Activity Deliverable

# SHARED MOBILITY REWARDS
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# Summary report

EIT Urban Mobility - Mobility for more liveable urban spaces

# Document information

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# Contents

# Executive Summary

The Share-More project aims to optimize the added value of car-sharing (CS) services and to promote a portfolio of transport services that enable and encourage sustainable urban mobility through the development of the infrastructure for personalized incentives. By understanding the needs of the three main stakeholders: travelers, transport authorities, and service providers, we can provide personalized incentives tailored to their needs to increase car-sharing efficient use while contributing to its sustainable integration with the existing overall transportation system. Through a partnership between municipalities, car-sharing commercial companies, and Universities in Copenhagen, London, Munich, and Tel Aviv, we aimed to understand the underlying mechanisms of potential incentives' designs. During this year, the project went through a gradual process of improving the understanding of stakeholders' needs. It began with a qualitative stage, continued into a large-scale survey, and commenced with demonstration of the results, thus completing this year's goals. This final report presents the main results of the process and the latest update. As the project had not received funding for its second year, future plans were omitted.

As unfortunate events led to the project being conducted at the year Coronavirus disease 2019 (COVID-19) was affecting individuals' accessibility, mobility and mobility choices, each stage of the project needed some alteration to its plan, to mitigate these effects. The qualitative phase had to move to online delivery, and the quantitative part included additional questions to examine the effects of the pandemic. Additionally, the survey and the demonstration were kept running for longer-than-planned periods to compensate for low responsiveness and low level of activity observed during this year.

In the first stage, exploratory focus groups and interviews with existing and future/prospect car-sharing users, service providers, and city officials from three cities of Tel Aviv, Munich, and Copenhagen were conducted. First, a preliminary structure was designed for the interviews and focus groups, and then, the collected qualitative data were analyzed to identify the key attributes.

Based on this understanding of stakeholders' concerns and preferences, at the second stage, the project conducted an online survey in the three partnering cities. The tailor-made online survey was developed with questions designed to capture the main points raised in the discussions and interviews performed during the qualitative phase. The questionnaire was translated into five languages required for conducting across the cities. It included the following sections: Socioeconomics to elucidate respondents general characteristics; Travel behavior and attitudes to clarify on how respondents used to move around in the city and how they perceive car-sharing services and private cars; Car-sharing incentives preferences to understand what different individuals value while using or deciding whether to subscribe to a car-sharing service, and; Stated preference experiment to identify the preferences of an individual or groups for specific incentives. The tool was made available online and the data was collected through July, August, and September of 2020 simultaneously in Copenhagen, Munich, Tal Aviv. The final sample used for the analysis consists of 1277 respondents: 543 from Copenhagen, 490 from Munich, and 244 from Tel Aviv. The analysis of the survey provided insights as to general and city specific potential incentives. The survey was designed by UCL and deployed, managed, and analyzed by DTU, with contributions from the other partners.

The study of choices reveals that local characteristics affect individuals' perceptions and preferences regarding different features of car-sharing services. The higher the perception of congestion and parking difficulties, for example, the higher the value that individuals associate with dedicated lanes and dedicated

parking. Thus, by analyzing at the local contexts, more suitable plans and incentives can be devised for each setting. The comparison between different travelers' groups allows for insights regarding the incentives which are to be used to motivate them to change their traveling habits. As a result of this analysis, a list of the incentives with the highest potential to leverage the sustainability of the transport system and the efficiency of the car-sharing operation service was elicited. These results were used to develop a specific scheme for incentives to be piloted.

In the project final demonstration stage, specific incentives were selected for demonstration. A real car-sharing service was altered to assess subscribers' initial responses to the proposed incentives and opportunities for improvements for the incentives. The tailoring to the CS application of Autotel, Tel Aviv was designed and developed to offer two kinds of incentives, each to a specific set of neighborhoods. During the trial period, information regarding the generated trips (both with and without incentives) was collected into a database, along with the available characteristics of service users. The demonstration was active for a five-week period, collecting a sample of 2,384 incentives used by 1,106 subscribers. The results were analyzed both for descriptive statistics and preliminary signs of potential personalization, addressing age, gender, and target neighborhoods attributes.

The project achieved its set goals in identifying potential incentives, types of stakeholders for which to perform personalization, and demonstration of its perceived influence. We have shown that: (1) CS policy-oriented incentives should be tailored to address specific needs; (2) Context tailoring is needed as cities differ by their baseline situation and by the local culture; (3) Existing CS apps can be adapted to supply such incentives and change users' choice towards more sustainable results, both for the city and the operators.

# 1. Introduction

## 1.1. The Share-More project

The Share-More project aims to optimize the added value of car-sharing services and promote a portfolio of transport services that enable and encourage sustainable urban mobility by developing a framework of personalized incentives. By understanding the needs of the three main stakeholders: travelers, transport authorities, and service providers, we can provide personalized incentives tailored to their needs to increase car-sharing efficient use while contributing to its integration with the existing overall transportation system and its sustainability. Through a partnership between municipalities, car-sharing commercial companies, and universities in Copenhagen, London, Munich, and Tel Aviv, our goal was to (i) understand the underlying mechanisms of potential incentives' designs, (ii) to develop a specific scheme for incentives, and (iii) to pilot the proposed scheme within a real car-sharing service (Figure 1).

Interviews and focus groups

Survey

Tailor-made incentive scheme

Pilot: test personalized incentives in a real car-sharing service
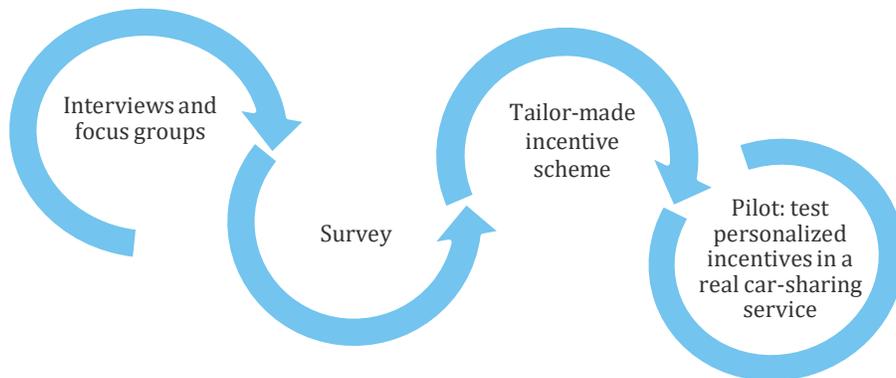
Figure 1 - Share-More project milestones

## 1.2. Report's objective

This final report summarizes the findings from the different stages of the project, during year 2020. Additionally, it contains the updated results of the online survey and of the pilot testing the potential of incorporating personalized incentives as part of a real CS service.

The report is structured as follows: Chapter 2, 3 and 4 present key findings and discussion of all the quantitative analysis, survey and demonstration respectively. Aappendix A presents the survey results, while Appendix B presents the pilot demonstration results. The Annex contains an updated description of the participating cities.

# 2. Key findings and discussion: Qualitative analysis

## 2.1. Introduction

The qualitative analysis, performed at the project onset, attempted to identify the main barriers in car-sharing systems implementation, and the incentives which can overcome these barriers, creating a more sustainable service for all stakeholders. As each mobility service, car-sharing has its own specific characteristics and barriers to development. The car-sharing market is extremely scattered, as it includes may forms (station-based services, free-floating services, and peer-to-peer services) and several ownership models (private, public, cooperative). When it comes to car-sharing, the public at large has a wide range of localized options that they often do not fully understand. Additionally, car-sharing service providers also have to deal with regulatory barriers that change from country to country, enormous upfront costs (fleets, insurance), and limited or even negative profits. Car-sharing is thus a complex ecosystem, the characteristics of which cannot be easily defined. Additionally, carsharing might compete with sustainable modalities, creating negative system-wide impacts. The objective of this part of the project was to understand which incentives can be adopted to help car-sharing business viability while at the same time promote sustainable mobility, through qualitative analysis. It made used of two main methods – focus groups with users and potential users, and interviews with different stakeholders. These tools were used in the 3 partner cities.

Most of the needs that were elicited in this qualitative stage activity agree with what has already been shown in previous studies (TCRP108). However, this analysis highlights two additional elements. First, it evaluated the needs of both car-sharing users and stakeholder for three case studies, Copenhagen, Munich, and Tel Aviv-Yafo. The analysis of the transcripts has been used to support the development of a travel survey that was used to identify user-needs at a population level. Second, the study did not only focus on existing barriers but also on suggestions to overcome them.

The presented results integrate the most prominent city-level findings. First, we discuss the users' needs. This subsection compares the user needs from all cities, analyses their differences, and suggests incentives that can be used to address them. Similarly, a second section performs the same analysis for the stakeholders. Finally, two lists of potential incentives are presented: one for the users and one for the stakeholders.

## 2.2. Users' needs and potential incentives

The integrated findings presented here are analysed by the categories which emerged during city-level analysis. Additionally, the feedback from stakeholders is also included in the discussion.

The list of categories mentioned in this section explains "why" users decide whether or not to use car sharing. These categories indicate the main barriers that car-sharing operators need to overcome and the main requirements that they need to fulfil. The selection presented in this chapter describes the most critical categories across the three cities.

### 2.2.1. Car ownership

Respondents in Copenhagen and Tel Aviv-Yafo showed to be more sensitive to this issue than users in Munich. In Tel Aviv-Yafo, reducing car ownership was reported as the overarching objective of car-sharing. In Copenhagen, it was reported that as long as regulators do not increase the cost for car ownership, car-sharing is hardly going to become an attractive replacement option. In Munich, the car-ownership cost was not reported as a major threat to car-sharing. However, car-ownership in Munich is quite high and increasing its cost could support promoting more sustainable mobility options. Users in Munich, as well as in Tel Aviv-Yafo, also reported that the integration with other mobility services would favour a modal shift to car-sharing.

Finally, nearly all respondents reported that at the moment car-sharing is, at most, a competitor for private vehicles. While this is not a negative aspect per se, the main problem is that car-owners simply perceive the private car as a more convenient option. This can be because car-sharing is too expensive or simply because it is not a valid option for their needs. Integrating different services might help car-sharing become more attractive and change this vision.

From the side of the stakeholders, it emerged that the public at a large is often not aware of the actual car-ownership cost and that marketing activities can help to make car-users much more aware of the actual cost.

### 2.2.2. CS Availability

Strongly related to the "car-ownership" issue, availability is regarded as an important need in all cities. When users are asked about their choices, answers are usually context-specific. Beyond the financial aspect, some users reported that car-sharing is simply not a valid option for them. The most common reasons are that the service is not available or, if it is available, does not cover the needs of the user. In other cases, it is simply too expensive. Also, car-sharing users reported this as a major threat to the car-sharing system. Users suggested using advanced booking systems to guarantee car-availability (Munich) and pricing schemes to balance the number of cars available in the city (Copenhagen).

From the perspective of the operator, service providers are not interested in providing the same quality of service in all areas of the city. Pricing could work to move vehicles in and out "hot areas" (i.e., areas with the high demand), but incentives are needed when the objective is to increase the car-availability at a network level (e.g., in areas that are not profitable).

### 2.2.3. CS Coverage

When the goal is creating a strong competitor for private automobile, coverage plays an important role. In this paragraph, coverage refers to the operating area of the car-sharing operator (where it can be driven, where it can be collected, and where it can be returned). For instance, some operators offer the possibility to rent the vehicle for several days and to drive it nearly to any location – at least within the same country. However, the rental has to start and terminate within the operator's operating area. Tel Aviv-Yafo, users requested that car-sharing should cover a larger share of the metropolitan area around Tel Aviv-Yafo. For Munich and Copenhagen, this problem did not emerge. Both cities have a large number of car-sharing

operators which altogether offer a wider range of options. However, in all cities, users complain that the service is mostly available within cities, and people living in the countryside (or outside the core of the metro area, in the case of Tel Aviv-Yafo) have no other option than private vehicles.

From the side of the operator, it emerges that service providers have already marginal profits in highly populated areas, so there is no real interest in providing services where the demand is low. However, different car-sharing operators have different business philosophy. Some of them – often traditional station-based that operates in close collaboration with the public authorities – have alternative business models. Some of the respondents explained that the service they offer does not aim at making profit but at integrating public transport and provide a valuable alternative to the private car (Munich, Copenhagen). Other operators provide platforms for peer-to-peer car-sharing, where citizens can share their vehicles with other people within the same area (Copenhagen). To increase the coverage, incentives from the authorities to operators are needed, specifically in those areas where there is not a critical mass of potential users capable of making car-sharing system profitable. Flexible pricing can be used to extend the driving limit at certain low-time periods.

## 2.2.4.  CS diversity/CS car settings

Users in the three cities reacted differently to this category. For the users in Tel Aviv-Yafo, diversity is not perceived as a particularly appealing feature of the service, as long as the vehicle provided can accommodate their needs (e.g., five seats). In Munich and Copenhagen, where the offer is more diverse, the response was quite different. In both cities, the respondents pointed out that fleet diversity is the main incentive for car-sharing. Among other reasons, the possibility to drive brand-new luxury vehicles, try electric cars, and having different vehicles that can adapt to different needs (such as transporters). Some of the conflicting results may be attributed to the shorter trips taken in Tel Aviv-Yafo. While diversity may be attractive, all respondents in Copenhagen stressed out that changing vehicles all the time could be stressful and even dangerous, due to the need for changing vehicle and car settings all the time. In general, respondents from the three cities agree that, when it comes to car settings, the possibility of having personalized car settings would be an important incentive. Users would positively evaluate the possibility to have access to the same vehicle (for instance through a booking system) and to have their settings saved so that there is no need to spend time adjusting the car each time.  Operators agree that in general having a large variety of vehicle is always a good choice, as it is more likely to cover all user needs and attract them to the service.

## 2.2.5.  CS Parking

In all cities, respondents reported parking-related issues. Due to the scarce parking availability, parking can be a major deterrent in those areas of the city where the driver has to spend a significant amount of time looking for a parking spot. Car-sharing users face a double penalty, as not only they have to spend time looking for a parking spot but, at the same time, they face the extra cost associated with the rental period. The situation is particularly critical in Tel Aviv-Yafo where, despite availability of dedicated parking spots, respondents reported that these are illegally used by private vehicles. One option, which has not been mentioned during the interviews nor focus groups, but provides a solution to this issue, is to include mobility credits (e.g., provided when the user is looking for a parking place) to partially compensate this

penalty. Other possibilities include dedicated parking spots for car-sharing, parking use enforcement, as well as the possibility of booking in advance a specific parking location.

In Copenhagen, specifically, respondents reported how car-sharing is often considered on the same level as private automobiles when it comes to parking policies.

## 2.2.6. CS Pricing

Overall, all respondents were satisfied with the existing pricing schemes. However, some minor differences emerged. In Tel Aviv-Yafo, respondents reported that the price can become too high for certain trips, specifically when there is congestion. In Munich, one respondent reported that the combination of time price and kilometre price is the best as it allows to easily calculate the rental cost in advance. Additionally, many services in Munich decreases the price of the service when the duration of the rental increase to avoid the trip becoming too expensive. Similarly to Tel Aviv-Yafo, in Copenhagen user reported how the price uncertainty can create a significant amount of stress as unpredictable issues can dramatically change the trip cost.

From the service provider perspective, pricing is always regarded as a good strategy to enlarge the customer base. Together with simple pricing policies, such as reducing the direct cost associated with each trip, loyalty programs and MaaS-like solutions are also considered good strategies to reach more costumers.

## 2.2.7. Integrated platforms, Car-Sharing applications, Privacy

While not familiar with the term "MaaS", respondents showed to be extremely familiar with the concept of Mobility-as-a-Service. Nearly all respondents in all cities stressed that car-sharing should be complementary to public transport. Respondents in both Copenhagen and Munich feel that, despite the wide range of applications already available, car-sharing is not sufficiently integrated with the public transport network and it often competes with it. Additionally, each of these platforms requires an independent and quite time-consuming registration procedure, meaning that there is no certainty that users can access all services in the platform. In Tel Aviv-Yafo, where no integration platform is offered, integrating Car Sharing services with other services was highly prioritized by the participants.

In Tel Aviv-Yafo, integrating car-sharing and car-pooling services was perceived almost as necessary. At the same time, both in Munich and Copenhagen, a minority of respondents reported that they would be reluctant to share the ride with other users, primarily for the additional travel time associated with detours. Finally, one user in Copenhagen raised some questions about privacy regulations and data protection. While this was an isolated case, transparency, and compliance in terms of privacy should always be considered as a priority when designing these systems.

From the perspective of the users, incentives should focus on integrating car-sharing and public transport, creating a more homogeneous user experience. Many users explained that they were extremely frustrated to register to different applications, as the process is too time-consuming and complicated. The easiest registration process requires each user to send a copy of the driving license together with a copy of their passport. Some operators also require paying insurance services and large registration fees before having

access to the vehicle. A single payment method, a more homogeneous service, and monthly packages are a better solution able to move some of the respondents away from their own car. Even more important, if users would have the possibility to submit their documents only once, that would already serve as an incentive.

