaller reductions in the use of the private car. In the long run, the reduction in the sales revenues of PTAs ends up having a negative impact in the level of service (quality) of public transport.

8.2 Management of subsidies

The management of fares and subsidies of public transport offers ample scope for improvement:

- All public authorities have developed highly sophisticated schemes of special fares for specific groups of users. The number of cases is almost limitless. In general, there is the perception that these schemes may have gone too far as they are not easy to manage and, in many cases, users may be receiving a subsidy (too low a fare) when they do not need it. There is a low knowledge of the cost that these schemes imply as, often there is not information on the actual use that the different groups make of public transport.
- Interestingly, the fare structure is not widely used in a targeted way to reduce the externalities of mobility and make it more sustainable. When determining fares, the key consideration is how they benefit different target groups, but very seldom they are determined considering other goals such as reducing congestion, pollution or CO_2 emissions.
- There is very little flexibility in changing fares. Fares are modified usually once a year (in some cases once every two years) and usually following preset criteria, like the CPI or some other cost index.
- In general, there is very little evaluation of the impact of the fare structure and how it serves to achieve distributional or sustainability goals.

8.3 Impact of subsidies

- In line with our conceptual framework (section 1), the literature review on the impact of subsidies confirms that currently subsidies are effective but not efficient. They serve to facilitate access to mobility to certain groups of users, but this could be achieved at a lower financial cost for PTAs if subsidies were more targeted. In general, specific subsidies to users are better than lump sum subsidies to operators.

- Subsidies do serve the purpose of reducing car dependency and increasing the use of public transport as they reduce its relative cost. The research shows that increasing the cost of private transport (either through tolls/congestion charges), especially at peak hours, or increasing the cost of parking at destination can be very effective tools to transfer users from the car to public transport. Interestingly, the literature shows also the sensitivity of users (i.e., the elasticity) tends to diminish as charging levels increase within a metropolitan area, a likely reason being that the most price-sensitive traffic is priced-off at the introduction of congestion charges. Like when trying to lose weight, the first kilos are relatively easy to get rid-off; afterwards things get harder.

- Beyond the relative cost between the private car and public transport, the transfer of user from the former to the latter depends also on relative travel times. Some studies find that, for example, dedicated bus lanes are a better stand-alone policy than public transport subsidisation or congestion pricing to the point that establishing dedicated bus lanes or implementing congestion pricing render subsidies unnecessary for high demand levels. Not surprisingly, this study notes that both subsidisation and dedicated bus lanes would count with public support while congestion pricing would probably encounter opposition. And it estimates that the optimal percentage of road capacity that should be devoted for bus traffic is around one third.

- Finally, there is the issue of the qualitative attributes of public transport that can attract car users. Qualitative attributes refer a wide array of features, including comfort (access to seat, noise levels, air conditioning, among others), safety (road safety and personal security), convenience (simplicity in the use of the service) and aesthetics (appeal of vehicles, stations and waiting areas). There is not much literature on this, but some authors claim that those attributes most effective in attracting car users are largely affective and connected to individual perceptions, motivations and contexts. Reduced fare promotions and other habit-interrupting transport policy measures can succeed in encouraging car users to try public transport services initially. But qualitative attributes that are perceived by the target market as important service attributes must then be provided if the shift is to be sustained in the longer run.

8.4 Financing of public transport

The financing of public transport has been under increased stress during the past years:

- Limitations of existing financing mechanisms to generate sufficient revenue. This is an especially relevant constraint in the face of the increasing budgetary difficulties that public administrations have to face in general.
- Inefficient pricing and economic distortions, favouring private transport. While public transport is in great need of investments, implicit subsidies are provided to the road network and private cars, which represent a minority of users.
- Unbalance in investment responsibilities and financial capacity at the city level. Decentralisation has generally strengthened local administration, but while municipalities have been empowered in terms of their expenditure responsibilities, there has been little movement by national governments to implement a strategy that would give the municipalities more budgetary self-sufficiency.
- Mismatch between the periodicity of revenue and expenditure. The nature of transport systems requires both large and up-front capital investments, as well as recurrent and relatively smaller expenses for operation and maintenance.

