Annex 4
Multimodal digital mobility services in passenger road transport

A-S-I: shift. Promote a modal shift to public transport by simplifying access to services and trip planning.

Context: urban, extra-urban passenger transport

Time frame: short to medium term. Digital technologies to better integrate public transport modes and improve accessibility to information on and ticketing of public transport are already available and are likely to improve and spread in the future.

A4.1 Definition

Multimodal digital mobility services (MDMS) can be defined as 'systems providing information about, inter alia, the location of transport facilities, schedules, availability and fares, of more than one transport provider, with or without facilities to make reservations, payments or issue tickets' (EC, 2021u). This definition is similar to that of mobility-as-a-service (MaaS), given by given by Heikkilä (2014) and Smith and Hensher (2020). Most of the considerations about MaaS hold for MDMS. With time, however, the former term has assumed more than one meaning, identifying either a specific service, the different actors providing such services or its effects on the system (e.g. an induced modal shift). Currently, an unambiguous definition is lacking in the scientific domain (Smith, and Hensher, 2020). In the following, for these reasons and to be consistent with the Commission legislative initiative currently being prepared (EC, 2022p), we will use the term MDMS.

Generally speaking, MDMS aim to facilitate the realisation of multimodal journeys, helping passengers and/or other intermediaries to compare different travel options, choices and prices, and to ease the sale and resale of mobility products from different operators, whether they are private or public or within one or across multiple modes. This is normally achieved through a single digital interface or platform (e.g. a smartphone application or a website). In this sense, MDMS are not the sum of different transport services but rather a unified and simplified way to access them (Smith, and Hensher, 2020). Importantly, MDMS per se will not create a service if there is none available. MDMS can potentially operate at different geographical scales and for all different passenger transport modes. This means, for example, road, rail, water and air transport at urban, interurban and rural scales. In addition, they can offer various types of payment options ranging from customisable subscription packages to pay-per-use options (Smith, and Hensher, 2020). In addition, the level of integration of MDMS can differ. The KOMPIS project (Smith, and Hensher, 2020; KOMPIS, 2020), involving the Swedish Government's collaboration group for next generation travel and transport, Drive Sweden and Vinnova, categorises these services according to the following progressively higher levels of integration and types of offer:

- Level 0: mobility services operate separately; there is no integration between the services.
- Level 1: informational services are available, for example on possible routes like web mapping services.
- Level 2: integrated booking and payment is available; users can pay for different services via a platform.
- Level 3: individual mobility services are bundled by a third party.
- Level 4: the mobility system fulfils societal goals, for example by incentivising individual users to choose more sustainable modes of transport.

MDMS are enabled by different digital technologies, also presented in Chapter 3, such as the internet, broadband connectivity, smartphones, cloud computing, big data and integration of information technology (IT) systems.

A4.2 Context

Chapter 2 showed how privately owned vehicles remain dominant in the passenger transport system, not only outside the cities but also in urban areas. These are particularly affected by the externalities caused by individual motorised transport modes, as discussed in more detail in Factsheet 7 and Annex 7. In this context, a modal shift to more sustainable and collective transport modes such as buses or trains has been often mentioned as a necessary measure (EEA, 2019a) to achieve the ambitious policy objectives identified in the European Green Deal. However, recent data show that this is currently not happening, with the share of travel by buses and passenger trains in the total transport demand steadily decreasing over the past 20 years, as shown in Chapter 2 and in EEA (2023).

Among the different connected factors that can explain this trend, it is worth considering the greater accessibility (real or perceived) of privately owned cars in comparison with public transport services, even in urban areas where such services are well developed (Becker et al., 2020; Storme, et al., 2020). This is even more relevant in rural areas, as shown in Aapaoja et al. (2017) and Eckhardt et al. (2018). Indeed, planning and buying tickets for multimodal journeys using public transport is often a challenge for travellers in the EU. MDMS can improve this by helping both passengers and/or other intermediaries to compare different travel options, choices and prices. In addition, they can facilitate the sale and resale of mobility products from different operators, whether they are private or public or within one mode or across modes. In this sense, MDMS can promote a modal shift to public transport by increasing its attractiveness and accessibility for the end users, especially in rural areas, without offering an additional means of transport. Indeed, the ITS4C workshop cites a Creafutur study stating that 'MDMS can help to solve the crucial last mile problem to make public transport attractive, but therefore, an offer of flexible last mile transport needs to be offered' (ITS4C Congress, 2019). Apart from making public transport more attractive, MDMS, especially when coupled with other measures aiming to discourage the use of individual cars (Factsheet 7), may contribute to reducing greenhouse gas and air pollutant emissions, traffic congestion, the need for parking spaces and the number of fatalities (Smith, and Hensher, 2020).