Some car-sharing service providers already embraced this MaaS philosophy. The analysis also showed that the most successful companies already integrated different services within one single application or in an ongoing process towards it. Many operators reported how this process is already too slow and for this reason several operators developed MaaS-like applications on their own, with partial integration. One of the main barriers for this integration is the complexity of the application per se, which needs to accommodate many different operators and mobility services with different needs. Even in the case of partial integration, this procedure is usually time-consuming.

## 2.3. Stakeholders' needs, challenges and potential incentives

During the interviews with the stakeholders, four main themes received significant attention in all cities, and appear to be the most relevant topics when studying new incentives for stakeholders. These themes are "*Regulations and Incentives*", "*Incentives to integrate car-sharing*", "*Direct and indirect incentives*", and "*Incentives to promote equity*". In this sub-section, each of them is discussed and comparison across cities is provided, together with a list of challenges that incentives can help overcome them.

### 2.3.1. Regulations and Incentives

Between the stakeholders, several forms of relationships serve to incentivize the carsharing operations. The first form is partnerships between public authorities and private ones, the second form is regulations set by public authorities and the third form is collaboration – an ongoing dialog. Emerging from the interviews' analysis, it is evident that partnership can be a convenient arrangement for both car-sharing companies and their public partners. However, public-partnership is perceived negatively by some car-sharing operators who declared that they have no interest in becoming heavily subsidized, nor becoming a new form of public transport.

Such free-market-oriented companies often use car-sharing as a sub-product within a larger business model, which contributes to the overall success of the company in various forms, such as complementing other mobility offers. These operators are typically large free-floating companies that try to compete mostly with taxis and car-hailing companies. For these types of companies, direct incentives, such as parking incentives, can be adopted for example to encourage them to provide car-sharing in areas of low profitability. Other forms of incentives should focus on the integration aspect, as these companies are often quite motivated to get more visibility and more market share.

Other car-sharing operators, on the contrary, use a non-profit business model, relying heavily on public provided subsidies. These companies are often traditional, station-based car-sharing services. While requiring high registration fee – these services proved to be quite successful in targeting drivers who are willing to get rid of their car.  The success depends on the rental cost – often a combination of time and distance – being low and easy to compute in advance. Similarly, the availability of the car is also an

important element of success. Differently from the first companies, these companies require more direct subsidies to keep their business alive, having no alternative business model and directly serving car-ownership reduction goal. Where available, peer-to-peer service providers have the potential to overcome some of the issues discussed before, specifically the upfront cost, as they have low initial costs. However, there are other major limitations that cannot be solved without proper support, such as regulatory barriers, which make this business model challenging if not impossible in countries like Germany. This means that regulations and integrations incentives are the main tools to promote this type of services. Without proper integration, these services stand the risk to become an Uber-like mobility services and, eventually, even increase the congestion.

These regulations and incentives issues presented themselves differently, in the three cities. In **Tel Aviv-Yafo**, where the presence of car-sharing systems is still limited, and the service is highly subsidized, respondents are concerned with carsharing sustainability contribution. They argue more incentives for public transport rather than carsharing are required towards car-ownership reduction, and that carsharing can actually increase congestion. For such carsharing developing cities, one of the main challenges to promote car-sharing is thus to prove its effectiveness in the fight against car-ownership and draw a viable deployment roadmap. Integration with carpooling and with public transport platforms can also serve a similar purpose.

Car-sharing in **Munich** is mature, being part of everyday life for every citizen that lives in the metropolitan area, achieving for many car-ownership replacement (as reported in the focus group). The car-sharing market offers a large variety of services, with peer-to-peer car-sharing services one of the few missing options. Operators reported overall a positive experience when dealing with the local authorities, which have dedicated teams working on of car-sharing and promoting its integration with the other existing mobility services. The challenge is mostly to design incentives that can support the authorities in achieving their mobility goals, specifically increasing the coverage of less commercially attractive neighbourhood, reducing parking demand and shifting demand patterns.

Finally, car sharing in **Copenhagen** is extremely advanced, with multiple existing operators ranging from free-floating to peer-to-peer car-sharing services. However, from a regulatory point of view, the city still lags behind. Respondents reported difficulties in initiating a discussion with the authorities, mostly because many different offices are responsible for carsharing impacting regulations and finding the right one is challenging. The situation becomes even more complex when considering that innovative mobility solutions at a regional level often crossover Danish and Swedish authorities, adding extra barriers on top of the existing ones. Integration incentives here should probably be offered in the form of integrative public body to address sharing mobility.

Based on this short description, it emerges that car-sharing clearly cannot tackle car-ownership on its own as a standalone, free-market solution. Integrating with other mobility solutions can help it become a sustainable solution. Authorities can incentives this integration by triggering this process and supporting it. From the regulatory point of view, it also emerges stronger policies to fight car-ownership are needed. If the authorities have not a clear plan, or if car-sharing is not part of it, incentives are likely to have marginal or no effect. Clear long-term strategies to promote sustainable mobility, and dedicated departments to deal with Car-sharing operators play a giant role in developing effective incentives.

## 2.3.2. Incentives to integrate car-sharing

As the previous sub-section highlighted, integration with other transport modes is an important aspect for car-sharing, meriting separate discussion. Without integration, both authorities and users will consider car-sharing as a simple alternative to car. While this is not necessarily a negative attribute, authorities may be reluctant to promote such a service and would more likely consider it similarly to private automobiles when developing new policies. This can have disastrous consequences when considering policies such as closing the city centre to cars. Thus, it serves both operators and authorities to explore better ways to integrate car-sharing services and make urban mobility more sustainable.

On this topic, the answers were extremely consistent in all cities. Integration is a priority for all the respondents, from public authorities to service operators, to citizens associations. However, it also emerges that currently the services are not sufficiently integrated, and the integration level is inconsistent between the cities.

 In **Munich**, where car-sharing is going strong, the most critical respondent stated quite frankly that car-sharing is simply not integrated with public transport. One incentive that has been deployed is to develop mobility stations close to public transport stops. However, some respondents reported resistance from the public transport operators to allow car-sharing providers using these stations. This is mostly because – based on our interviews – many car-sharing trips are replacing public-transport trips. This potential competition with public transport makes integration more challenging. Another limitation is that integration is often too slow, as it takes years to integrate all mobility services into one single application. Similar problems have been reported in **Copenhagen**, for example, it took almost 8 years for one operator to achieve agreement on integrated platform. In both cities, private operators reported that they are already integrating other services within their own platform in order to speed up the process. Finally, for **Tel Aviv-Yafo**, integration also emerged as a barrier that needs to be addressed, having no current integrated platform. Respondents suggested using the development of the new light rail network as catalysator for a holistic approach to transportation, where other mobility services – such as car-sharing – are not anymore considered as isolated services but as part of a larger ecosystem.

In all cities, the major solutions that have been indicated are the creation of mobility stations, integrated ticketing services, mobility packages that combine car-sharing and public transport in one unique mobility option, and mobility credits (to use in exchange of goods but mainly for mobility services).

## 2.3.3. Direct and indirect incentives

When it comes to incentives, respondents separated them into two main categories – direct and indirect incentives. Direct incentives directly reduce operator costs (reducing the parking cost is one example of a direct incentive), while indirect incentives, as the name suggests, consist of introducing elements, such as mobility stations, that modify the existing transport offer in favour of car-sharing. Once again, some of the incentives discussed in this section influence both the user and the operator. As such, some of these incentives are also present in the previous section. However, in this section, we focus on the impact that these incentives may have on the operator.

DIRECT INCENTIVES

Most of the respondents focused on three main direct incentives that can make car-sharing more profitable for the operator and more attractive for the users. Parking, pricing, and tax incentives.

— **Parking:** Parking is by far the most important direct incentives, ranked highest for users as well. In Tel Aviv-Yafo, interview respondents claimed that car-sharing should always have a sufficient number of parking facilities in the most attractive areas (such as transportation hub, commercial centres and High-Tech zones) to enlarge the customer base and reduce the cost associated to car-sharing (e.g., driving while searching for a parking spot). In Munich, respondents reported that parking is a significant cost for the operator that the city can use as a leverage when negotiating with the car-sharing operator. In Copenhagen, operators reported limited support from the authorities, and that parking-related incentive would support both cost reduction and higher level of service of the system. This should include dedicated parking spots to reduce the rental period and thus the overall cost of the service for the end-user.

— **Pricing:** Car-Sharing is about balance. Low prices lead to the cannibalization of public transport while high fares reduce car-sharing competitiveness with taxis and car-ownership. Some respondents stressed that car-sharing should be an alternative to private cars, ride-hailing, and taxi. In this context, pricing is the main controller. As the price for these services (public transport, taxi) change from country to country, authorities should make sure that the price of the car-sharing is low enough to make it a strong competitor for private transportation, taxi, and ride-hailing, but high enough to make public transport overall more convenient. Subsidies incentives should be used to help the car-sharing operator maintain this balanced price.

— **Tax-Incentives:** Nearly all respondents agreed that tax-incentives should be only used to promote sustainable mobility options. Car-sharing should be eligible only when: (1) promoting electrification of the car-sharing fleet (or emission-free vehicles in general); (2) having the same taxation as the highly regulated taxi operators when complying to similar regulations.

## INDIRECT INCENTIVES

The three most popular forms of indirect incentives are incentives for the integration, marketing and communication strategies, and incentives for promoting electrification.

— **Integration:** As highlighted in the previous section, integration is a major player in the transport market. Integration can help service providers enlarging their consumer base, develop mobility packages in collaboration with public operators and, thus, develop a wider range of personalized incentives. Finally, it is a fundamental incentive to avoid cannibalization of public transport.

— **Marketing and Communication strategies:** Emerging from Munich and Copenhagen discussion, marketing and communication campaigns can help the service provider making customers more aware of alternatives to the private automobile, including car-sharing. By showing car-sharing as a more convenient option and organizing test-drives, the operator can not only showcase its mobility offer but also propose a personalized package to the users engaged in the activity.

— **Promoting electrification:** As emerging in all the cities, electrification can only occur with strong support from the public authorities. Some service providers are willing to switch to electric

vehicles as soon as the conditions will mature. This means that (i) vehicles meeting users' needs and (ii) the city needs to have the infrastructure to support EV vehicles – e.g., sufficient number of accessible charging stations, and reasonable charging prices. The operators will naturally shift to electric vehicles once that the market is ready but will hardly push for electrification without proper support.

The list below shows the emerging direct and indirect incentives. Again, some of these incentives target the users (such as *Transit passes and membership/ family packages/ Integrated Services/ticketing)*. However, these incentives can also support the service provider developing a better and more sustainable car-sharing system.

## 2.3.4. Promoting equity and sustainability

Public authorities in general, try to promote greener solutions and social equity while addressing mobility improvements. When referring to equity, we mostly refer to how likely is the car-sharing system to be equally available for all users in the transport system. In a completely unregulated market, without any form of incentive, equity is not likely to happen. Car-sharing works best in highly populated, more prosperous areas and not all parts of the city are equally profitable. It is almost impossible to expect a similar level of services in both the city centre and the suburbs – not to mention rural areas. While equal access to carsharing is not necessarily a goal that should be pursued, carsharing can support equity while serving areas where mass-transit is inefficient. Stakeholders opinion on the subjects differ across types and cities. In **Tel Aviv-Yafo**, for example, policymakers showed doubts about promoting car-sharing instead of public transport and stressed that car-sharing should be accessible to low-income people. Operators in **Munich** reported their willingness to provide a good service in all areas of the network but also stressed that incentives should help to make this model more profitable. In **Copenhagen**, which offer impressive car-sharing services, operators reported that the main problem with equity is the lack of support from the authorities.

Based on the results of our analysis, it emerges that incentives, and in particular financial incentives, should mostly be used to support this goal when applicable, resulting in alignment of public and private objectives.

As to environmental sustainability, when users use car sharing, their impact on congestion, pollution, as well as their occupancy (in terms of infrastructure) is potentially the same as for any private vehicle. Therefore, incentives can – and should – be used to make car-sharing greener. This vision can be through a series of incentives discussed in the previous section, including integration, pricing, parking policies, electrification, and increased accessibility.

## 2.3.5. Parking incentives

Parking related incentives deserve a dedicated section, given the amount of time that has been dedicated to it during the interviewing process. Probably the most effective source of direct incentive, according to this last indicator. Parking represents the first incentive to be adopted for nearly all the cases discussed until now. For operator companies, this is a significant cost that authorities can easily remove from their budget. Concerning equity, the authorities can use parking incentives to promote social equity. For

instance, reducing parking fees in the "hot" areas in exchange for vehicles deployed in less attractive areas. Parking-related incentives can also be used to increase the visibility of the operator, thus increasing its opportunities to attract more clients. By developing mobility hubs, the municipality can use the parking to promote integration between modes, as well as to promote electrification of vehicles.

## 2.3.6. Marketing and communication strategies

Marketing and communication campaigns can be an important incentive, which is often underestimated by the authorities. Munich is a city that is quite progressive on car sharing. Operators and authorities have a direct channel of communication, and the city support several communication strategies. On the website of the city, the municipality has a list of car-sharing operators and a short description about how they operate. It also prepares events and disseminate material (flyers, informative brochure) to promote awareness. Many respondents highlighted that this has a positive impact on the car-sharing, as well as promoting car-sharing as a sustainable mobility option. However, traditional communication strategies still cannot reach all users, as not all users are equally involved in the activities of the city.

## 2.3.7. Availability, coverage, and fleet diversity

Car availability, coverage, and fleet diversity emerged as highly ranked on users' needs. It is, however, difficult to directly translate these needs into incentives. Some users would like to always drive the same vehicle, others would prefer to have access to a wide range of vehicles, and others prioritized instant car availability. Additionally, coverage is also a problem. Users would like to have a flexible service that allow them to have a car during the weekend or for a few hours during the week. Accommodating all these needs is quite a challenge and translating these needs into incentive can be even more complex.

From the operator point of view, most of these aspects can be integrated into fleet management strategies. Forms of incentive should thus focus on supporting this activity. From the user perspective, different users have different needs. Personalization plays an important role here. If users can indicate their preferences, personalized packages and offers can be created for each of them. Not all users need instant availability and not all users need a car during the weekend. Also, free-floating car-sharing, station-based car sharing, and peer-to-peer car-sharing serve different mobility needs. These incentives should be tailor-made for the user as well as for the operators' needs.

## 2.3.8. Additional notes

One of the main conclusions that can be drawn from the qualitative analysis is that car-sharing services are currently not able to replace car-ownership on their own. The analysis shows that the decision to choose car-sharing over a private car is mostly – but not entirely – an economical decision. For some users, giving up on the car means giving up on performing certain activities, as car-sharing is simply not perceived as a valid alternative. Another observation is that these needs change significantly from individual to individual. For some users, the possibility to have a shared-car over the weekend is the most important aspect, while for others instant availability is more critical. The car-sharing eco-systems present another level of inherent

complexity. Free-floating and station-based systems operate differently, attract different users, and need different types of incentives. Thus, users who are better at planning often rely almost uniquely on station-based systems, while flexible users mostly adopt free-floating services. Yet, there is a large pool of users in the middle that need to be addressed. Personalized incentives present the only viable solution to satisfy all needs. As personalization may increase the otherwise complex system, care should be taken to select solutions that will not confuse the user further and deter carsharing use.

A second element, closely aligned to the first one, is that car-sharing is not sufficiently integrated with other mobility services. As such, it represents at most a poor replacement for the private car. Integration brings the added value of other mobility services, such as public transport, e-scooters, taxis, and bike-sharing, into the car-sharing model, making all services more attractive. Together with the concept of tailor-made mobility offers already introduced, this opportunity is perceived as the main way to promote car-sharing and fight car-ownership.

Without directed incentives, car-sharing initiatives risk will remain a standalone system, with limited integration to other mobility services, missing the opportunity of MaaS provision. They also stand the risk of local failure. The window of opportunity to produce viable and fully integrated solutions (e.g., with public transport) is thus limited.

# 3. Key findings and discussion: Survey

Based on the analysis of the qualitative part, we have designed a survey for the three cities, including stated preferences and revealed preference. We examined behavioral preferences towards different incentives associated with car-sharing services and their potential impacts on individual travel patterns. The sample size used for the analysis consists of 1277 respondents: 543 from Copenhagen, 490 from Munich, and 244 from Tel Aviv, exceeded the planed dissemination and allowed good coverage. The study of choices, based on the analysis of a large sample, reveals variations between the different cities. Additionally, local specificities affect individuals' perceptions and preferences with regards to different features of car-sharing services. The higher the perception of congestion and parking difficulties, for example, the higher the value that individuals associate with dedicated lanes and dedicated parking. Thus, by analysis of the local contexts, we can provide insights on what is more suitable in terms of plans and incentives for each setting.