All in all, this leads to the need to rethink the funding of public transport and of mobility in general. The challenge is to achieve high quality and affordable public transport systems. In particular the following lines seem desirable:

- Seek new sources of funding: this is something that public authorities are doing on a permanent basis.
- Optimise funding (i.e. subsidies to public transport): both the distributional and efficiency effects of subsidies are not optimal, so there is important scope to improve the management of subsidies to public transport. And here is where microsubsidies have a role to play.
- The need to optimise subsidies to public transport is linked to the discussion on increasing fares (i.e. sales revenue). This discussion is urgently needed in light of the reductions applied with COVID-19 and to soften the inflationary pressures derived from the war in Ukraine. Increasing sales revenue will require a big dose of political courage.
- Optimise funding to mobility: developments over the last decade in many European cities, and especially during the COVID-19 pandemic, have shown the increasing relevance of transport options like micromobility, ride hailing or carpooling in the mobility mix in European cities and, potentially, as useful ways to reduce private car dependency. This is leading public authorities to start exploring possibilities to support these modes of transport to make mobility more sustainable.

8.5 The survey

We conducted a survey in five cities (Barcelona, Madrid, Lisbon, Berlin and Oslo) to test the potential of microsubsidies. The survey had two parts: in the first one, interviewees were asked some general questions on the use of the private car and on public transport. In the second part, we explored the potential for the practical application of microsubsidies in two use cases, based on stated preferences of the interviewees. We summarise the main conclusions of both parts below:

Part A General questions

1. When asked about the reasons for not owning a car, the answers are very convergent in almost all cases: the strongest reasons relate to the fact that respondents feel that they do not need a car or that they have made the conscious decision not to own a car. Cost issues or the inability to drive rank lower in the answer from the interviews. The only Metropolitan Area where this does not apply is Lisbon, where high costs represent the main reason for not owning a car.

2. When asked why they use the car, time, convenience (understood as comfort and flexibility) and cost come in this order. This is so in all cases and is very much in line with the results of the literature review we did in previous sections. People travel by car because travel time is shorter and it is more convenient, even though it is more expensive that public transport.

3. When car owners are asked why they use public transport, there appears to be a clear difference between Barcelona, Madrid and Lisbon, on the one hand, and Berlin and Oslo, on the other. In the first case, the curve shows a downward trend, with lack of parking and cost (tolls, fuel, etc) as the main reason for opting for public transport. In the case of Berlin and Oslo, the curve is flatter, with reasons like comfort or sustainability appearing as relevant factors in the decision to opt for public transport.

4. When asked on payment systems and on the fare structure two interesting patterns appeared from the analysis of these answers:

   - There is very strong support in all cases to have a single card allowing payments for all mobility modes, both public and private. In all cities, support for this option is higher than 4 (out of 5).

   - There seems to be significant support in all five cities for the possibility to increase price differentiation following different criteria (distance, special events, sustainability of mode of transport, etc). In all cases, support is above three in the five cities surveyed.

Part B Stated preferences

When trying to shed some light on the potential impact that more targeted incentives could have on the use of public transport in the five cities (Barcelona, Madrid, Lisbon, Berlin and Oslo), the results suggest that this impact could be significant:

1. Using microincentives to incentivise the switch from the private car to a multimodal trip:

The results suggest that there may be ample scope for policy action to incentivise the switch from the private car to multimodal trips:

- For all cities (except Lisbon) an approximate discount of 50% or less would be needed for users to make the switch (with a 50%+ likelihood) to multimodal trips taking 10 minutes (or more) less than with the private car.
- Oslo seems to be the city where users are more willing to make the switch: a discount of approximately 50% would suffice for users to abandon the private car (with a 50%+ likelihood).
- In Barcelona and Madrid, the trade-off between time and cost is quite pronounced, as the necessary discount to make the switch (with a 50%+ likelihood) decreases very rapidly as the time saved increases.
- If we lower the probability to just 20%, then the necessary discount is much lower. In fact, no discount would be needed in Berlin and Oslo for any kind of trip and this would be the case also in Barcelona and Madrid for faster trips.

2. Using microincentives to incentivise travelling off peak

The results suggest that users are quite inflexible when it comes to accepting changing the time of their trip at peak hours:

- Discounts between 60%-85% would be needed for users to accept (with a 50% likelihood) to switch to a trip leaving 10-30 minutes before or after peak time. But these discounts would be between 40%-60% for a 20% likelihood.
- Also, it is worth noting that the trade-off between time and cost is not very pronounced in none of the five cities: even for leaving just 10 minutes before or after the preferred time, the discount needed (approximately) would be higher than 50% in all cases. This may explain why PTAs are not offering discounts to incentivise such trips.
- It should be noted, however, congestion of public transport is very time sensitive and that small changes in time can help very much reduce overcrowding. This means that it might be worth exploring giving discounts that may switch the demand even if only by 10 minutes as this may help flatten peaks of demand in a significant way.