Despite these potential benefits, MDMS trials are still very limited and, as a consequence, there is a scarcity of experimental evidence in the scientific literature (Smith, and Hensher, 2020). This contributes to considerable uncertainty about the potential societal or environmental benefits that such services can actually deliver. For example, it is currently largely unknown how the different MDMS business models will affect mobility and the environment. According to Smith et al. (2018), the development of MDMS will require the introduction of two new roles in the transport system: MDMS integrators and MDMS operators. The former will gather the offers available from different transport providers and make them available to the operators (also providing technical integration), while the latter will package the offers and deliver them to the final users. Three different general scenarios for the future development of MDMS can be envisaged (Smith et al., 2018):

1. Market driven development. In this situation the MDMS are provided by private entities at both the integrator and operator levels. This scenario will require a viable business case for the private player, while the role of public transport providers will remain essentially unchanged, with only the additional requirement to allow third-party ticket reselling.

2. Public-controlled development. In this case MDMS are aggregated and operated by a public entity. This scenario is motivated by the fact that public and private actors can have mutually conflicting interests. This is particularly relevant if the main goal of MDMS would be to realise societal or environmental benefits. To achieve this, public transport must remain a backbone of MDMS as the main viable and sustainable alternative to extensive individual car use.

3. Public-private development. In this scenario the role of the MDMS integrator is assumed by the (public) transport service provider, while the role of operators is taken by private companies. It has been argued that this could lower the initial investment costs for MDMS operators, facilitating the integration process. In addition, by acting as a buffer between MDMS operators and transport service providers, the publicly controlled MDMS integrator could mitigate the risk of any of the MDMS operator becoming too dominant.

Depending on the development models that will be followed and the pricing schemes that will be proposed, specific MDMS could end up having different priorities and objectives not necessarily in line with the environmental goals highlighted at the beginning of this section. It is unclear whether a purely market-driven approach could be compatible with the sustainable transition sought. Indeed, profits are normally not the main focus of a well-developed and fair public transport system. At the moment, there is no evidence that MDMS alone will be able to shift the existing paradigm of incremental change to one of fundamental transformation of our transport system, critical for reaching the EU sustainability goals (EEA, 2019a).

A4.3 Time frame

Multimodal digital mobility services are based on digital technologies that are already widely available, as discussed in detail in Chapter 3. Indeed, some examples of MDMS are already available such, as Jelbi in Berlin, described in more detail in case study 4.1 (Section A4.7), Citymapper in London or Whim in Helsinki, which started operations in 2017. All allow the use of several public transport services provided by different operators with a single subscription. Although the digital technologies for a successful large-scale introduction of MDMS are already available, some barriers may still be present in specific contexts. In particular, the development of and the acceptance among the different players of standardised communication protocols, open APIs (application programming interfaces) and the use of interoperable formats for data exchange are seen as a key step to enabling MDMS (Smith, and Hensher, 2020; Polydoropoulou et al., 2020). In general, big data and algorithms will play a significant role in MDMS. This must be properly accounted for by regulatory entities. The remaining technological barriers are often minor compared to the relational one between different parties (Rudzinski and Van Schijndel, 2022). The more mobility providing parties participating in MDMS, the more added value MDMS can provide. Indeed, the greater the participation, the more services and combinations of them can be provided and the more attractive the offer can be. However, the parties involved can anticipate the risks of participating in MDMS such as losing their position in the mobility market or being overtaken by a bigger player. Building trust between parties (and among users) is crucial. The large investment needed to build the platforms and integrate the data are another barrier for the development of MDMS (Rudzinski et al., 2022).