## 3.1. Use purpose of carsharing

Currently, the main purpose of car-sharing trips is leisure and visiting friends and relatives. This suggests a higher use of car-sharing for non-mandatory and less frequent trips, which usually have flexible arrival time. Among the perceived positive aspects of car-sharing, most respondents from all cities agree that car-sharing services allow for savings in time, money, and effort in comparison to car ownership. The use of car-sharing services is also perceived as more environmentally friendly than the car ownership alternative. However, among the reasons for not subscribing to a car-sharing service, it is the perception that the service does not meet their travel needs and being outside the car-sharing services coverage area. Both reveal to some extent, unrealized demand and, thus, better understanding of the travel needs of individuals is essential for increasing the car-sharing market and ridership.

## 3.2. Incentives ranking

Not surprisingly, pricing/cost related incentives are the most important type of incentive for the respondents in all cities. In Copenhagen, this translates through not having to pay for one-time subscription and monthly membership costs. It is understandable that operational differences for different car sharing schemes (i.e., free-floating, peer-to-peer, station-based) may lead to lower or higher monthly membership costs, however low frequency users are highly sensitive to this cost. Also, flexible/dynamic pricing is seen as a good incentive for users as they may pay less for using car-sharing services in some contexts. This incentive can potentially assist car-sharing operators to better balance the spatial distribution of their fleet and increase the use of cars. For non-members, guaranteed price beforehand was pointed out as a good incentive, which suggests concerns related to pricing of new users.

Exploring pricing/cost incentives in Munich reveals no monthly membership cost and clear and consistent pricing are essential. Also, daily fees/packages are pointed-out as very important, especially for members, which may be connected to their stated main use of car-sharing: holidays and weekend getaways. For past members and non-members, not having to pay for one-time subscription is also relevant and suggests that it can refrain potential users from subscribing and using the service.

Similarly, in Tel Aviv, the one-time subscription is also highly deterrent for past-members and non-members. However, the monthly membership is the most important for all groups in Tel Aviv, especially for past-members, which may be connected to why they cancel their membership, since their primary motive for stopping their car-sharing membership was the fact that did not use the service frequently (the monthly membership cost is a fixed expense disregarding the level of use). Moreover, a higher percentage of respondents in Tel Aviv think that tax incentives for those commuting by car-sharing is positive, compared to Copenhagen and Munich (a result different from the qualitative analysis). This indicates that the society in Tel Aviv is more open to this type of incentive, which is controversial in Copenhagen's and Munich's contexts.

Incentives related to flexibility in car-sharing plans are the second most important for Copenhagen and Munich respondents, but only the fourth most important for Tel Aviv respondents. For respondents in all cities, flexibility in plans means special rates (e.g., packages for longer trips, for the weekend, off-peak travels) and integration with other transport modes (both public transport and other mobility solutions available in the city). In all cities, plans in-line with the concept of Mobility as a Service (MaaS) were preferred. These plans consist of the association of different mobility services from public and private operators and allow users to access and combine different transport modes providing seamless door to door trips. Particularly in Tel Aviv, travel outside the city was also pointed out by several respondents as supportive incentive. Also, family or friends account with discount rates are desired by Copenhagen's respondents and a less restrictive cancellation policy for Munich's respondents.

Parking-related incentives appear as the second most important incentive for Tel Aviv respondents and the third for Copenhagen and Munich's respondents. This is not surprising, since most of Tel Aviv respondents agreed that it is difficult to find parking. In both Tel Aviv and Copenhagen, respondents think that the most important incentives related to parking are dedicated parking lots, information about parking availability at the destination beforehand, and parking discounted rates at all locations. For the Tel Aviv's context, it is worth mentioning that car-sharing members highlighted the need for more supervision of the dedicated parking regulations. As for Copenhagen's context, while members would like to have free parking, both a

past member and a non-member have stated that there should be no difference in parking rules whether you drive privately or shared-car, which indicates a potential deeper discussion involving this type of incentive in Copenhagen.

For Munich respondents, dedicated parking lots close to public transport are essential, which may be a result of Munich's sample, which has only residents of the city of Munich boroughs. Contrasting with Copenhagen's respondents, both car-sharing members and non-members in Munich desire free parking. Additionally, they express a desire for being able to book and pay for parking through the car-sharing system.

Ranked after pricing/cost-related and parking-related incentives, Tel Aviv's respondents value more aspects related to the service, while this type of incentive is the fourth and fifth most important for Munich's and Copenhagen's respondents, respectively. In all cities, respondents think that proximity and availability of vehicles and having good service coverage area is important. In this context, special rates for balancing the distribution of vehicles configures a potential good monetary incentive for users that also has the potential to benefit the system and increase ridership. Also, 24/7 support is seen as a highly important feature of car-sharing services for Tel Aviv car-sharing members.

Car-sharing vehicle related incentives are the fourth most important in Copenhagen, but the least important (among the factors studied) for Munich and Tel Aviv respondents. While electric vehicles are highly important in Copenhagen and Munich, having a good variety of vehicles is highly important in all contexts.

## 3.3. COVID-19 related incentives

In all cities, the most important incentive of this category is the cleanliness of the vehicles, which is likely to be linked to the current context (COVID-19 pandemic). It is important to also notice that a change in priorities and concerns related to mode choice happened because of the COVID-19 outbreak. While it is uncertain how long the situation will persist and whether it will result in permanent changes or individuals will resume their prior behavior, there is an opportunity to explore factors and measures associated with hygiene and safety to attract users.

# 4. Key findings and discussion: Demonstration

Based on the survey results, we had chosen to demonstrate the applicability of the emerging ideas by supplying incentive of type cost/pricing, specifically flexible/dynamic ones (OUT08), to certain neighborhoods of the city of Tel Aviv. This high ranked incentive can influence users' choice, while contributing to the sustainability of the service provider. The partnership with Autotel CS service gave us access to valuable trip performance parameters. This allowed us to select neighborhoods according to the waiting time parameter before the demonstration, and according to expected CS traffic. The incentive delivery was designed into the existing CS platform of Autotel. While using an existing application imposed constraints, it provided real-life opportunity to test our ideas' potential. The app version was tested and released to all subscribers on Nov 1st, several weeks after the end of the second wave lockdown, after the

end of day-light saving period and the onset of winter. While this period is certainly challenging, we managed to conduct the pilot and the analysis of its results allow us to achieve our demonstration goals. First, we had shown the ability to integrate a tailored incentive campaign into an existing CS service. This is the first step towards personalization. Second, we had demonstrated turning the earlier incentive recommendations into actual delivery. We have exceeded our planned demonstration by manyfold, whereas over 2,384 incentives offerings were used by 1,106 users (instead of the target 50). Third, the initial results analysis implied certain users group respond to the incentive offered and are willing to alter their behavior accordingly. Further analysis of these results, one more week of demo, as well as results of a survey which was distributed to further characterize to users who used these incentives are supplied as appendix A. As the project was terminated without its second year, no further pursue is currently planned, however, the promising results can be used as the starting point of future research.

# 5. Limitations of research

The limitations of the research are specific to each stage. Explicitly for the qualitative part, three limitations should be considered when reading the results from the users' focus groups. First, focus group participants represent diverse categories of people, such as existing and potential users. However, an individual does not necessarily "represent" his or her class entirely. Thus, it should mainly be used as a supportive instrument, to the survey, that can better identify preferences for each class. Second, respondents of the focus group were recruited on a voluntary basis. As known, this often leads to having more respondents that are already committed to the service or to the specific problem, car-sharing in this case. During the SHARE-MORE project, participants have undergone a rigorous selection process in the attempt to avoid this issue. We attempted to represent age, gender, car-ownership, and education level, yet some user classes were not fully captured during the recruiting process. These classes include: (1) participants without an academic degree. Bachelor's degree was the lowest level of education in Munich and Tel Aviv-Yafo, and there is no guarantee that their preferences are aligned with users without a degree, (2), Participants living outside the city or in rural areas. Only Copenhagen reported some users living outside the city, and (3) Car-owners who use the car inside the city. There were many respondents who own and regularly use the car. However, many respondents also reported that they do use the car only when public transport is not a convenient option. In this case, the needs of users who own and drive a car into the city might not be fully represented in this report. In the case other researchers are planning to perform a similar study, we recommend to specifically address these elements during the recruiting process.

As to the survey, the Copenhagen sample as recruited from around 13,000 active panelists. It allowed well-balanced invitations for answering the survey, covering three groups: CS users identified through a pre-screening, respondents from different geographical zones, and respondents from different age groups and gender. A last distribution of the survey was done, focusing on respondents from age groups below 50 years old. At the same time, Munich and Tel Aviv samples were less balanced, due to the local recruitment strategy. In Munich, the municipality of Munich disseminated the survey through a mailing list composed of 3,000 participants from a previous city-level household survey on mobility-related issues (conducted in 2019) who have indicated that they were willing to participate in further studies about mobility. Since the municipality of Munich list included only participants who live within the city of Munich, the sample reflects only the perspective and behavior of inner-city respondents, but not the metropolitan region. Thus, the results from Munich cannot be used to understand the mobility needs of those living outside the city of Munich. The sample of Tel Aviv was achieved through the support of Tel Aviv Yafo municipality. They

recruited respondents by publication posts on Tel Aviv residents' website, Tel Aviv's transportation page and newsletter to Tel Aviv digital subscribers, inviting residents to participate in the survey. Additionally, the car-sharing operators AutoTel and Car2go have published a request to all their subscribers to answer the survey. This resulted in a sample which is biased somewhat towards CS users with higher education.

Regrading the pilot, it was planned from the start as a limited demonstration, thus its planed limited scope – in the proposed incentives, the delivery period, and the geographical scope. Our final strategy exceeded our goals in allowing us more coverage and a short survey conducted at the end of the demo allowed further insights.

However, during the project planning, no one foresaw the impact of the COVID-19. It had changed our ability to communicate with users and stakeholders and it changed the habits of the city dwellers, both regarding their activities and mobility options, including travel restrictions, remote work, and self-restrictions on travel by different group of population (e.g., population at risk). As a result, each stage had to activate mitigation strategy. The qualitative stage had to move focus groups and interviews into online format. The survey extended its delivery period, as answering rates were low and incorporated questions regarding the pandemic to try to offset the pandemic influence. The pilot demonstration was extended both in time and in scope. However, despite the best countermeasures deployed by the team, this extreme event might have influenced this study and it may also have unforeseen future impacts on our lives, our mobility options and of course on our shared-mobility patterns. Thus, future research will need to validate these results.

Regardless, the project created a toolset that can assist cities and providers to assess their local situation and devise their own adapted plans towards more sustainable CS and validating our work.

# Appendix A: Quantitative analysis

## A.1 Methodology

### A1.1 Survey design and implementation

A tailor-made online survey was developed with questions designed to capture the main points raised in the discussions and interviews performed during the qualitative phase. The qualitative phase enabled us to understand better the perspectives of users, car-sharing operators, green associations, and governmental organizations.

For designing the survey, several aspects and constraints were considered. First, as our goal was to collect comparable data across three different cities and different typologies of car-sharing services, we have defined questions and incentives as generic as possible. Second, to collect the amount of data desired in all cities, a centralized web-based survey was defined as the most suitable solution since it allows for faster data collection and standardization of variables, which contributes to making the analysis easier. Third, as respondents have both limited attention span and willingness to spend time, a 15-minute target was set for the duration of the survey. Thus, after an initial draft, we needed to proceed with some trade-off and remove some questions while keeping questions that are essential for the objectives of this project. Finally, due to the COVID-19 pandemic and all the changes it forced, we have considered aspects connected with the ongoing context in the design of the survey. We also decided to include a dedicated section about the effects of the pandemic on urban mobility, focusing on possible effects on the use of car-sharing services.

The survey was implemented by Epinion, combining Sawtooth and SPSS, and made available online in both web and mobile versions. In Copenhagen, the survey was available in English and Danish; in Germany, the survey could be answered in German or English, and; in Tel Aviv, it could be answered in Hebrew or Arabic.

The survey was composed of 6 sections:

1. **Introduction:** to provide context on the survey and its purpose;

2. **Socioeconomics:** to elucidate respondents general characteristics;

3. **Travel behaviour and attitudes:** to clarify on how respondents used to move around in the city and how they perceive car-sharing services and private cars;

4. **Car-sharing incentives preferences:** to understand what different individuals value while using or deciding whether to subscribe to a car-sharing service;

5. **Stated preference experiment:** to identify the preferences of an individual or groups for specific incentives;

6. **Effects of COVID-19 on mobility:** to examine possible effects of the COVID-19 pandemic on urban mobility behaviour.

The next subsections of this chapter provide a summary of each one of these survey sections.

# Introduction

The survey was accessed through links that were specific to each city, and thus, respondents only needed to select the language that they want to answer the survey. The survey started with a brief introduction of the project, its objective, and information on data collection, handling, and on the possibility of withdrawing from the survey at any time. Respondents could also access the data privacy policy document (see Appendix C) on the initial introductory page, which had, at its bottom, a question regarding consent for voluntary participation in the survey.

Additionally, questions to assess the eligibility of individuals were posed at the beginning of the survey, so respondents not eligible were screened-out before spending much time. The general eligibility criteria were being 18 years or older and had a driver's license. However, in Tel Aviv, specifically, only those who were 21 years old or more were eligible because the minimum age for using car-sharing services there is 21 years.

# Socioeconomic questions

The first part of this section included questions to elucidate whether the person had experience with car-sharing, namely whether s/he is a current, past, or never have being a member of any car-sharing scheme. We also collected information on general socioeconomic characteristics, namely age, gender, education, income level, household size, and employment status. To better characterize the mobility opportunities that they have access to, we asked whether they have access to private cars (ownership and leasing) and bicycle at the household level, and where they live and work (both at the zip code level) as well as how the parking conditions are at both places.

# Travel behaviour and attitudes

In this section, we asked individuals about their frequency of using private cars and car-sharing services, as well as their primary purposes for using shared-cars. Additionally, attitudinal questions were posed to understand better individuals' attitudes towards private cars and car-sharing services. For answering these questions about their travel behavior, we asked all respondents to consider their status before the COVID-19 outbreak.

# Car-sharing incentives preferences

We also had a section about car-sharing incentives, where we grouped the incentives in the following categories:

- Pricing/cost
- Vehicle characteristics
- Parking of shared cars
- Flexibility of the service
- Service characteristics

We asked respondents to choose the most important ones or suggest new ones.

## Stated preference experiment

The survey also included a stated preference experiment to understand the choice of respondents in regards to the subscription to different car-sharing plans. Due to our main objective being to assess the impact of incentives, we have defined the attributes from a perspective of incentives, but we also added attributes related to the characteristics of the different services as control variables.

## Effects of COVID-19 on mobility

Due to the Covid-19 outbreak, we have also included questions to understand its impacts on individuals' mobility, especially on car-sharing usage. They encompassed both the modes that individuals used before the COVID-19 outbreak, as well as the modes used by the time they were answering the survey. These questions allowed us to assess whether individuals have changed their mode-related choices due to the COVID-19 outbreak. We also included questions to clarify on their attitudes towards the COVID-19 measures and mobility and to understand whether the importance of different factors related to mode choice has changed.

## A.1.2 Data collection

Before starting the data collection, we have defined eligibility criteria: being 18 years old or older and have a valid driver's license. In Tel Aviv, particularly, as the minimum age for using car-sharing services is 21 years, only those who were 21 years old or more were eligible. For each city, a minimum sample size of 200 individuals was defined, and specific targets were defined.

In the Copenhagen area, Epinion was responsible for recruiting the respondents. In the capital region, they have around 13.000 active panelists. The invitations for answering the survey targeted three groups: CS users identified through a pre-screening, respondents from different geographical zones, and respondents from different age groups and gender. A last distribution of the survey was done, focusing on respondents from age groups below 50 years old.

In Munich, the municipality of Munich was responsible for the dissemination of the survey. They have distributed the survey through a mailing list composed of 3,000 participants from a previous city-level household survey on mobility-related issues (conducted in 2019) who have indicated that they were willing to participate in further studies about mobility. They have contacted 1664 potential respondents and asked them to participate in the survey. Since the list from the municipality of Munich only included participants who live within the city of Munich, the sample from Munich has limitations and reflects only the perspective and behavior of respondents living in Munich, but not in the metropolitan region (different from Copenhagen and Tel Aviv samples). Thus, the results from Munich cannot be used to understand the mobility needs of those living outside the city of Munich.

In Tel Aviv, with the support of Tel Aviv Yafo municipality, the recruitment of respondents comprised of the publication of posts on Tel Aviv residents' website and on Tel Aviv's transportation page inviting residents to participate in the survey. An article was also published in the newsletter that all Tel Aviv digital subscribers receive. Additionally, the car-sharing operators AutoTel and Car2go have published a request to all their subscribers to answer the survey.

## A1.3 Data handling

The survey's implementation was carried out by Epinion. As the data from Copenhagen was collected through a panel, it was pseudo-anonymized by Epinion, removing any identification related to the panelists before making the data available to the data processor (DTU). As for the data from Munich and Tel Aviv, it is anonymous since

no identifier was collected. The processing and analysis were developed by DTU. In compliance with the EU General Data Protection Regulation, the partners in the project have signed a data transfer agreement with DTU in order to have access to the raw data. By doing so, they have agreed that the data will only be used for statistical and scientific purposes.