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ANNEX Stated preference study

a. Stated preference block to car users

The structure of the stated preference block consists of 14 different scenarios, in which respondents must choose between re-doing the same car trip at an increased cost, or taking an alternative route at an incentivised cost. For each scenario, the alternative route will vary in terms of travel time, mode, and cost, as indicated in *Table 10*.

Levels	Alternative route	Car
Travel time		
<Travel time previous trip>*0.4	✓	
<Travel time previous trip>*0.8	✓	
<Travel time previous trip>	✓	✓
<Travel time previous trip>*1,2	✓	
<Travel time previous trip>*1.6	✓	
Modes		
Carpooling	✓	
Public transport	✓	
Public transport + shared (electric) bicycle	✓	
Public transport + shared (electric) scooter	✓	
Public transport + shared (electric) moped	✓	
Public transport + ride-hailing option or taxi	✓	
Car		✓

Cost		
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 0.2	✓	
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Data of P13 >)* 0.4	✓	
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 0.6	✓	
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 0.8	✓	
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)		✓
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 1,2		✓
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 1.4		✓
(Single ticket cost + <Cost of tolls> + <Cost of fuel> + <Cost of parking per hour>*<Duration of parking in hours>)* 1.6		✓

Table 10: Applicability of attributes across levels (car users scenario)

In this scenario, the cost was calculated using the following formula:

$$Cost = (single\ ticket\ cost + tolls + fuel + parking_{time} \cdot parking_{cost}) \cdot discount\ ratio$$

Where tolls, fuel, parking time and parking cost are the exact values provided by the respondent when previously asked in the survey.

Finally, the single ticket price is a constant that varies across cities and it represents the cost of cheapest public transport single ticket available in the PTA area. The following is a list of the costs for each of the metropolitan areas in which the survey was performed:

- Barcelona: 2,40 EUR
- Berlin: 3,20 EUR
- Lisbon: 1,35 EUR
- Madrid: 2,40 EUR
- Oslo: 40 kr

The reason for adding this constant is to avoid having extremely low base costs, for example if the respondent had stated that in their last trip they drove their car for only 10 minutes and did not pay any toll or parking. Such scenario would lead to a negligible monetary cost, for which any type of discount would become also negligible. The theoretical standpoint behind this, and a concept also expressed in the previous chapters is that incentivisation of sustainable modes is inevitably intertwined with disincentivisiation of private modes. As prices can only get so much lower on one side, it is necessary for them to increase on the other for the comparison to be appreciated. Evidently, in this exercise, the cost of redoing the same trip is set higher than what the users actually paid. On top of that, three price increases can be assigned to a non-incentivised trip: 120%, 140% and 160%.

Each question assigned a different discount value to the base cost to be associated with the incentivised option. These values are 20%, 40%, 60% or 80%. As can be seen from Table 10, no discount is given to those who do not accept the incentive.

The alternative mode also varied for each question, the available options were:

- Carpooling
- Public transport
- Public transport + shared (electric) bicycle
- Public transport + shared (electric) scooter
- Public transport + shared (electric) moped
- Public transport + ride-hailing option or taxi

The ride-hailing option was different based on the availability of operators in the different metropolitan areas. Moreover respondents were told that they could reach their closest public transport station using their private vehicle if necessary and that free and available parking is guaranteed for them there.

Finally the travel time attribute has the following formula to determine its five possible levels:

$$Travel\ time = Stated\ travel\ time\ \cdot travel\ time\ ratio$$

Where travel time ratio for the incentivised option could assume one the following values:

- 0.4
- 0.6
- 0.8
- 1
- 1.2
- 1.4

And could only assume value 1 for the non-incentivised one (corresponding to the exact time the respondent stated in the survey).

b. Stated preference block to public transport users

On the other hand, public transport users are presented with different scenarios where they must choose between traveling during peak times at a certain cost, or traveling before or after peak times at a lower cost, the survey aims to gather data on the trade-offs that respondents are willing to make in terms of cost and time in order to reduce overcrowding in public transport at peak times.