From a policy perspective, MDMS are currently under discussion at different levels. First, the revision of the Intelligent Transport Systems (ITS) Directive (EC 2021v) envisages a streamlined recording and reporting of data (see Chapter 4). Its revision will support multimodal ticketing. A dedicated regulation on MDMS is in preparation. Its objective is to create optimal conditions for the creation of MDMS, implementing action 37 of the smart mobility strategy. Its main drivers are (1) to address the opaque conditions for combining and reselling mobility products in land-based, waterborne and maritime transport; (2) the difficulty of ensuring that incumbent MDMS do not adopt anti-competition practices or that deployment of MDMS is not limited by anti-competition practices; and (3) the difficulty of ensuring that MDMS support sustainability. The revised directive is indicatively planned for Q2 2023 (EC, 2021o; European Parliament, 2022c).

Policy can promote the future development of MDMS through a series of initiatives. Particularly relevant is the obligation for transport service providers to allow third-party resale of their tickets, as for example in the new Finnish transport regulation for single journey tickets (Smith, and Hensher, 2020). Similarly, Denmark has decided to release public transport data and tickets for third-party resale (Qvartz, 2018; Smith, and Hensher, 2020). In the framework of the MaaS4EU project, a review of existing policies and whether these act as enablers of or barriers to the development of such services has been undertaken. In particular, it is worth mentioning that, in the context of the EU passenger rights regulation (EU, 2004; Brunagel et al., 2019; European Parliament, 2022d), multimodal trips are still not covered. Additionally, the roles and responsibilities of MDMS actors are not yet clearly defined. For example, it is not clear if and how a multimodal trip purchased through an MDMS operator will be reimbursed if the final user misses a plane due to a train delay or vice versa.

Several research projects in the MDMS domain are ongoing or have been financed recently. An example is the above-mentioned EU-funded project MaaS4EU, which aimed to provide 'quantifiable evidence, frameworks and tools, to remove the barriers and enable a cooperative and interconnected EU single transport market for the mobility as a service (Maas) concept, by addressing challenges at four levels: business, end-users, technology and policy' (MaaS4EU Consortium, 2020). Similarly, in Sweden, KOMPIS, a collaboration programme to support the development of combined mobility by reducing initial barriers and creating favourable conditions, has been realised. The feasibility of MDMS has also been explored in pilot projects such as SMILE in Austria (Audouin, 2019) and in multiple other trials both in Europe and worldwide, as reviewed by Kamargianni (2016).

Despite the favourable technical conditions and the ongoing legislative initiatives, barriers still exist in the collection, interoperability and sharing of data among the established transport operators and MDMS actors. As explained above, the reasons for this are not necessarily technological but often relational or economic. Moreover, such systems will have to demonstrate their scalability across different transport modes and geographical areas and for a large number of users.

A4.4 Environmental impacts

To estimate the environmental benefits of MDMS, is important to evaluate the impact of MDMS on modal choices such as reducing personal car use in favour of public transport or other mobility services, such as shared and pooled transport. Similarly, it is relevant to understand how pedestrians and cyclists will be influenced. The literature provides some evidence, although it is not sufficient to draw clear conclusions. The indications reported here therefore need to be considered preliminary and treated with caution.

Using the taxonomy set out in Chapter 3 the following higher order environmental impacts of MDMS can be identified.

A4.4.1 Indirect impacts — substitution effects

MDMS are likely to have environmental impacts, as they will offer new combinations of existing modal alternatives to satisfy mobility needs. Depending on the modal choices these new combinations will replace, the overall result could be either positive or negative for the environment.

In general, studies show that the shift from active modes to public transport is easier than from individual car use to public transport (EEA, 2020b). To reduce car use, measures that discourage it are necessary, such as internalising its external costs. A study performed for the city of Zurich simulated the impacts of the introduction of MDMS, including different transport modes such as cars, public transport, free-floating car-sharing and ride-hailing services, personal bikes, free-floating bike-sharing services and walking. The results indicate that the presence of large car-sharing and bike-sharing fleets can decrease the overall energy consumption of the simulated system by up to 7% by attracting users from other modes. However, the most relevant reduction is achieved when the total cost of private cars is charged in the model simulations instead of considering the cost of car use only (see also Factsheet 7 and Annex 7). This reduces transport-related energy consumption by approximately 25% (for trips within the service area). In addition, the study indicates that the only shared mode that has a negative impact on energy consumption is ride-hailing, because it tends to compete with public transport and active modes. Interestingly, on a system level, the benefits in other domains such as travel time savings or the generalised costs of the system were marginal (Becker et al., 2020).