## A.1.4 Data analysis

This chapter presents the analysis of the data collected on car-sharing incentives in Copenhagen, Munich, and Tel Aviv. Respondents' attitudes towards car-sharing and private cars were elicited by the analysis of how many respondents have agreed or strongly agreed with statements related to those. Moreover, we have performed factor analysis to examine how the statements could be combined into that better translate users' attitudes. The incentives were grouped into five categories: pricing/cost-related factors, parking-related factors, car-sharing vehicle-related factors, flexibility in car-sharing plans-related factors, and service-related factors.

## A.1.5 Sample characteristics

The data was collected from July 16th to August 06th simultaneously in the three cities, and an additional data collection was performed in Munich between the 11th and 29th of September. The completion rate in Copenhagen was 80%, while in Munich was 77% and in Tel-Aviv was 39%. The relatively low completion rate in Tel Aviv is believed to be associated with the difference in the recruitment method used and, consequently, the willingness and commitment of individuals contacted to answer the rather lengthy survey. While Copenhagen's respondents came from a panel and Munich's respondents were contacted because they had stated to be willing to participate in further studies about mobility, in Tel Aviv, respondents were contacted through general mailing lists of the municipality or car-sharing operators. In total, the sample used in the analysis presented in this chapter consists of 1277 respondents: 543 from Copenhagen, 490 from Munich, and 244 from Tel Aviv. We have removed respondents that had inconsistent answers and those who have answered the survey in fewer minutes than the 40% median. Table 1 presents the characteristics of the sample grouped by city. In terms of car-sharing usage status, while the sample from Munich is the most balanced, the sample from Copenhagen has more non-car-sharing members, while the sample from Tel Aviv is mostly composed of car-sharing members. As for car-sharing awareness, in all three cities, more than 90% of respondents stated to be aware of car-sharing services, which indicates that the car-sharing services are well-known. However, the high level of car-sharing awareness in Tel Aviv (97.13%) must be interpreted with caution, as only 27.87% of their sample is composed of non-members of car-sharing, i.e., those who were not aware of car-sharing services.

Table 1 - Sample characteristics

| | | Copenhagen | | Munich | | Tel Aviv | |
|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % |
| Car-sharing membership status | Car-sharing member | 96 | 17.68 | 225 | 45.92 | 156 | 63.93 |
| | Past car-sharing member | 64 | 11.79 | 32 | 6.53 | 20 | 8.20 |
| | Non-car-sharing member | 383 | 70.53 | 233 | 47.55 | 68 | 27.87 |
| Car-sharing awareness | Yes | 490 | 90.24 | 445 | 90.82 | 237 | 97.13 |
| | No | 53 | 9.76 | 45 | 9.18 | 7 | 2.87 |
| Gender | Man | 267 | 49.17 | 284 | 57.96 | 134 | 54.92 |
| | Woman | 275 | 50.64 | 203 | 41.43 | 108 | 44.26 |
| | Prefer not to answer | 1 | 0.18 | 3 | 0.61 | 2 | 0.82 |
| Age | 18-30 | 146 | 26.89 | 58 | 11.84 | 36 | 14.75 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 31-40 | 88 | 16.21 | 158 | 32.24 | 88 | 36.07 |
| | 41-50 | 97 | 17.86 | 147 | 30.00 | 63 | 25.82 |
| | 51-60 | 88 | 16.21 | 71 | 14.49 | 36 | 14.75 |
| | More than 60 | 124 | 22.84 | 56 | 11.43 | 21 | 8.61 |
| Place of residence | City center | 235 | 43.28 | 303 | 61.84 | 117 | 47.95 |
| | Suburbs | 190 | 34.99 | 185 | 37.76 | 84 | 34.43 |
| | Another city in the metropolitan region | 71 | 13.08 | 2 | 0.41 | 16 | 6.56 |
| | Outside the metropolitan region | 47 | 8.66 | 0 | 0.00 | 27 | 11.07 |
| Employment status | Student | 74 | 13.63 | 18 | 3.67 | 22 | 9.02 |
| | Employed | 354 | 65.19 | 422 | 86.12 | 222 | 90.98 |
| | Unemployed | 12 | 2.21 | 6 | 1.22 | 7 | 2.87 |
| | On leave | 7 | 1.29 | - | - | - | - |
| | Retired | 100 | 18.42 | 42 | 8.57 | 9 | 3.69 |
| | Other | 8 | 1.47 | 21 | 4.29 | 7 | 2.87 |
| Level of education | Less Than High School | 39 | 7.18 | 22 | 4.49 | 2 | 0.82 |
| | High school diploma or equivalent | 150 | 27.62 | 96 | 19.59 | 12 | 4.92 |
| | Bachelor's degree | 169 | 31.12 | 52 | 10.61 | 97 | 39.75 |
| | Master's degree | 134 | 24.68 | 181 | 36.94 | 77 | 31.56 |
| | Doctoral degree | 8 | 1.47 | 57 | 11.63 | 12 | 4.92 |
| | Other | 17 | 3.13 | 56 | 11.43 | 10 | 4.10 |
| | Did not answer | 26 | 4.79 | 26 | 5.31 | 34 | 13.93 |
| Size of the household | 1 | 152 | 27.99 | 141 | 28.78 | 54 | 22.13 |
| | 2 | 223 | 41.07 | 199 | 40.61 | 68 | 27.87 |
| | 3 | 80 | 14.73 | 64 | 13.06 | 37 | 15.16 |
| | 4 | 68 | 12.52 | 68 | 13.88 | 61 | 25.00 |
| | >4 | 20 | 3.68 | 18 | 3.67 | 24 | 9.84 |
| Number of cars in the household | 0 | 139 | 25.60 | 162 | 33.06 | 112 | 45.90 |
| | 1 | 304 | 55.99 | 244 | 49.80 | 86 | 35.25 |
| | 2 | 91 | 16.76 | 71 | 14.49 | 37 | 15.16 |
| | >2 | 9 | 1.66 | 13 | 2.65 | 9 | 3.69 |
| Number of bicycles in the household | 0 | 40 | 7.37 | 17 | 3.47 | 98 | 40.16 |
| | 1 | 128 | 23.57 | 85 | 17.35 | 60 | 24.59 |
| | 2 | 156 | 28.73 | 128 | 26.12 | 39 | 15.98 |
| | >2 | 219 | 40.33 | 260 | 53.06 | 47 | 19.26 |

Copenhagen has the most balanced sample in terms of gender, while both Munich and Tel Aviv samples have slightly more men than women. The higher presence of men in the sample from Munich is in line with other mobility-related surveys performed in Munich, which suggests that this is not a limitation of this specific study but a general tendency in Munich. Regarding age, while Copenhagen's sample has more respondents in the extreme categories (young and old ages), Munich and Tel Aviv have more adults between 31 and 50 years old. It is worth mentioning that in terms of age, Copenhagen's sample is proportionally representative of the population. In all three cities, most of the respondents live in the city center and are employed. Only Munich's sample presents almost no respondent living in other cities of the metropolitan region or outside it, which is a consequence of the dissemination of the survey, as mentioned earlier. As for the level of education, most respondents have at least a bachelor's degree, but the sample from Tel Aviv is slightly more educated in general (76.23% has at least a bachelor's degree), and almost half the sample from Munich has at least a Master degree. The

underrepresentation of the population that has up to a High school diploma or equivalent in Tel Aviv is likely to be connected with their eligibility criteria (21 years old or above) and the fact that car-sharing members in Tel Aviv tend to be highly educated. In Munich, there is hardly any good source for the categories used for the variable level of education, however official statistics show high levels of education in Munich, suggesting that the distortion in the distribution of the education level in Munich's sample is limited.

Additionally, most of the households have 1 or 2 members and up to one car. Respondents from car-free households compose almost 50% of Tel Aviv's sample. While most of the respondents have at least two bicycles at their households in Copenhagen and Munich, most of the respondents from Tel Aviv's sample has up to one bicycle at the household.

Table 2 presents the income level of the respondents, before taxes and other deductions, grouped by city. Most of the respondents in Copenhagen earn more than 350.000 kr./year, while most of Munich's sample earn more than €65,000/year, and most Tel Aviv respondents earn more than 11,000 ₪/month.

Table 2 - Sample's income level

| Income | | Total | % |
|---|---|---|---|
| Copenhagen | Low (Up to 250.000 kr.) | 82 | 15.1 |
| | Medium (251-500.000 kr.) | 140 | 25.8 |
| | High (Over 500.000 kr.) | 221 | 40.7 |
| | Did not answer | 100 | 18.4 |
| Munich | Low (Up to €29,999) | 32 | 6.5 |
| | Medium (€30,000 - €94,999) | 219 | 44.7 |
| | High (€95,000 or more) | 146 | 29.8 |
| | Did not answer | 93 | 19.0 |
| Tel Aviv | Low (Below 11,000 ₪/month) | 56 | 22.9 |
| | Medium (About 11,000₪ /month) | 46 | 18.8 |
| | High (Above 11,000 ₪/month) | 96 | 39.4 |
| | Did not answer | 46 | 18.9 |

Exchange rate (01st of September of 2020): 1 € = 7.4434 Kr. = 4.0183 ₪

Most of the respondents in all cities earn around the average or above, but Munich's sample has a lower number of respondents in the lower category, which is likely to be related to the high level of education of the sample.

## A.2 Results

The analyses of Copenhagen, Munich, and Tel Aviv's samples are presented together and in terms of percentage to facilitate the comparison between the cities. We have assigned colors to each city to facilitate the identification of the results of each of them: green represents Copenhagen (CPH), blue represents Munich (MUN), and grey represents Tel Aviv (TLV).

### Attitudes towards private car and car-sharing

For assessing respondents' perceptions towards the private car and car-sharing services, we have looked into their responses to the attitudinal questions. The statements were graded on a 5-point Likert scale from 1="strongly disagree" to 5="strongly agree." For this analysis, we have investigated the proportion of respondents who have selected that "agree" or "strongly agree" with each statement.

In all three cities, respondents agreed that car-sharing services allow them not to have to deal with vehicle maintenance and repair and that by using it, they also save in fuel, taxes, insurance, and parking expenses compared to a privately owned car. Thus, car-sharing is seen as an advantage to car ownership due to the perceived time and effort savings in arranging regular maintenance or repair and money savings related to the costs of car ownership. Environmental and affordability factors were also of high agreement rate levels among the respondents. They refer to the understanding of car-sharing services as more environmentally friendly and affordable than car ownership. The use of car-sharing allows individuals to access mobility shared resources (vehicles) only when needed, so they can fulfill their needs while cities' mobility resources have their use optimized. Particularly in Tel Aviv, most of the respondents (55.7%) perceive car-sharing as more convenient than public transport, which reveals that the perceived public transport level of service is lower compared to Copenhagen and Munich. Thus, car-sharing incentives and operation should be more carefully planned in Tel Aviv to avoid car-sharing use as a result of public transport trips replacement.

As for general attitudes towards the private car, more respondents from Munich agreed that they feel stressed while driving than others. It is worthy of highlighting that this may be a consequence of the sample, as Munich's sample is composed mainly of respondents living in Munich city center or its suburbs, while the samples for Copenhagen and Tel Aviv also have respondents that live in smaller cities. In all cities, the private car is seen as a considerable expense rather than a status symbol. In Denmark (Copenhagen), when buying a car with a combustion engine, an individual needs to pay a registration tax that is between 85% and 150% of the taxable value of the car (Skat - Danish Customs and Tax Administration, 2020). For buying an electric car, this tax is 20% of the taxable value of the car in 2020, but this will increase during the next years(Skat - Danish Customs and Tax Administration, 2020). In Germany (Munich), there is a motor vehicle tax obligation (Kraftfahrzeugsteuergesetz) that private owners need to pay. The tax rates vary depending on the vehicle type and generally payable one year in advance. The motor vehicle tax law provides temporary tax exemption for purely electric vehicles. In Israel (Tel Aviv), most of the cars are taxed up to 83%. Hybrid cars have a temporary tax of 30%.

Also, respondents from Munich displayed a higher level of environmental concern, as 78.2% of the respondents agreed to be worried about the carbon footprint generated by car usage. In contrast, only 28.0% of the respondents in Copenhagen agreed with that. Difficulty in finding parking and easiness in conducting daily activities without a private car also presented relatively high levels of agreement among respondents in all cities.

We have also performed a factor analysis considering the seventeen statements on attitudes towards car-sharing and private cars. We have used the Principal axis factoring method with Varimax (orthogonal) rotation. The analysis yielded four factors explaining a total of 51.667% of the variance for the entire set of variables. The result allowed us to identify four factors related to the individual answers:

- o  Factor 1: "Positively inclined towards car-sharing concept" refers to the perceived positive aspects of the car-sharing idea, including perceived savings of resources that car-sharing services provide to their members. Those who have high scores on this factor believe that by using car-sharing, they are saving money, time, and effort in comparison with car ownership.
- o  Factor 2: "Car-related issues" describes feelings and perceptions associated with car use and ownership.
- o  Factor 3: "Car-sharing as a good alternative to car ownership" refers to the flexibility conferred by car-sharing service that makes it possible to get the benefits of a car without having to own it.
- o  Factor 4: "Car independency" refers to how individuals can manage their daily travels without a private car. Those who have high scores on this factor believe that they can conveniently travel without a private car.

## Barriers for car-sharing usage

Current non-members of car-sharing services were asked about the reasons why they do not use car-sharing. As respondents could select as many reasons as they wanted, in some questions, we have included in the legend of the figures both the number of people that answered the question (N) and the total number of choices made (n).

In all three cities, the main reasons for non-membership of those who have never subscribed to car-sharing services are car ownership and the perception that the service does not meet their travel needs. While changes in car ownership are more challenging to achieve, as the acquisition of a car tends to be a long-term decision affected by several factors (e.g., household composition, income, accessibility to public transport), a better understanding of the travel needs of non-members has the potential of increase car-sharing market.

Additionally, despite smaller, there is a share of respondents, among those who were never members, who do not have car-sharing services available in their area, which reveals some possible unmet demand. Associated with that, the second most chosen motive for stop being a member of car-sharing services in Munich was accessibility/long walk distance to shared cars at frequently visited locations.

While for the respondents in Munich and Tel Aviv, the primary motive for stopping their car-sharing membership was that they did not use the service frequently, in Copenhagen, the main reason for stopping using car-sharing services was car acquisition. Additionally, in Copenhagen, the other highly chosen motives were changes in travel needs and low frequency of car-sharing usage. In Tel Aviv and Munich, several respondents stopped being a member of car-sharing services because of the perceived high cost of usage and the perception that the service did not meet their travel needs. Thus, packages that can allow individuals to use more the service at a lower cost have the potential to increase member usage but also of making them less likely to cancel their memberships.

Respondents were also given the opportunity to choose the option "Other" and specify their own reason when that was not listed. In all cities, respondents who have chosen "Other" reported reasons related to gaining access to other cars or do not need to use a car anymore. Beyond that, Munich's respondents also stated that they experienced vehicles that were not in good condition and that station-based services were not useful for some trips. Additionally, Tel Aviv respondents reported that problems in reporting car malfunctions, lack of coverage of the desired area, and costs were decisive for stopping their membership. Related to the latter, one respondent stated that if the service had no fixed monthly cost associated (monthly membership), s/he would have continued being a member and could use the service occasionally. In this context, packages with different monthly membership costs according to the planned frequency of car-sharing usage could be a good strategy for operators instead of a total exemption of monthly membership costs.

## Car-sharing usage patterns

Both current members and past members of car-sharing services were asked about frequency, average total time using the shared car, and purpose of car-sharing usage. We also asked what type of car-sharing service they have used.

While in Copenhagen and Munich, most of the respondents mainly use One-way free-floating car-sharing, in Tel Aviv, the number of users of One-way (summing free-floating and station-based) and Round-trip types of service is the same (see Figure 2). It is worth mentioning that some car-sharing services operate in between these types, such as the case of a mainly free-floating one-way service that has some hotspots (stations) where you can park the car or the case of services that offer electric vehicles and thus have dedicated parking in some areas.
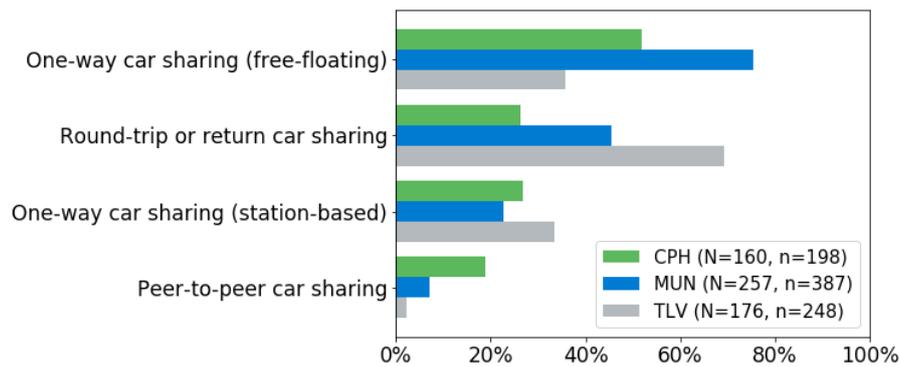
Figure 2 - Type of car-sharing used

As for the purpose related to car-sharing trips, trips for leisure, and visiting friends and relatives were the most chosen categories. This suggests a higher use of car-sharing for non-mandatory trips that usually have flexible arrival time. In Munich, several respondents also use car-sharing for holidays and weekend getaways and for shopping, while in Tel Aviv, respondents use car-sharing for work/education purposes and run errands more intensively than in Copenhagen and Munich.