Levels	Travel before rush hour	Travel after rush hour	Travel in rush hour
Cost			
<Cost of previous trip>			✓
<Cost of previous trip>*0.6	✓	✓	
<Cost of previous trip>*0.3	✓	✓	
<Cost of previous trip>*0.15	✓	✓	

Table 11: Applicability of attributes across levels (public transport users scenario)

In this scenario, the cost was calculated using the following formula:

$$Cost = Stated\ cost \cdot discount\ ratio$$

Where the stated cost is the cost the respondents claimed to have paid during their last on-peak public transport journey and the discount ratio can assume one of the following values:

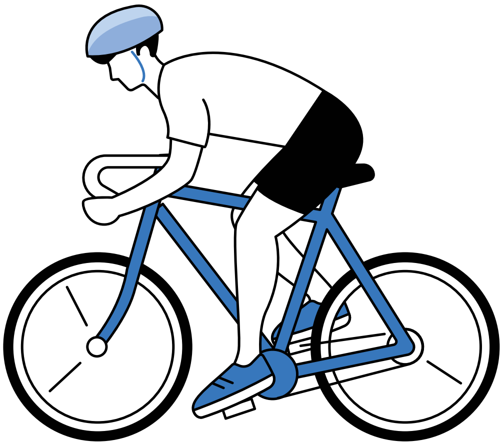
- 1
- 0.6
- 0.3
- 0.15

The actual travel time of the respondents is known from the survey, thus we were able to calculate the difference in starting times between the incentivised options and the base rush hour option for each respondent.

To analyse the data collected from the survey, a logistic model and a mode choice model was used. The logistic model was developed to predict the probability of a respondent choosing one of the options presented in each scenario. The mode choice model was used predict the likelihood of a respondent choosing other modes of transport over the car, based on the cost, duration and mode of the trip.