Storme et al.(2020) question the potential of MDMS to significantly substitute for the use of private cars in urban areas. In their pilot project in Ghent, Belgium, none of the alternatives was close to completely substituting for the use of private cars, especially for leisure trips. However, car use in commuting trips was significantly reduced, although the sample used in the study mostly consisted of highly educated and motivated employees of Ghent University.

A study on Whim in Helsinki shows that MDMS users travel more frequently by public transport and shared modes than other city inhabitants. It is, however, unclear how the mobility behaviour of Whim users was influenced by Whim compared to the situation before Whim existed (Ramboll, 2019).

The MDMS pilot Ubigo was carried out in Gothenburg. The study shows that the participants in the trial already used public transport and bicycles more and car less than the average Gothenburg resident. The results were similar to the findings in Helsinki. After the trial participants stated that they travelled more by public transport and bicycle and less by private car than before. Private car use among the participants decreased by 50% and their perception of the other modes became more positive (Sochor, et al., 2014). See also case study 4.2 (Section A4.8).

It is still unclear whether car drivers will adapt their behaviour. Alyavina et al. (2020) state that this could be difficult, and there is the risk that future MDMS users could substitute public transport trips with car trips and ride-sharing services. Another challenge is the digital divide. A Belgian report from the King Baudouin Foundation finds that 46% of Belgians are digitally vulnerable. This is also true for 45% of youngsters with a low education level (Faure, et al., 2022). A general discussion of this is also available in Chapter 6.

Trials of MDMS and surveys of users suggest that the typical early adopter is likely to be young, live in a dense urban area, have high digital competence, tend to travel multimodally already and have relatively high levels of public transport use (ITF, 2021). To maximise the impact of MDMS it is important that those services can be easily accessed by a wider variety of final users.

It is difficult to draw a conclusion on the impact of MDMS on modal choice based on the above studies. Although they seem to suggest that such services could reduce car use, especially for digitally skilled young people who are open to alternatives, it is complex to assess the exact quantitative impact and how MDMS will influence the modal choices of other societal groups.

MDMS are likely to be used more where the offer of existing mobility solutions is dense and they meet the users' mobility needs. This holds especially for occasional short trips and, in particular, when two or more transfers between modes are necessary. Indeed, in the case of several mobility solutions, users may not be aware of all the different possibilities and make a choice ignoring a potentially interesting non-car solution. In the case of longer or frequent trips, it is more likely that users will try to optimise their transport solution, even without using MDMS, in this way partially offsetting the benefits of MDMS. However, the transport system is dynamic and optimal solutions may change over time depending on, for example, congestion levels. Moreover, final users are often unaware of the external costs of their modal choices, as described in Factsheet 7 and Annex 7. Both dimensions can be accounted for in MDMS, which has the potential to make such externalities transparent to individual users and nudge their individual choices towards more sustainable transport modes.

Regular urban trips, such as commuting for work and education, count for between 30% (Germany) and 50% (Croatia) of urban trips (Eurostat, 2021e). In addition, half of personal business, leisure, accompanying and shopping trips are regular trips. Irregular trips, for which MDMS could have most impact, account for 25-45% of urban trips (Eurostat, 2021e). As urban mobility accounts for 40% of CO_2 emissions from road transport (Cepeliauskaite, et al., 2021), MDMS could potentially influence between 10% and 20% of the emissions. A 1% or 2% reduction in car use could thus reduce the emissions of the road transport sector by 0.1-0.2%.

As discussed, the main feature of MDMS is to facilitate access to the transport system, without creating additional services if those are not available. For example, if there are no mobility options apart from the private car, MDMS will not be able to provide an alternative apart from a carpooling solution. However, such solutions are not very popular, except for longer distances with apps such as BlaBlaCar. The environmental gains are limited: CO_2 emission reductions are estimated at only 12% as a trip with BlaBlaCar often replaces a train journey or is a new journey (Mayeres, et al., 2018).