As for the car-sharing frequency of use, while in Copenhagen and Munich, most respondents use car-sharing a few times per year, in Tel Aviv, most of the people surveyed use car-sharing once in a fortnight or a few times per week. This is likely to be related to the fact that respondents from Tel Aviv perform more trips for work/education purposes and run errands than respondents in Copenhagen and Munich. Additionally, Tel Aviv's recruitment has included the distribution of the survey through direct messaging active members of two car-sharing companies.

We have also asked respondents how long they usually have the shared-car each time they use the service (not considering reservation/booking time). Although in all three cities, the category "up to 30 minutes" was the most chosen, in Tel Aviv, 33.5% of respondents indicated that they usually have the car for at least 3h.

## Car-sharing incentives per city

To better examine the different incentives and factors influencing the car-sharing subscription and usage, we have analyzed the data separately for each city. We have asked the same questions to all the respondents that reported awareness of car-sharing services to understand what are the most important factors related to the use of car-sharing. We have grouped the responses of members, past members, and non-members about different incentives that will be presented according to five main groups:

- Pricing/Cost-related factors;
- Car-sharing vehicle-related factors;
- Parking-related factors;
- Flexibility in car-sharing plans-related factors;
- Service-related factors.

In Copenhagen, in regards to pricing and cost factors, car-sharing members, past members, and non-members all consider as very important for using car-sharing services not to have both one-time subscription and monthly membership costs. Clear and consistent pricing, as well as flexible/dynamic pricing, were also pointed out as important for using car-sharing services. While the former refers to how simple the pricing scheme of the service is to understand and also to how steady it is, the latter is associated with the possibility of paying less in strategical contexts. Thus, providing simple and straightforward information on all aspects related to the pricing and its variation while keeping the pricing scheme constant is seen as positive and necessary for users of the service.

Moreover, they are open to help the car-sharing system to balance the usage and spatial distribution of shared cars in exchange for discounts during its use.

In particular, past car-sharing members from Copenhagen believe that reduced fares when carpooling and the opportunity of accumulating credits while using car-sharing services that could be exchanged for goods were also desired incentives for starting being a car-sharing member again. For those who have never being a member of car-sharing services, having a guaranteed price beforehand was a positive factor when considering to become a member of car-sharing. Respondents who have chosen "Other" stated that it is important that the service is cheaper than owning a car (members), low membership costs (past members), and cheaper prices (non-members).

In Munich, most of the car-sharing members pointed out that not having to pay a monthly membership (79.1%) and having a clear and consistent pricing scheme (74.7%) are essential. While flexible pricing was also highly chosen by Munich's car-sharing members as important, like Copenhagen's car-sharing members, daily fees instead of hourly or distance-based fees are among the most preferred in Munich. This is likely to be related to the fact that in Munich, respondents stated to use more car-sharing for holidays and weekend getaways than in the other cities. Past members perceive no one-time subscription cost as more important for becoming a member again than current members, which suggests that even though it is a one-time payment (not fixed), that can refrain some people from subscribing and using the service.

As for Munich's respondents who have chosen "Other," car-sharing members have stated that using car-sharing must be cheaper than Uber, and transparency in terms of sustainability and involvement of car-sharing companies with social work are also relevant for them. Moreover, they would like to receive bonus minutes for refueling the shared car and have access to packages of 2h, 6h, and 24h. As for non-members, they would like to have access to packages of 2-4 days and have available cars at short notice in their vicinity.

Observing the results of what is important in regards to pricing and cost factors for Tel Aviv's respondents, we see that no monthly membership is the most important for all groups in Tel Aviv, especially for past members (80.0%). Clear and consistent pricing is important for most members (56.4%), and flexible pricing (55.0%) are important, especially for past members. Additionally, more respondents from Tel Aviv (all groups) believe that tax incentives for those commuting by car-sharing are important than in Copenhagen or Munich.

Beyond that, Tel Aviv respondents have stated through the option "Other" that they desire reduced price for longer rent periods (members), a service that is less expensive than taking a taxi (past members), and the prohibition of abnormal prices (non-members).

As for the factors related to <u>car-sharing vehicles</u>, in Copenhagen, all groups agree that the most important is the cleanliness of the vehicles. It is worthy of clarifying that this can be related to the current context since the COVID-19 outbreak has led to an increase in hygiene awareness. Additionally, a variety of vehicle types and availability of electric vehicles were also seen as important for all groups. Information about shared car conditions in advance and the existence of vehicles with advanced safety features (such as adaptive cruise control, rearview camera, and forward-collision warning system) were also highly chosen by respondents. Moreover, respondents have pointed out thought the option "Other" that having access to cars with good charge levels and with a drawbar (members) and that are large, and allergy-friendly (no perfume, no pets) cars (past members) are also perceived as relevant.

In Munich, car-sharing members (66.7%) and non-members (38.6%) believe that the cleanliness of the vehicles is the most important vehicle-related factor. However, for most past members, the availability of electric cars is essential (this is also important for members and non-members). This is likely to be related to the greater environmental concern that Munich's respondents expressed.

Additionally, a variety of vehicle types is also an important factor for Munich's respondents, especially for members and past members. The availability of car seats for kids is highly relevant for past-members, which can be related to their travel needs and, then, to one of the reasons why they have stopped being members. As for other vehicle-related desired features, Munich's respondents pointed out having regularly maintained vehicles and a larger selection of cars for the different needs, such as cars with automatic gearboxes, small cars, and cars with good internal size (members) and cars with larger trunks, cars with roof rack and cars that have a drawbar safe for high loads (e.g., to pull a caravan) (non-members).

As for the preferences of Tel Aviv's respondents, members (74.4%) are mainly valuing the cleanliness of the vehicles, which, as mentioned earlier, is likely to be linked to the current context (COVID-19 pandemic). For past users, a variety of vehicles is highly important, which can be related to their travel needs. For all groups of respondents, a fleet with vehicles with advanced safety features is also important for using and becoming members of car-sharing services.

Both members and non-members in Tel Aviv also stated through the option "Other" that the availability of cars, in general, is important. While vehicles that fit seven people and new cars were pointed out as relevant for members and manual driving cars, fuel-efficient cars, cars adapted for people with disabilities (hand mechanism), and cars suitable for families were stated as relevant for non-members.

In regards to the factors related to parking of shared cars, in Copenhagen, most of the respondents from all groups have chosen dedicated parking lots and information about parking availability at the destination beforehand as essential incentives for using and subscribing to car-sharing services. Additionally, especially past members consider that parking discounted rates at all locations would be a good incentive for becoming a member of car-sharing services again. Beyond that, members who have chosen the "Other" alternative have stated their desire for free parking across the city or within some zones and having parking spaces close to their destinations. However, both a past member and a non-member that have chosen "Other" have stated that there should be no difference in parking rules whether you drive privately or share a car. This indicates that measures associated with parking regulations are likely to provoke a debate in Danish society.

In Munich, the connection between car-sharing services and the public transport system through dedicated parking lots close to the latter is essential, especially for past members (81.2%). This group also displays relatively higher preferences for being able to book and pay for parking through the car-sharing service. In contrast with Copenhagen's respondents, both car-sharing members and non-members in Munich stated through the option "Others" that they desire free parking. Non-members also suggested that an underground car park and unrestricted permission for parking (including parking even residents' parking zones) would be positive incentives for subscribing. Moreover, members believe that having parking discounted rates at all locations is important for using more car-sharing services.

In Tel Aviv, dedicated parking lots and information about parking availability at the destination beforehand were chosen by most of the respondents from all groups as important for using and subscribing to car-sharing services. It is worth mentioning that 74.6% of all respondents from Tel Aviv agreed that finding parking is difficult.

As for further incentives mentioned through the option "Other," members and non-members also cited convenient parking as important. While past-members stated that free parking is important, guaranteed parking was stated by non-members as important. Additionally, members desire improvements in the coverage and number of parking spaces, as well as to be able to park for free in municipal parking lots. It is also worth mentioning that car-sharing members highlighted the need for more supervision of the dedicated parking regulations, as it happens that some people who are not using car-sharing services block the parking space.

Among the features associated with the flexibility of the service, while for most of the members (80.2%) of Copenhagen's car-sharing services discounted rates for the weekend and long bookings are important, for past

members and non-members, the possibility of combining car-sharing plans with public transport passes and other transport modes available in the city are the most relevant aspects. Moreover, the opportunity of having a family or friends account with discount rates and also have access to use car-sharing with discounts for business trips is especially relevant for past members to subscribe to car-sharing again. Related to that, a car-sharing member also suggested the possibility of having a shared family account, where everyone in the family that has a driver's license could be a part of and use it, would be a good incentive. For a non-member, discounts during off-peak hours are seen as relevant.

As for Munich, most of the members (89.8%), past members (81.2%), and non-members (56.7%) think that discounted rates for the weekend and long bookings are important. This is likely to be associated with the fact that most respondents in Munich use car-sharing for holidays and weekend getaways. Moreover, having the opportunity of combining car-sharing plans with public transport passes and other transport modes available in the city were also highly chosen as desirable, particularly for past members. As for current members, they have stated through the option "Other" offering more favorable tariffs for commuters and less restrictive cancellation conditions are important incentives, while a non-member stated that they would like to have the possibility of booking a car for fixed recurrent schedules (e.g., every Tuesday from 16h to 17h).

Similar to Munich's results, most of Tel Aviv's members (90.4%), past members (80.0%), and non-members (57.4%) of car-sharing services also value having discounted rates for the weekend and long bookings. Also, family/friends account with discount is considered a good incentive, especially for car-sharing past-members from Tel Aviv. The possibility of combining car-sharing with public transport and other transport modes is less attractive in Tel Aviv's context than in Copenhagen's or Munich's contexts. This should be further analyzed, as it can be associated with the fact that most of the respondents in Tel Aviv perceive car-sharing as more convenient than public transport and, thus, do not see car-sharing services in a complementary way, but instead in a competitive way.

Through the option "Other," car-sharing members in Tel Aviv stated that they believe that the integration of car-sharing services with other collaborative services like on-demand Bubble Dan and between free-floating and station-based car-sharing services is important. Flexibility in returning vehicles and discounted rates during off-peak hours were also pointed out as important for members. While past members think that it is important to be able to travel outside the city cheaply, non-members believe that an option to leave the vehicle in another location is relevant.

Finally, among the characteristics of the car-sharing service, most respondents from all groups in Copenhagen agree that the proximity of the vehicles is the most important aspect. Especially for past members, guaranteed car availability and coverage outside the cities for longer trips/ connectivity between big cities are also important attributes when choosing to subscribe to a car-sharing service. A wide availability of shared cars across the city and the possibility of booking in advance are very important for most car-sharing members.

Most of Munich's respondents from all groups agree that proximity of the vehicles and a wide availability of shared cars across the city are the most important factors related to the characteristics of the service. While past members and non-members also believe that guaranteed car availability is very important, both past-members and members think that a more user-friendly app is essential. This suggests the need for a more intuitive and easy to use application. Past members of car-sharing in Munich, in particular, value also the possibility of using bus lanes or high occupancy lanes while using shared-cars.

Moreover, both members and past members stated as important to provide a larger operational area or the relaxation of restrictions regarding the area of use. Members also think that it is important to be assured that you will not be blamed in the event of damage to the vehicle by previous users. For non-members, free support in case of an accident or damage and easy booking are relevant.

Similarly, for Tel Aviv's respondents, the proximity of the vehicles, wide availability of shared cars across the city, and guaranteed car availability are highly important. Coverage outside the cities for longer trips/connectivity between big cities is especially important for past members. Additionally, both past members and non-members in Tel Aviv stated through the option "Other" that it is important for them to be able to travel out of town. While non-members think that it is relevant that a car-sharing service has enough cars in order members do not have to book a long time in advance, past members stated as important the option of having the vehicle refueled in advance. Users also raised some concerns in regards to reporting faults and defects in the cars, as they believe that they could be blamed for a defect caused by someone else (e.g., previous users).

Overall, observing respondents' preferences for each category analyzed (see **Error! Reference source not found.**), we can observe that in all cities, pricing/cost and parking-related factors are highly important, pricing being the most important for both subscribing and using car-sharing services. The importance of parking seems to be related to how difficult it is to find parking in the cities. As many respondents in Tel Aviv stated that it is highly difficult to find parking in Tel Aviv, it is easier to understand why slightly more members, non-members, and past-members of car-sharing in Tel Aviv agree that parking incentives are essential. Additionally, while in Copenhagen and Munich, flexibility in the car-sharing plans is highly valued as well, in Tel Aviv, more importance is given to Service-related factors, such as availability and coverage.
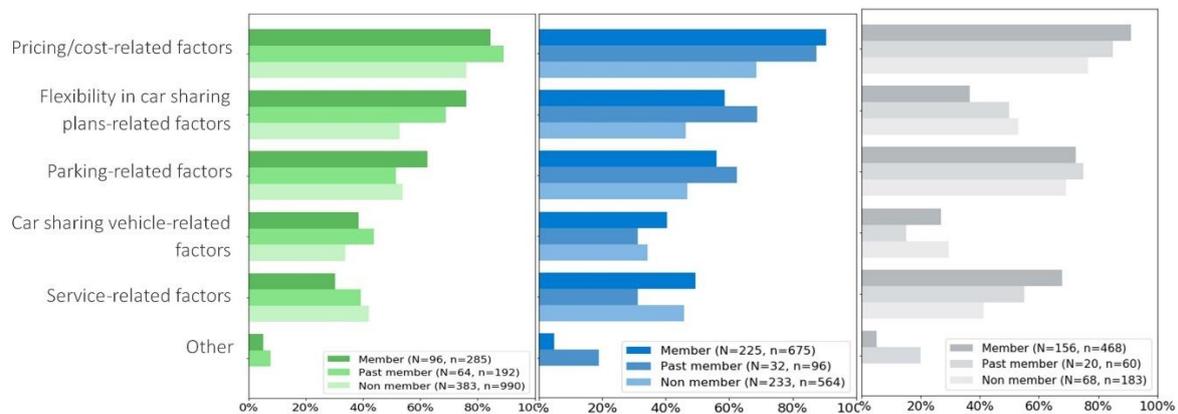


Figure 3 - Most important factors for respondents **by membership status and city.** Green represents Copenhagen, blue represents Munich, and grey represents Tel Aviv

Munich's car-sharing members also stated through "Other" that they believe it is important that the service shows measures towards climate protection, sustainability, and support to a social enterprise, and past-members in Munich stated that it is important to have emission-free cars. Tel Aviv's car-sharing members stated that car availability in the North Tel Aviv area and the monthly membership cost are important, especially if it's an extra charge that is not deducted from the usage costs

# Appendix B: Demonstration of incentives in Tel Aviv

In the final stage of the project, several incnetives were selected for demonstration through integration with existing CS application. The pilot demostrates both the ability to provide incentives in real-life situation as well as demostrating some of the possible impacts.

## B.1 Methodology

### B.1.1 Incentives design and implementation

The type of incentives selected for implementation belongs to the Flexible/dynamic pricing (e.g., reduced prices outside rush hours or in low demand areas) – one of the highest ranked categories found in the project survey. It included price reduction for specific neighborhoods, during specific hours, as well as price reduction for second trip within 4 hours. The selected incentives where implemented as an app add-on of Autotel CS application, following the design provided in OUT09 (App design and development).

The first incentive (30% price reduction) was offered in 12 neighborhoods of the city of Tel Aviv, from 18PM until 5AM. The neighborhoods where selected by three criteria: (1) Waiting time of the cars (measured as the time between the end of one trip and the beginning of the next trip) in these places exceeds by twofold the average waiting time (WT) across town; (2) traffic of CS cars is substantial enough to allow discrimination of change; (3) representing the full range of socio-demographic parameters or the city. Conditions 1,2 were estimated using May-July 2020 trips analysis. It should be noted that this period represents the end of COVID-19 first wave. The second wave which subdued just before the pilot period is slightly different as lockdown restrictions which were raised fast after the first wave were still in effect. The hours in which the incentive was offered were selected as high WT was observed. The participating neighborhoods socio-demographic parameters are shown in the next Table 3. For analysis purposes, the 12 neighborhoods of incentive 1 were gathered into 5 representative groups.