	Company car: taxable benefit for employees (per year)	Company car: taxes for employer	Public transport reimbursement	Fiscal incentives for cycling to work	Mode-neutral solutions	Income Tax Reduction for Commuting
Benchmark	According to economic studies, the taxable benefit should be around 50% of the car's list price per year in order to reflect the real value for the employee.	Taxation should incentivise companies to only provide company cars to their employees if this is necessary for business.	If employers provide tickets or reimbursements for public transport, this should be treated favourably in the tax system.	Cycling to work should be promoted by fiscal incentives, either through the provision of a company bike, a reimbursement or, ideally, both.	Mode-neutral reimbursements or "mobility budgets" should be promoted in the fiscal system as an alternative to company cars.	Ideally, there should be no income tax reduction for home-work travel. If there is one, it should favourise public transport and/or cycling and walking over car travel, or at least be mode-neutral.
Austria	★★ 18% (9% if private use < 6000 km/year) of purchase price, upper limit € 8640/year	★★★ Deduction of costs up to € 40,000; VAT not deductible	★★★ Tickets for home-work travel provided by the employer are free of tax	★★★★ Company bike is not taken into account as taxable advantage for the employee	★★ Reimbursement for home-work travel up to price of corresponding public transport ticket is free of social security contributions, but not free of tax	★★ Automatic commuting deduction € 291/year; if no company car or public transport ticket provided by employer, additional deduction possible depending on home-work distance and mode of transport (higher for cars)
Belgium	★★ 2.39%-15.43% of car's list price depending on CO_2 emissions, but not less than € 1,250 per year	★★★ 50%-120% of costs deductible, depending on CO_2 emissions; VAT deductible only for business use	★★★★★ Obligatory and tax-free reimbursement of at least 75% of the costs for public transport	★★★★★ Voluntary cycling allowance of € 0.22/km; Provision of bike and installations for cycling: no taxable advantage for employee, 120% of costs and entire VAT deductible for employer	★★ Currently none, but pilot project conducted in 2011-2013, and law proposal under discussion	★★★★ € 0.22/km for cycling (can be combined with tax free cycling allowance); € 0.15/km for other transport modes (cannot be combined with tax free reimbursements by employer)
Denmark	★★★ 25% of original car value for values of up to ca. € 40,100, 20% for values above, but at least ca. € 5,200; environmental supplement of ca. € 1,000	★★★★ Costs deductible only for proven business use; VAT not deductible, except for leasing cars (25% of VAT)	★★★ Tax-free reimbursement for public transport tickets used mainly for home-work travel	★★ Tax free provision of company bikes if used exclusively for business and home-work travel (but hard to prove); Costs deductible for employer, VAT only for pure business use	★★ Employer-provided home-work transport is free of tax (but not reimbursements)	★★ Deduction only for home-work distances of more than 12 km; ca. € 0.282/km until 120 km of daily journey, € 0.141/km for higher distances
France	★ 9% (no fuel provided) or 12% (fuel is provided) of purchase price; tax-free reimbursement of costs per km for private car use	★★★★ Deduction of costs limited to € 18,300 (€ 9,900 for highly polluting cars); Company vehicle tax depending on CO_2 emissions; no VAT deduction	★★★★ Obligatory and tax-free reimbursement of at least 50% of the costs for public transport	★ No incentives apart from reimbursements for subscriptions to public bike share systems	★ None	★ Reduction differs between modes of transports and corresponds to amounts that could be paid by the employer (none for cycling, very generous for car use)
Germany	★ 12 % of list price	★★ Full deduction of costs and VAT, except for value of employee benefit	★★ Tax-free if all benefits do not exceed 44 €/month; otherwise full tax	★★★ Provision of company bikes with only 12% of the list price counted as taxable benefit	★★★ Reimbursement of € 0.30/km of simple distance possible at reduced flat-rate tax of 15%	★★★ € 0.30/km of simple distance regardless of mode and transport and total distance
Italy	★★ Based on average costs for using specific car model for 4,500 km	★★★★ 20% (cars used by directors) or 70% (cars used by employees) of costs deductible, 40% of VAT deductible	★★ Only public transport directly provided by the employer is free of tax	★ None	★★ Maximum of € 258.33 per year can be provided free of tax as fringe benefits	★★★★★ None
Spain	★ 20% of purchase price if 100% private use; no specific rule for determining private use without log keeping, but often 10% of purchase price set by tax administration	★★ Costs deductible (advantage of private use as staff costs); 50% of VAT deductible (or more if higher business use)	★★★ Public transport tickets bought directly by the company free of tax for up to € 1,500/year, but not free of social security contributions	★ None	★ None	★★★★★ None; income tax deduction for formerly unemployed who had to move their residence to take up a new job
Sweden	★★ Calculation based on list price of car, inflation and government bond interest rates. If price is > € 36,350, benefit is higher. Provision of fuel is additional taxable benefit, based on 120% of its value.	★★★ Costs deductible; VAT not deductible except for leasing cars (50% of VAT)	★ None	★★★ Provision of a company bike is a taxable benefit, but can be fiscally advantageous	★ None	★★ Deduction only for costs over ca. € 1,095/year; Deductible amounts: Public transport: actual costs; car: ca. € 0.20 per km travelled (only if public transport no feasible option), bike: ca. € 27.36/year
Switzerland	★ 9.6% of purchase price, but at least ca. € 1,500 per year	★★ Costs and VAT deductible only for business use	★★★ Public transport tickets for mixed business + private use can be provided free of tax	★★★ No specific legislation; private use of company bike not considered as taxable employee benefit by tax administration	★★ Up to ca. €500/year can be provided free of tax in form of vouchers for transport and touristic services	★★★ Deductible amounts: Public transport: actual costs; car: ca. € 0.58-0.41 per km travelled, decreasing with the distance (only if public transport no feasible option), bike: ca. € 600/year
The Netherlands	★★★ 4%-25% of list price, depending on CO_2 emissions	★★ Costs and VAT deductible only for business use	★★★ Full costs for public transport reimbursable free of tax	★★★★ Currently: tax-free provision of a bike for up to € 749 every 3 years; from 2015: bikes included in general fringe benefit regulation	★★★★ Tax free travel cost compensation of € 0.19/km; general tax free benefit of 1.5% of salary costs	★★★★ Only costs for public transport deductible
United Kingdom	★★★ 0%-35%, depending on CO_2 emissions; additional benefit for provision of fuel	★★★ Capital allowance depending on CO_2 emissions; no VAT deduction if there is private use	★★ Interest-free employer loans free of tax up to £ 10,000/year; tax-free subsidies for local bus lines	★★★★ "Bike to work" scheme: Tax exemption for bikes loaned to employees for home-work travel	★ None	★★★★★ None

Figure 39: Table summarising different fiscal rules concerning home-work travel and categorising according to their contribution to a more sustainable transport system. Five stars stand for "exemplary", while one star stands for "harmful" (ECF, 2014).



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