It is also the case that the way in which the MDMS scheme is developed will influence its environmental impacts and attractiveness. As described in Section A4.2, MDMS could be developed according to various general schemes that are likely to influence the final objectives and environmental benefits of such services. Similarly, the proposed pricing structures will differ, which will affect the overall system. It has been argued that modal choices are often based on actual costs of use rather than on overall figures that also account for sunk costs (Becker, et al., 2020) (e.g. in the case of a private car the purchase price, insurance, etc.) or, even better, the externalities generated. This topic will be extensively explored in Factsheet 7 and Annex 7, but it is also relevant for MDMS. Indeed, Hörcher and Graham (2020) show that flat rate subscriptions can generate market distortions because they do not include the marginal costs of use. This induces overconsumption by owners of a subscription passes and a modal shift to private cars by infrequent travellers, due to the increased congestion of the system and the higher access costs. In contrast, non-linear pricing is found to be less harmful from a social welfare perspective, allowing revenue generation at the same time.

A4.4.2 Structural and behavioural effects — direct rebound effects

By freeing up personal resources or by making the available transport modes more attractive, MDMS will also lead to new trips if no additional measure to contain the demand is in place (Ringenson, and Kramers, 2022). Although new trips respond to a need and therefore have a societal benefit, from an environmental point of view new trips have a negative impact. If travellers are not confronted with the full external costs of their travel, the societal costs of their trips can be higher than the societal benefits, as is widely discussed in Factsheet 7 and Annex 7. Active mode trips nearly always have a positive impact thanks to their positive health impact.

A4.4.3 Structural and behavioural effects — indirect rebound effects

MDMS could promote a modal shift to collective transport modes by making access to public transport easier and more attractive. This could also lead to a decrease in traffic in congested areas because of a reduction in traffic volumes. This will have a positive impact on public transport in the short and mid-term (Honey-Roses et al., 2020). At the same time, however, the reduction in congestion will attract new traffic. It is therefore important that such rebound effects are properly controlled using, for example, the tools described in Factsheet 7 and Annex 7.

MDMS could have impacts on location patterns and urban structures in the long term. Areas around public transport hubs will develop more and/or certain transport or mobility lines will develop more. An efficient and attractive public transport system could promote relocation outside the city centre, promoting urban sprawl (Ringenson et al., 2022). Copenhagen is a well-known example of transit-oriented growth since 1947 with its 'Finger plan' (Knowles, 2012).

A4.5 Policy corner

MDMS are an important tool that can contribute to promoting modal shift to collective transport modes and public transport. However, it is important to stress that MDMS alone will not provide the structural changes in our transport system that will make it sustainable. MDMS improve access to the urban and potentially peri-urban transport system, mostly for the digitally literate. Investment in the physical infrastructure for active transport modes, investment in public transport services, a pricing system internalising external costs for all transport modes, including private cars, and a strategy for digital inclusion are fundamental building blocks in the transition to a sustainable transport system. MDMS will make that transport system more accessible. It is also fundamental for scaling up and developing MDMS that dynamic and static data (also real-time) from transport providers are made accessible and comply with harmonised standards.

To fully harvest the potential environmental benefits of MDMS, developing a global transport system framework will thus be necessary, with the following characteristics:

- Active modes and public transport are the backbones of the transport system (and MDMS). Both must be supported by public engagement. Public transport should offer high-quality and accessible services. Active modes should be able to rely on high-quality and safe infrastructure.
- Active modes, electrically assisted for longer distances, are encouraged as a flexible and healthy mode on their own or as a first and last mile option in combination with public transport. A shift away from active modes to public transport, private car or other MDMS is avoided.
- Transport pricing schemes, such as those described in Factsheet 7 and Annex 7, that can fully internalise transport externalities are a third building block of sustainable transport systems. MDMS can make the application of pricing policies for the services they provide easier and approach optimal economic marginal cost pricing (ITF, 2015).
- The transport system framework is developed in dialogue with traditional urban planning (Creutzig et al., 2019). This also applies to MDMS and other digitalised services.
- MDMS complete the transport system framework. Digital platforms provide seamless integration of all mobility services and service providers. The framework also ensures, again through government involvement, that suboptimal

monopolistic situations are avoided, as digitalisation can facilitate their occurrence (Vij, and Dühr, 2022).

- The transport system guarantees access to digitally illiterate people via (digital) inclusion strategies or strategies that guarantee access to the transport system in another way.

A4.6 Bottom line

It is hard to draw clear conclusions on the potential environmental impacts of MDMS. One reason for the difficulty of making a thorough assessment is that fully integrated MDMS are still rather rare, and the integration of the ticketing and services from different providers is often difficult.