Table 3: Incentive 1 neighborhoods characteristics

| neighborhood | Socio-demographic rank | Average car availability (+18) | Median age | group |
|---|---|---|---|---|
| Ramat Aviv g' | 9.3 | 0.7 | 40 | 1 |
| Afeka | 10 | 0.8 | 52 | 1 |
| Neot Afeka | 9 | 0.7 | 36 | 2 |
| Maoz Aviv | 9.6 | 0.8 | 37 | 2 |
| Tel Baruch North | 9.6 | 0.8 | 37 | 2 |
| Yafo North | 6 | 0.5 | 32 | 3 |

| neighborhood | Socio-demographic rank | Average car availability (+18) | Median age | group |
|---|---|---|---|---|
| Neve Sha'anan | 3.6 | 0.2 | 35 | 4 |
| Shapira | 3 | 0.2 | 30 | 4 |
| Zahalon | 3 | 0.3 | 30 | 5 |
| Dakar | 3.6 | 0.2 | 35 | 5 |
| Neve Golan | 2.4 | 0.1 | 38 | 5 |
| Givat Hatmarim | 3.4 | 0.2 | 41 | 5 |

The second incentive (20% price reduction) was offered in 4 different neighborhoods of the city of Tel Aviv, for a second trip within 4 hours. The neighborhoods where selected by the same three criteria and are described in the next table.

The incentives were offered to all Autotel subscribers and were published through all available publication channels beforehand.

Table 4: Incentive 2 neighborhoods characteristics

| neighborhood | Socio-demographic rank (1-10) | Average car availability (for +18) | Median age |
|---|---|---|---|
| Tel Aviv University | 8.4 | 0.5 | 34 |
| Neve Sharet | 5.4 | 0.4 | 32 |
| Ha'tikva | 3 | 0.2 | 36 |
| Glilot | 9 | 0.8 | 35 |

## B.1.2 Data collection and handling

The collected data included trip data and members data, as available in Autotel database. The characteristics of each trip performed through the city of Tel Aviv using the CS service were collected. The data handling process included pseudo-anonymizing of the data in Autotel servers and removal of any identification related to the users.

## B.1.3 Data analysis

This chapter presents the analysis of the data collected during 5 weeks of pilot offering CS incentives in Tel Aviv – the duration of Nov 1st to December 5th (weeks 45-49 of 2020). The pilot was carried during a period that is marked by external disruptions. The city was just recovering from the second wave of the epidemic and lockdown was lifted gradually, winter was just setting and day-light saving time was set back to winter-time. These disruptions generated city-wide change in CS patterns, regardless of the pilot introduction.

The analysis mainly focused on the change in the number of trips across the demo weeks, across the neighborhoods (both eligible and others) and across periods, comparing the system performance before the demo (May-July) and during the demo weeks. Additionally, for incentive 1, analysis of change across the periods was conducted to elicit possible correlation to (1) neighborhoods, specifically in weekdays and weekends; (2) age group; (3) gender; (4) level of prior CS use.

## B.2 Results

Travel habits change slowly and impacts of innovations can only be realized after substantial time has elapsed. However, the results described in this chapter provide some initial clues for a potential of a habit-building process.

Table 5 presents the use of the incentives during the pilot period weeks in terms of the number of trips. The larger geographic area throughout incentive 1 was offered, compared to incentive 2, provides partial explanation for its intenser use. However, it might be that this type of incentive is more attractive. The increase in the use of incentive 2 in the last two weeks of the pilot, compared to the stable number of trips associated with incentive 1, might suggest that incentive 2 requires longer adoption time. The scope of the pilot is too limited to accept or reject these hypotheses, and deeper investigation in these directions is called for.

Table 5 – Use of incentives over the pilot period

| Week for year 2020 | Use of incentive 1 (number of trips) | Use of incentive 1 (number of trips) |
|---|---|---|
| 45 | 337 | 92 |
| 46 | 390 | 90 |
| 47 | 372 | 92 |
| 48 | 386 | 140 |
| 49 | 349 | 138 |

Given the larger uptake of incentive 1, further analysis focused on this type, and the data was normalized to account for changes over the entire urban network.

Analysing the uptake of incentives by grouped neighbourhoods (Figure 4 and Figure 5) reveals substantial difference in weekday/ weekend use patterns. While the southern neighbourhoods of lower social-economic

status increased their CS use and responded to the incentive mainly during weekdays, the northern more affluent ones responded mainly through the weekend, indicating different uses and potential for personalization.



Figure 4: Incentive 1 trips by grouped neighborhoods, weekdays
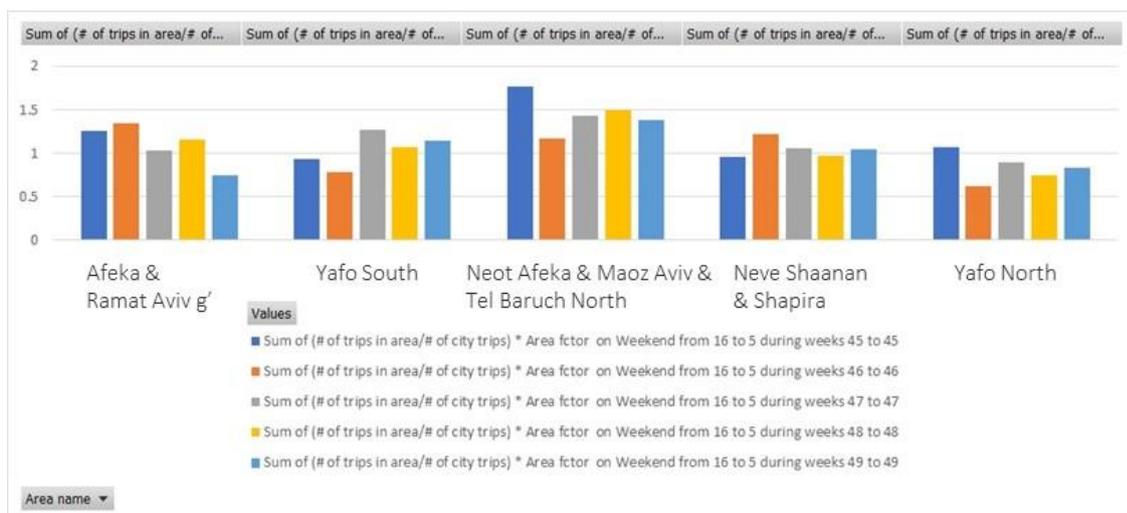


Figure 5: Incentive 1 trips by grouped neighborhoods, weekends

Figure 6 and Figure 7 depict the use of CS services during the pilot period compared to May-June 2020 in the relevant neighbourhoods and time of day. The figures show the distribution by age groups of those who decreased or didn't change their habits compared to those who increased the number of trips. During weekdays (

Figure 6), the share of the age group of up to 30 is higher for those who increased the number of trips compared to those who decreased or didn't this number. The opposite phenomenon characterizes the age group of 50-65.

The same analysis for weekends (Figure 7) reveals that again, the age group of up to 30 seem to take advantage of the incentives compared to other age groups. However, on weekends, it seems that the 30-40 age group is more conservative in exploiting the benefits of the incentive.

The findings regarding the younger groups might be explained by younger users often being early adopters. For the relatively low uptake of the 30-40 group over weekends, an age group that typically care for young children, it might indicate the Autotel's CS services are less appropriate for family travels.
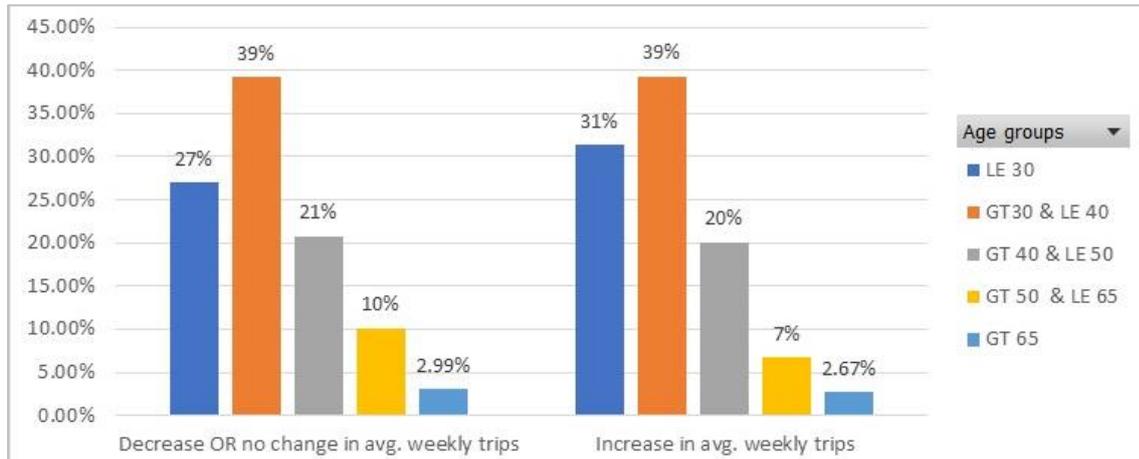


Figure 6: Incentive 1 response by age group, during weekdays
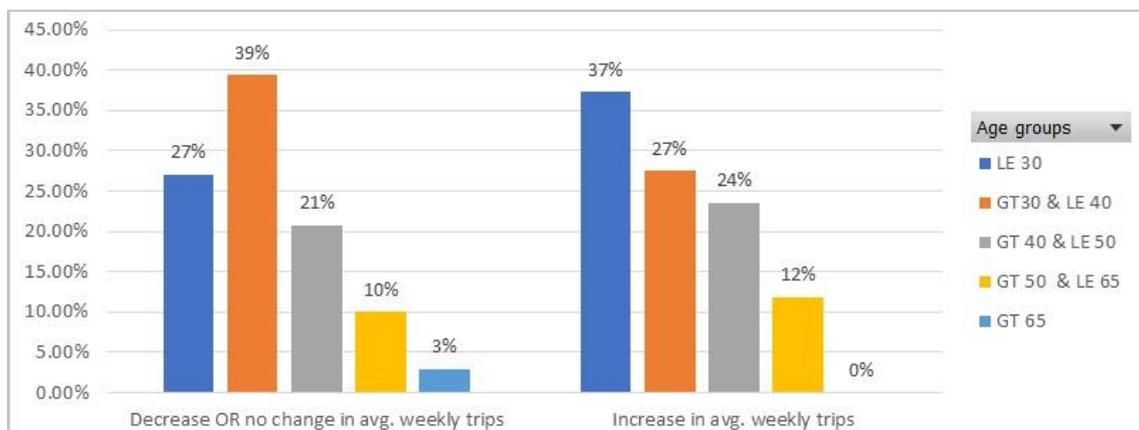


Figure 7: Incentive 1 response by age group, during weekends

To analyze gender-related uptake of incentives, three categories of users were defined – those increasing their overall uptake, those not changing it and those decreasing their accumulated use. Figure 8 shows that women respond less to the offered incentives. This can be contributed to the incentive failing to attract them, or to their lower share in early adopters.
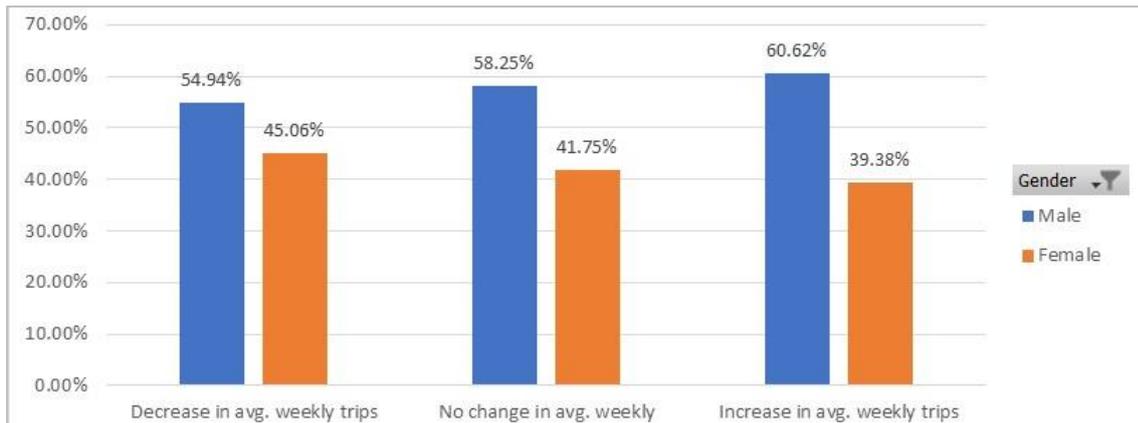
Figure 8: Gender split among analysed groups

Figure 9 depicts the findings concerning the tendency of frequent users (based on habits before the incentives' implementation) to increase their trips when incentives are being offered compared to the other users. The results indicate that this group is less inclined to take advantage of the incentives.
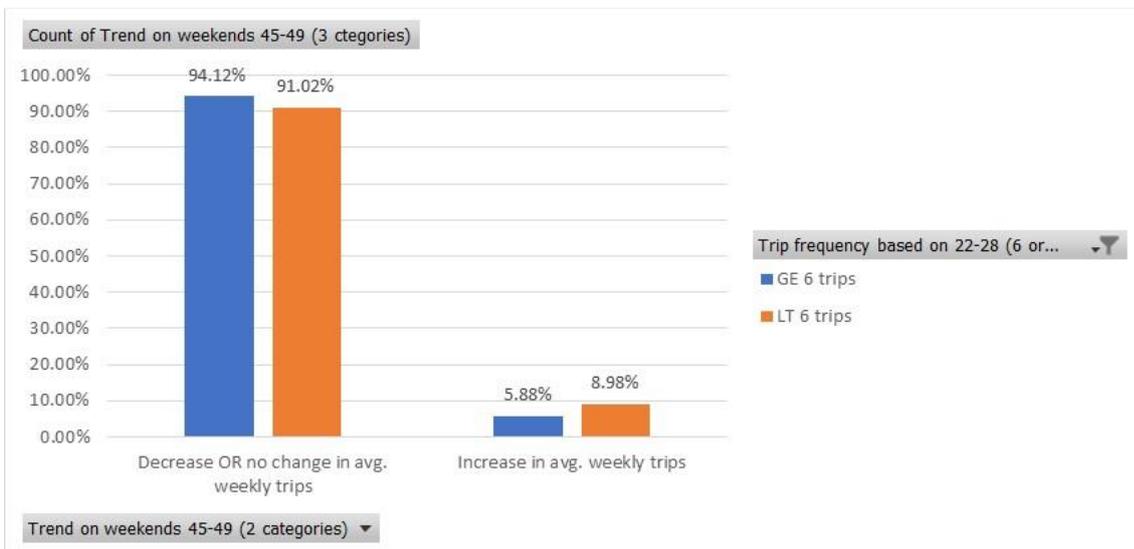


Figure 9: Trips changes related to recurring use pattern

## B.2.1 Users' characteristics – complementary survey

Following the conclusion of the demonstration phase, a survey was distributed to further characterize the users who used the incentives. The survey was required as CS operators typically do not ask their subscribers for details which can be used for building incentive profiles. The survey was distributed to users of incentive 1 and 2, as well as to users who could potentially have gotten those incentives. Overall, 307 AutoTel users replied to the survey; among them 137 of used the incentives.

**16% of the users who used the incentives, used AutoTel for these rides because of the incentives.** These users either changed their travel time, made a more frequent use of the service, or even tried the service for the first time. The main reason for doing so is the reduced cost of the service which is coupled with the convenience of the service in compare to public transport or the use of private car.

The users who used the incentives and answered the complementary survey are characterized by:

1. **Higher income** – 36% of the users who used the incentives have higher than the average household income, in compare to 22% of the users who did not use the incentive.
2. **Younger –** The average age of the users who used the incentive is 34 and their median age is 31, in compare to the users who did not use the incentive who are with an average age of 37 and a median age of 35.
3. **Living with a partner** (with and/or without kids) – 61% of the users who used the incentives are living with a partner, in compare to 46% of the users who did not use the incentive.
4. **The use of active modes of transport as a major mode of transport** – 61% are walking and 47% are using bicycle and scooters, in compare to 48% (walking) and 41% (bicycle and scooters) of the users who did not use the incentives.
5. **The use of private cars** – 31% of the users who used the incentives are using private cars as a major mode of transport, in compare to 20% of the users who did not use the incentive.
6. **Living in the city center** – 45% of the users who used the incentives are living in the city center, in compare to 36% of the users who did not use the incentive.
7. **Not living in Yafo** (group 3 and 5)– 9% of the users who used the incentives are living in Yafo, in compare to 19% of the users who did not use the incentive. All users living in Yafo, who participated in the survey, stated that their average household income in lower than the average.
8. **Using AutoTel for running errands** – 58% of the users who used the incentives are using carsharing for running errands, while only 31-35% of them are using carsharing for going to and from work (31%), visiting friends and family (35%), or going out at night (35%). Among the users who did not use the incentives 48-55% are using carsharing for visiting friends and family (48%), running errands (53%), or going out at night (55%).

Among the users who did not use the incentives, the following were mentioned as the major factors which could have influenced them to use the incentives:

- Finding a closer available vehicle – 41%.
- Certain availability of vehicle – 38%.
- Securing parking at the destination – 35%.
- Increasing the discount – 33%.
- Changing the time in which the incentives were offered – 32%.

To sum, while the incentives did influence users' use patterns, it looks like that the overall limited coverage and availability of the service throughout the city is a major barrier for personalizing incentives on a large scale. However, young users with relatively high income, who are living in the city center, and are using the service not on a regular basis, were able to use the incentive more than other users. This finding calls for further and more thorough investigation of personalized incentives.

# Acknowledgment

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# Annex I - Cities' mobility context

## 1. Copenhagen

## Context

Figure 1 - Rail-based infrastructure in Copenhagen metropolitan region
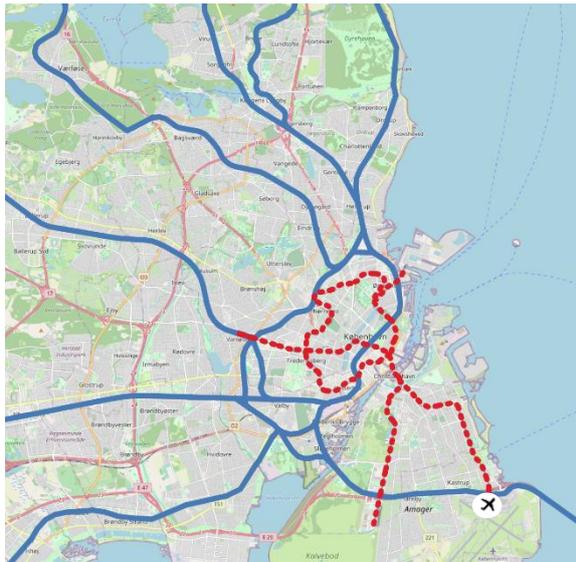
**POPULATION AND DENSITY** (Statistics Denmark 2020)

**Copenhagen + Frederikisberg:**

Pop: 736,645 habitants

Area: 98.8 km$^2$

Density: 7,455.92 hab/km$^2$

**Copenhagen metropolitan area:**

Pop: 1,846,023 habitants

Area: 2,562.80 km$^2$

Density: 720.31 hab/km$^2$

- Metro
- Train
- CPH airport

## Copenhagen mobility landscape

### Public transport

There are both buses and harbor buses in Copenhagen (CPH). It also has driverless metro trains that get you to the city center from the airport in just 20 minutes. The metropolitan area has long-distance and intercity-trains that can either be high-speed trains or regional trains.

The metro only covers central CPH and has 4 lines with a total of 41 stations. The urban-suburban rail (S-train) serves the Greater Copenhagen and has 7 lines, 85 stations and an average distance between stations of 2.0 km, shorter in the city core. There is a train line that connects CPH to Sweden (Malmö).

All public transport networks use a common system for fare zones and tickets at the national level.

## Cycling

Cycling in CPH in many cases is the easiest and fastest way to get around: 49% of the population commute by bike to work or education in CPH and 63% of school kids in CPH bike or walk to school. This is the result of many years of political and administrational focus on improving the conditions for cycling in Copenhagen. A crucial element is the comprehensive network of dedicated bicycle infrastructure with separated tracks and safe intersection design (Københavns Kommune 2020). There are 382 kilometers of cycle tracks and the traffic lights are coordinated in favor of cyclists during rush hour (Visit Copenhagen 2020).  It is possible to board the metro, train and harbor bus with bikes (you need a bike ticket, though, except for the S-trains).

## Other mobility alternatives

Shared bikes and e-bikes are available both in free-floating and station-based schemes in Copenhagen and in part of CPH metropolitan area costing 1-1.6 dkk/min; discount packages and monthly memberships are also available.

Shared electrical scooters are available in CPH costing 10dkk (starting fee) + 2-3.5dkk/min.

CPH metropolitan area has several taxi operators available: 29-39 dkk (starting fee) + 8.50-9 dkk/km + 6.25-7 dkk/min.

Uber does not operate in Denmark.

## Modal share
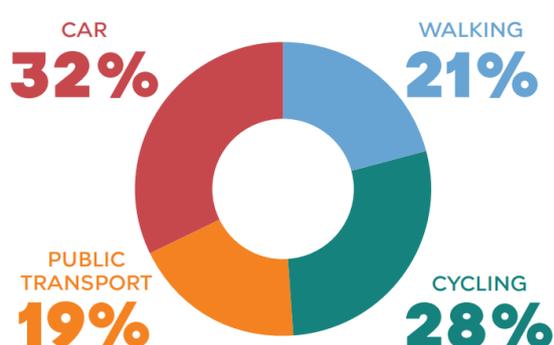


Figure 2 - Modal share of Copenhagen (considering trips to, from and in Copenhagen in 2018)

Source: (City of Copenhagen, 2019)
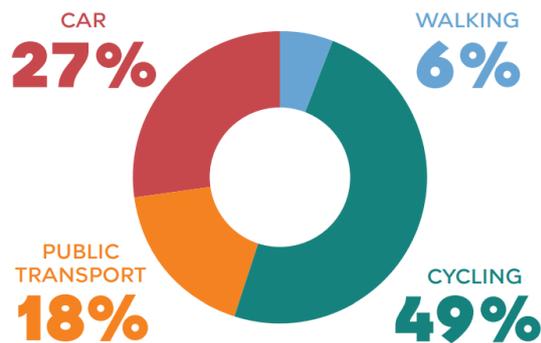
Figure 3 - Modal share of Copenhagen (considering only trips to work and education in Copenhagen in 2018)

Source: (City of Copenhagen, 2019)

Considering all trips regardless purpose, in 2018, Copenhagen's modal share reveals that 49% of all trips are made by soft modes (cycling or walking), 19% by public transport and 32% by car (City of Copenhagen, 2019). Observing only trips related to work or study, in 2018, 55% of these trips are made by soft modes, 18% by public transport and 27% by car (City of Copenhagen, 2019).

## Taxation on car ownership

When you buy a car in Denmark, you need to pay registration tax, which is 85% of the taxable value (of the car) up to DKK 185,100 and 150% of the taxable value (of the car) for those above DKK 185,100. Until the 1st of January

of 2016, electric cars were exempt from registration tax. After that by registering between 2016-2020, a person would pay 20% of the calculated vehicle registration tax. For 2021, a person pays 65% of the calculated vehicle registration tax, while in 2022, the amount to pay is 90% of the calculated vehicle registration tax, and from 2023, the amount is 100% of the calculated vehicle registration tax. Also, between 2016 and 2018, the registration tax of electrical vehicles had a further reduction of DKK 10,000 and between 2019 and 2020, this reduction was of DKK 40,000 (Skat - Danish Customs and Tax Administration 2020).

## Parking

Electric cars, hydrogen cars, and electric motorcycles can park for free at street level on public parking spaces. Parking fine = 750 dkk (~100 €).

## Multimodal journey planner app and car-sharing information

In 2018, MinRejseplan app (My travel planner app), the Danish multimodal journey planner app, started to include information about travel with all modes of public transport, combined with the private (e.g. car-sharing, bike sharing) transport services for the residents of North Denmark Region (Hvid, Sørensen, and Rasmussen 2018). This integrated information was made available in the Copenhagen region in 2019.

## Available car-sharing services and products being offered

The first organized car-sharing scheme in Denmark was established in 1997 in Odense. The year after, in 1998, Hertz car rental offered a car-sharing scheme in Copenhagen at the request of the City of Copenhagen (Københavns Kommune). Subsequently, many car-sharing schemes have been established, typically in association form. Free-floating Car-sharing (CS) was introduced in Copenhagen in September of 2014 (Car2go), followed by DriveNow (current ShareNow) in September of 2015 and by Green Mobility in January of 2016. Car2go has withdrawn from Denmark in 2016 (Københavns Kommune 2017). Selected car-sharing services available in Copenhagen metropolitan region are presented in Table 1 to give an overview of the current car-sharing system. As for dedicated parking spaces for car-sharing cars, currently, there are 192 parking spaces reserved for station-based car-sharing cars, 7% of those being destined to electric cars.

Table 1 - Car-sharing services available in CPH and its metropolitan area

| | Information on fleet | Where they operate | | Products offered | | | Pricing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CPH | Metropolitan region | Car-sharing | Ride sharing | Rental/ Leasing | Membership | Minute | Hour | Day | Km |
| Multinational car-sharing providers | | | | | | | | | | | |
| ShareNow/DriveNow (Free-floating) | Electric and petrol cars | X | X | X | | | 90 dkk (credits for use) | 2 – 4 DKK/min | 300dkk /3h  400dkk  /6h | 500dkk  /day | |
| GoMore (Peer-to-peer) | Petrol, diesel, hybrid and electric | X | X | | X | X (daily, monthly or yearly) | | | | 195-3500 dkk /day | |
| Green Mobility (Free-floating) | 400 cars (Electric) | X | X | X | | | Free | 2 – 4 DKK/min | | 595dkk/ day | |

* Payment is a combination of hours and kms

Cont Table 1 - Car-sharing services available in CPH and its metropolitan area

| | Information on fleet | Where they operate | | Products offered | | | Pricing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CPH | Metropolitan region | Car-sharing | Ride sharing | Rental/ Leasing | Membership | Minute | Hour | Day | Km |
| **Local car-sharing organisations** | | | | | | | | | | | |
| **LetsGo (Station-based)*** | 250 cars (Electric and petrol) | X | | X | | | 950dkk + 50, 270 or 490 dkk/mo | | 0-29.00 dkk | | 2.65 – 2.85 dkk (1st 100 km) then 1.35-2.85 dkk |
| **Albertslund Delebil (Station-based)*** | Petrol cars | | X | X | | | 1000dkk + 130 dkk/mo | | 15.00 dkk | | 2.15 – 2.90 dkk (1st 100 km) then 1.90-2.65 dkk |
| **Islandsbrygge Delebil (Station-based)* - around 30 members** | 4 cars | X | | X | | | 2500dkk + 200 dkk/mo | | 18.00 dkk | | 3.25 – 4.00 dkk/km |
| **Lyngby Delebiler (Station-based)* - around 70 members** | 17 cars (Petrol and diesel) | | X | X | | | 2000dkk + 200 dkk/mo | | 12.00 dkk | 228.00 dkk | 1.20 – 2.50 dkk/km |
| **Køge Delebiler (Station-based)*** (Partnership with LetsGo) | 5 cars (Petrol and hybrid cars) | | X | X | | | 1000dkk +120dkk/mo | | 20.00 dkk | 250.00 dkk | 2dkk/km |

* Payment is a combination of hours and kms

## 2. Munich

## Context

Munich is the capital of the state of Bavaria and Germany's third largest city. It is of great economic importance as a strategic hub in the south of Germany, and as a consequence, it needs to accommodate large traffic volumes. It has about 2.6 million inhabitants with about 50% living in the city area and the other 50% living in suburban districts. The city area covers approximately 310 km$^2$. Its old centre is encircled by the Altstadtring (Old City Ring Road); the wider inner city area is encircled by the Mittlerer Ring (Middle Ring Road); the city area is encircled by the Autobahnring (Motorway Ring Road) (see Figure 1).
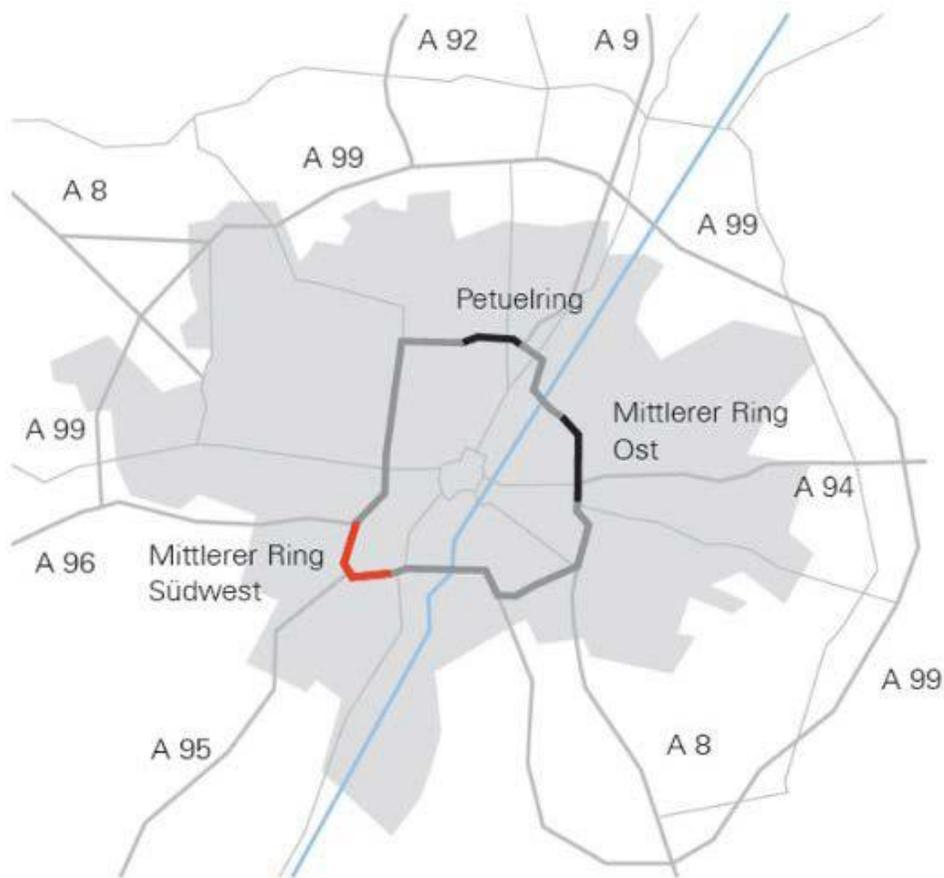
*Figure 1 - Major roads in the Munich city area: Altstadtring (inner circle), Mittlerer Ring (middle circle, dark grey) and Autobahnring (outer circle) (Source: City of Munich website, accessed 31 January 2019)*

## Munich mobility landscape

### Public Transport

Munich has an impressive public transport infrastructure that, according to the Munich Transport Company (MVG) serves around 38% of the total mobility demand in the Munich area ("Munich Transport Corporation (MVG) Sustainability Report," n.d.). At the moment, the transportation system includes trams (72 km of infrastructure), 94 bus routes (with a total of 2083 stops), and a 100km underground system (U-Bahn, 8 lines, 96 stations), and it is fully integrated with the regional light-railway (S-Bahn), which connect Munich with other satellite cities in Bavaria. According to MVG, this impressive infrastructure is used every day by more than a million people.

## Cycling

Together with Berlin, Munich is one of the German's most bike-friendly cities.  A special "Bicycle Traffic Development Plan" coordinates the inner city planning of bicycle routes with Munich's surrounding communities in order to improve the city's regional integration. The main routes radiating out from the city center are complemented by an inner and outer ring route ("Transport Development Plan" 2006). With more than 20% of mode share and a network that cover approximately 1200 km, cycling is part of the daily life in Munich. In addition, bike-sharing is extremely popular in Munich, services offered both by public operators (MVG, Deutsche Bahn) as well as private ones (Jump, Donkey Republic).



| Stadtbezirke München 2017 | Zu Fuß | Fahrrad | MIV-Fahrer | MIV-Mitfahrer | ÖV |
|---|---|---|---|---|---|
| Altstadt-Lehel | 29% | 29% | 18% | 6% | 18% |
| Ludwigsvorstadt-Isarvorstadt | 32% | 23% | 12% | 7% | 26% |
| Maxvorstadt | 28% | 30% | 12% | 7% | 23% |
| Schwabing-West | 25% | 25% | 19% | 7% | 24% |
| Au-Haidhausen | 30% | 19% | 15% | 8% | 28% |
| Sendling | 25% | 20% | 20% | 10% | 25% |
| Sendling-Westpark | 20% | 20% | 24% | 11% | 25% |
| Schwanthalerhöhe | 28% | 25% | 15% | 8% | 24% |
| Neuhausen-Nymphenburg | 26% | 20% | 24% | 8% | 21% |
| Moosach | 21% | 13% | 27% | 13% | 26% |
| Milbershofen-Am Hart | 25% | 14% | 22% | 8% | 30% |
| Schwabing-Freimann | 25% | 18% | 22% | 9% | 25% |
| Bogenhausen | 24% | 16% | 27% | 12% | 21% |
| Berg am Laim | 23% | 17% | 27% | 10% | 23% |
| Trudering-Riem | 18% | 17% | 36% | 12% | 17% |
| Ramersdorf-Perlach | 23% | 13% | 28% | 11% | 25% |
| Obergiesing-Fasangarten | 28% | 11% | 23% | 6% | 31% |
| Untergiesing-Harlaching | 25% | 23% | 17% | 9% | 26% |
| Thalkirchen-Obersendling-etc. | 23% | 15% | 24% | 12% | 27% |
| Hadern | 27% | 14% | 29% | 11% | 19% |
| Pasing-Obermenzing | 22% | 19% | 25% | 11% | 23% |
| Aubing-Lochhausen-Langwied | 24% | 7% | 37% | 11% | 21% |
| Allach-Untermenzing | 16% | 19% | 36% | 14% | 15% |
| Feldmoching-Hasenbergl | 20% | 11% | 31% | 15% | 22% |
| Laim | 21% | 13% | 24% | 7% | 35% |

*Figure 2 - Modal split in Munich according to https://www.muenchen-transparent.de/dokumente/5499206/datei*

## Taxation on car ownership

The private ownership of cars for traffic on public roads complies with the motor vehicle tax obligation (Kraftfahrzeugsteuergesetz) in Germany. The tax rates vary depending on the vehicle type and generally payable one year in advance. For cars with a first registration date until 30 June 2009, the following parameters are decisive in addition to the first registration date: engine type (petrol, diesel, wankel engine), engine displacement (in cc), and emission (according to EURO Standard). The $CO_2$-oriented taxation is applied to cars with a first registration date from 1 July 2009. In this way, cars with low $CO_2$ emissions are taxed more favorably than cars with high $CO_2$ emissions. The annual tax is made up of a basic amount based on the engine displacement of the vehicle and a $CO_2$-oriented amount.

The tax is for cars with petrol and wankel engines:

- 2.00 euros basic amount per 100 cc displacement started plus.
- 2.00 Euro $CO_2$ dependent amount per g / km.

For the first time registration until 31 December 2011, 120 g / km of the $CO_2$ value remain tax-free. For first registrations from 1 January 2012, this value is reduced to 110 g / km. With first registration from 1 January 2014 to 95 g / km.

The tax is for cars with a diesel engine:

- Basic amount of EUR 9.50 per 100 cc displacement started plus.
- 2.00 Euro $CO_2$ dependent amount per g / km.

The motor vehicle tax law provides for a temporary tax exemption for purely electric vehicles. After the tax-exempt period, pure electric vehicles are subject to weight-based taxation with the same rates used for passenger cars. However, tin support of the environment, the motor vehicle tax for electric vehicles calculated on the basis of these tax rates is reduced by 50 percent. A gradual tax rate is applied in the calculation of the annual tax for all cars, if the permissible total weight of the motor vehicle exceeds 2,000 kilograms (German customs agency).

## Other Mobility Alternatives

*Electrical scooters*: Next to the bike-sharing system and to complete them, shared electrical scooters are also available in Munich. There are currently 7 different providers active in Munich.

*Taxi and car-Hailing services:* Munich has several taxi operators available. Uber is also present in Munich. However, in Munich only professional drivers can operate as Uber drivers. There are also two on demand mobility providers, CleverShuttle and MVG IsarTiger. CleverShuttle is an eco-friendly ridepooling service that provides door to door services. MVG IsarTiger works in a similar way, but belongs to the public transport operator MVG.

## Multimodal Journey Planner App And App-Based Information

Mobility offer in Munich is not only complete but – to a certain extent – also integrated. Next to its public transport offer, MVG also provides e-scooters (TIER), bike-sharing and ride-pooling (IsarTiger). These services are integrated within one APP (MVG More) that integrates regional railway (S-Bahn), underground (U-Bahn), tram-stops, bus-stops, e-scooters, bike-sharing (electric and conventional vehicles), car-sharing (ShareNow and Stattauto) and Taxi. The app also includes the location of the charging stations available in Munich. While quite impressive, some limitations still exist. First, the app mostly includes MVG services. Car-sharing services represents perhaps the only mobility service offered by a private operator. Second, probably due to the complexity of the system, only a few private operators are included in the platform. As a consequence, other private operators created similar apps on their own. The application developed by the car-rental (and car-sharing) operator Sixt, for example, includes car-sharing, car-rental, e-scooters, and Taxi within one single app. Similarly, the application from Uber is also available car-hailing, scooters, and bike sharing under one single app. Next to the diversity of journey planner and mobility applications, it is also important to stress that most of the services integrated within MVG More still require the user to install and register to other platforms. For instance, in order to use ShareNow (car-sharing), users still need to install the proprietary application from ShareNow and to register to the service.

## Available car-sharing services and products being offered

Car-sharing is extremely popular in Munich and several operators exist. In this report, we report the seven most popular options. Car2Go, DriveNow, and SixtShare are free-floating car-sharing systems. Their characteristics are quite similar. The rental is based on the number of minutes and there is no registration fee. For longer durations – more than one hour – operators offer some discount. More information on the pricing policies is provided below. It should also be stressed that Car2Go and DriveNow merged and use a common platform called ShareNow. However, vehicles and prices are still different, as one is operated by Mercedes and the other one from BMW. Flinkster and Stattauto represent traditional, station-based services. Finally, Miles and Oply are located in the middle. While still station based, they provide more flexibility to the user, as registration is free. On the other hand, they are slightly more expensive than traditional station-based car-sharing services. Also, it should be noted that in February 2020 Oply went out of business. The reason the car-operator is still included within the list is that it was quite popular in Munich and users were very familiar with their business model. The service was offering the following types of cars: Ford Fiesta, Ford Focus, Maxda MX5 (sport car), Renault Traffic(transporter).

Table 1 - Vehicles by operator 01/2020

| Operator name | Vehicles in total | E-vehicles | ICE vehicles |
|---|---|---|---|
| Car2Go (now ShareNow) | **441** | 0 | 441 |
| DriveNow (now ShareNow) | **837** | 217 | 620 |
| SixtShare | **1048** | 93 | 955 |
| Miles | **171** | 0 | 171 |
| Oply* | **123** | 0 | 123 |
| Flinkster (DB Rent) | Currently 81, from 01.11.2019 only **14** | 0 | 81, resp. 14 |
| Stattauto | **410** | 3 | 407 |
| Total | **3111** | 313 | 2798 |

Source: Department of Public Order – KVR

Table 2 - Pricing

| Pricing (€) | | | | | |
|---|---|---|---|---|---|
| Operator name | Membership | Minute | Hour | Day | Km |
| Car2Go (now ShareNow) | | 0.19-0.31 | 13-18 x 2/hours | 49-79 | 0.19 €/Km after 200 km |
| DriveNow (now ShareNow) | | 0.31 € | 16-18 x 2/hours | 59-69 | 0.19 €/Km after 200 km |
| SixtShare | | 0.21-0.23 | | 76-98 | |
| Miles | | | 35 x 6h | 59 | 0,89 /Km |
| Oply* (Examotive) | | | 6-9 | 35-45 €/Hour | 0,25 €/Km after 200 km |
| Flinkster (DB Rent) | 9 | 1,5-1,90 | | 33-48 | 0,25 €/Km |
| Stattauto** | 40 € + 500 € Deposit | | 2,30-4 | 23-40 | 0,18-0,39 €/Km after 100 km |

* Terminated , ** Also offers for weekend (46-80 €/we) and week (115-200 €/week).

Table 3 - Coverage of different car-sharing services (12/2018)

| Operator name (plus additional coverage within walking distance) | Residents as per 31.12.2017 | Area in km² | % of residents reached | % in area covered |
|---|---|---|---|---|
| **City of Munich** | **1.560.531** | **310,7** | **-** | **-** |
| Business area Car2Go | 860.704 | 89,4 | 55% | 29% |
| Within 400 m linear distance to business area Car2Go | 152.675 | 29,6 | 10% | 10% |
| Business area DriveNow | 869.119 | 91,4 | 56% | 29% |
| Within 400 m linear distance to business area DriveNow | 152.124 | 33,5 | 10% | 11% |
| Business area Oply | 461.551 | 26,7 | 30% | 9% |
| Within 400 m linear distance to business area Oply | 679.724 | 33,6 | 15% | 11% |
| Business area Flinkster | 362.383 | 22,5 | 23% | 7% |
| Within 400 m linear distance to business area Flinkster | 118.423 | 16,2 | 8% | 5% |
| Stattauto with 400 m radius | 490.023 | 44,4 | 31% | 14% |
| Business areas of all 4 operators plus 400m radius for StattAuto (station-based provider) | 1.025.704 | 115,4 | 66% | 37% |
| **Business areas of all 5 operators incl 400 m linear walking distance** | **1.130.049** | **140,3** | **72%** | **45%** |

Note: The business area of Sixt Share covers around 80km² and largely corresponds to ShareNow. Oply has developed additional areas in 2019 but ceased operation in March 2020.
Database: business areas of operators as per end of 2018; own calculations by LHM based on own datasets

# 3. Tel Aviv

## Context

Tel Aviv Metro Area Population and Density (2018)
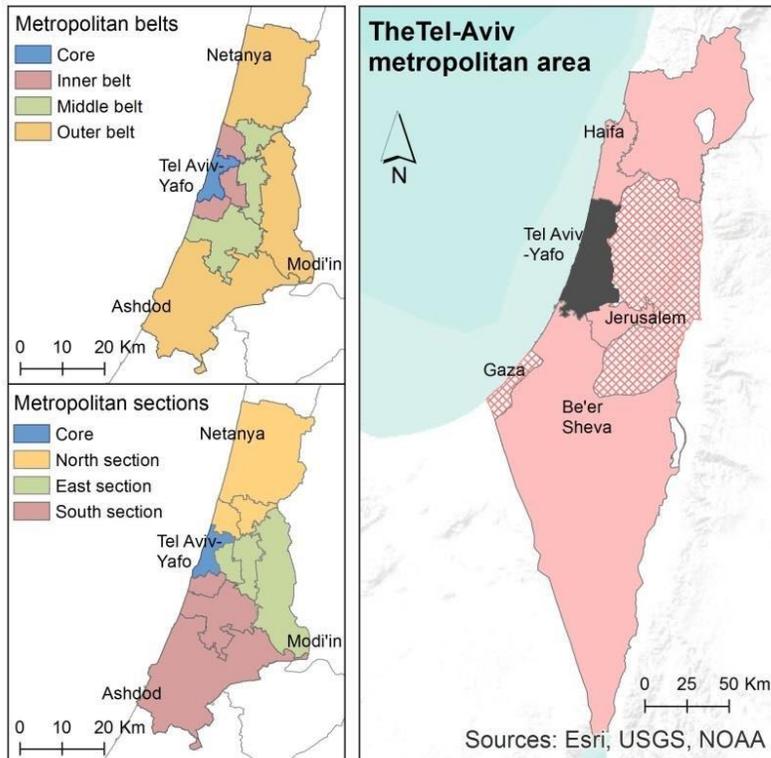


Tel Aviv-Yafo has a population of over 450,000 people and is the second largest city in Israel. The city is the core of the largest metropolitan area in Israel with a population of about 4,000,000 inhabitants. A built area, relatively dense, extends around the city and covers the metropolitan Inner and Middle Rings, has a population of about 2.6 million inhabitants. Most of the city is up to 6 km from the city-center while a range of about 10 Km also covers most of Inner Ring cities, and a range of 20 km covers most of the Middle Ring cities.

Figure 1 - The Roles of Increasing Inequality and Divergent Urban Development in Understanding Spatial Polarization in Tel-Aviv.

*Source (map): Modai-Snir, Tal & van Ham, Maarten. (2017).*

Table 1 - Tel Aviv Metro Area Population, Annual Growth and Density

| | Localities (#) | Total Population (thousands) | Annual Growth (%) | Population Density (per sq. km) |
|---|---|---|---|---|
| Tel Aviv-Yafo (Core) | 1 | 451.5 | 1.7 | 8,718.6 |
| Inner Ring | 13 | 975.6 | 1.4 | 8,097.0 |
| Middle Ring | 31 | 1,219.8 | 1.6 | 4,157.4 |
| Outer Ring | 258 | 1,338.0 | 2.0 | 1,052.9 |
| Total | **303** | **3,984.9** | **1.7** | **2,361.4** |

Source: Israel Bureau of Statistics (2019) localities, population and Density per sq. km by Metropolitan Area and Selected Localities.

## Transportation, Public Transport and other Shared Mobility Services in Tel Aviv-Yafo

### Overview

According to latest metropolitan travel habits survey, which was carried just before electric micro mobility became a trend, it is estimated that 46% of the trips in Tel Aviv Yafo are done by private cars (10% out of the 46% are done by passengers), 30% are of pedestrians, 10% are done by public transport, 7% by bicycles, and 3% by motorcycles.

The Tel Aviv Metro area and the City of Tel Aviv-Yafo are the hub of Israel transport network. Most of the major routes of the national road network, as for now all inter-metropolitan rail lines, and the International Airport are either centered in the city or are around the city.

According to the Israel Central Bureau of Statistics, in 2017, residents living in Tel Aviv owned over 232,000 private cars, which means every second resident of Tel Aviv-Yafo is owning a car. Taxation on most of the cars imported to Israel (no local manufacturing) reaches 83%. Hybrid cars are currently taxed at 30%, a policy that is on the process of termination. Gas in Israel is heavily taxed as well – about 65% of its value.

### Israel rail

Israel rail implemented a multi-billion development plan in the last two decades. A major objective of this plan (that is still undergoing and extended to the year 2040) is to connect Israel periphery to the center. However, most of the implementation was focused in the Tel Aviv Metro area. As a result, the four Tel Aviv Yafo's train stations are the busiest in the country, with over 120,000 passengers a day.

### Light rail

In August 2015, the construction of the first light rail line - the red line – began. The red line connects five cities: Petah Tikva, Bnei Brak, Ramat Gan, Tel Aviv-Yafo and Bat Yam. The line is scheduled to begin operation by the end of 2021. In December 2018, the construction of the Purple Line began, while the construction of the green line began in January 2020. These two lines are expected to start operating in 2026-2027.

## Bubble dan

An on-demand van-service in Tel Aviv-Yafo and the surrounding cities of Ramat Gan and Givatayim. A partnership of Via Transportation Inc. and Dan Transportation public transit operator. The service began as a pilot in April 2019, operates 100 vehicles, and is financially supported by Israel Ministry of Transport.

## Cycling

According to latest metropolitan travel habits survey, it is estimated that there are about 137,000 bicycle trips in Tel Aviv-Yafo a day. About 90% of all bicycle trips are done by residents of the city. According to the survey, bicycle trips account for about 11% of trips.

Tel-O-Fun – Tel-O-Fun is a municipal bicycle rental service (schedule to terminate in summer 2020). The service is available to residents, visitors and tourists, and operates 24 hours a day. Throughout the city there are about 200 active stations, providing around 2,200 bicycles.

### *E-bikes and e-scooters*

The use of various electric micro mobility vehicles (mostly E-Bikes and E-Scooters) has evolved tremendously in recent years. E-Bikes are extremely popular, and it is estimated that more than 50% of the 300,000 Electric Bike users in Israel are living in the Tel Aviv Metro area. E-Scooters usage in Tel Aviv-Yafo has increased in an exponential level in the last two years as a result of introducing E-Scooters sharing services by 4 private providers It is estimated that in total theses providers provide 8,000 vehicles, that are being used for 1,300,000 trips a month. E-bikes and e-scooters are 2/3 of all rides in TLV.

## Car-sharing Providers and Services in the Tel Aviv Yafo Metro Area

*AutoTel* is a joint Car-sharing venture initiated by the Tel Aviv-Yafo Municipality and the Tel Aviv-Yafo Economic Development Authority Ltd. For the establishment, operation and service delivery, the Tel Aviv-Yafo Economic Development Authority Ltd. is collaborating with Car2Go, a Car-sharing provider (see below). Launched in October 2017, AutoTel operates 260 Hyundai i10 vehicles and has 520 dedicated parking spaces across the city, allowing subscribers to pick up a vehicle from one point in the city and return it at another point. The AutoTel vehicles can be parked in one of the 520 designated parking spaces or in any regulated, "blue and white", parking space in the city. For such, the operational model is a combination of the A2B and the free-floating model. The service is provided only within the municipal area of Tel Aviv-Yafo, while users can make trips beyond this area. The main components of the service cost consist of monthly subscription fees (10 or 40 NIS in 2 tracks) and travel costs per minute (1.7 0r 1.2 NIS). Higher rates are charged outside the municipal area. Business tracks are also available.

*Car2Go* ("Car to Go") is a Car-sharing company founded in Israel in 2008. Car2Go offers Car-sharing services for private and business use. Within the Tel Aviv metro area, the service is currently provided in 5 cities of the inner ring – Tel Aviv-Yafo, Ramat Gan, Givatayim, Herzeliya, and Raanana; and is planned to expend to additional cities. In the Tel Aviv metro area Car2Go operates a fleet of around 300 vehicles under the A2A

operational model. The main components of the service cost (for private subscribers) consist of monthly subscription fees (20-50 NIS in 2 tracks), an hourly fee (17-50 NIS) up to the sum of a daily rate (160-500 NIS), and travel costs per KM (1-2 NIS). Several types of cars are offered, including small, family, small trucks and "prestige" vehicles.  Weekend supplement fees apply.

Table 2 - Car-sharing *services available in Tel Aviv and its metropolitan area*

| | Types of cars | Where? | | Products | | | How much to pay? | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TLV | Metro region | Car-sharing | Ride sharing | Rental/ Leasing | Membership | Minute | Hour | Day | Km |
| *Municipal provider* | | | | | | | | | | | |
| *AutoTel* | 260 Petrol cars | X | | X | | | 10-40 NIS (Monthly fee) | 1.2-1.7 NIS | - | - | - |
| *Local car-sharing organisations* | | | | | | | | | | | |
| *Car2Go* | ~300 Petrol Cars | X | X | X | | | Private account 20-50 NIS | - | 17-50 NIS | 160-500 NIS* | 1-2 NIS* |
| | | | | | | | Company account 50-190 NIS | | 13-46 NIS | 117-460 NIS | 1.7 NIS |