A number of the above-mentioned studies and communications state that MDMS have the potential to be environmentally beneficial. To fully harvest that potential, it is important that MDMS comes at the top of an integrated transport system with the following characteristics:

- Active modes and public transport are the backbone of the system.
- Transport pricing schemes are in place to internalise external costs.
- The system is coherent with traditional planning.
- It pays attention to (digital) inclusion.

In isolation, MDMS will hardly be sufficient to realise important environmental benefits.

A4.7 Case study 4.1: Jelbi, Berlin

This case study describes the Jelbi system in Berlin and the impacts the COVID-19 had on it. Research on the impacts on modal share is still ongoing. Therefore, case study 4.2 also provides some information from user groups in a pilot study in Gothenburg, which give an idea of the mobility impacts.

Jelbi is an integrated system of mobility services. Where previously different mobility solutions existed separately, each with a different app, with Jelbi all kinds of mobility solutions are integrated into one app. This means that all public transport, bus and local trains but also several services for car sharing, bike sharing, sharing e-mopeds, e-scooters and taxis and ride sharing are part of it (Cepeliauskaite et al., 2021). The service started in June 2019 as a limited pilot project. By October 2021, 250,000 people had already downloaded the app in a city of 3.5 million inhabitants. The project also envisaged creating 72 Jelbi stations or hubs by the end of 2021, where different mobility solutions would be brought together to make easy transfers between mobility solutions possible.

A study investigating Jelbi's impact on modal shares is ongoing, but results are not yet available. However, the results of a study on the impact of COVID are available. They show that the use of public transport fell dramatically (by 80%) during COVID, while the use of other sharing services grew modestly (by 6%). Before the crisis, public transport made up 80% of Jelbi use, whereas during the crisis it fell to 20% of Jelbi use, while other sharing services moved in the opposite way. Once normal life was re-established, the use of public transport grew more rapidly among Jelbi users than among traditional public transport users. The study therefore concludes that integrating different mobility solutions keeps users closer to public transport (Mobility Institute Berlin and Jelbi, 2020).

A4.8 Case study 4.1: UbiGo pilot, Gothenburg

UbiGo is an example of an MDMS provider developed and tested for 6 months (November 2013 to April 2014) in the framework of the Go:Smart project in Gothenburg, Sweden (Sochor et al., 2015, 2016). UbiGo was developed for urban households that already have access to existing transport modes, such as public transport and car sharing, and with mobility needs sufficiently large for the service to be competitive with their already available solution. In the testing phase, 195 participants tried the new service through 83 customer subscriptions (173 adults and 22 individuals under 18 years of age at the start of the trial). The base UbiGo subscription was set at approximately EUR 135 per month at the time of the trial, although users were able to purchase additional services. Indeed, the average subscription expenditure was approximately 150% of this value.

The sample tested was young (38 years old on average) and digitally skilled: more than 88% used the internet and applications on computers, tablets and smartphones on a daily basis. In the questionnaire before the start of the trial, approximately 54% of the sample interviewed stated that they did not own a car, although in case of need 42% of this group could borrow one. Interestingly, the vast majority were neither car-sharing (69%) nor bike-sharing scheme members (81%). Most of the participants owned a bicycle (81%) and had a public transport card (88%).

The preliminary results obtained through the pilot suggest that the participants were able to reduce the use of private car by 50% while increasing their use of other modes such as car sharing by 200%, express buses by 100% and conventional buses by 35%. Train use increased by 20% and tram use by 5%. Among the active modes there was a slight decrease in walking (by 5%) but a significant increase in the use of private bikes (by 35%). The fact that during the project the participants purchased approximately 30% more car hours than the amount that they actually used, indicating that the perception of mobility needs is a relevant variable to take into account, is important. It is interesting to note that not only the use of but also the attitude towards the various travel modes changed during the trial, with participants becoming less positive about the private car (23%) and more positive about other modes (e.g. car sharing 61%; bus or tram 52%; bike sharing 42%). Although these results are not straightforward to quantify in terms of environmental benefits, they suggest that, when properly implemented, MDMS have the potential to contribute to mitigating the impacts of the transport sector on the environment.

It is worth noting that, from the interviews held during and after the trial, users believed that their accessibility to and the flexibility they have in using the transport system increased following the introduction of the MDMS.

The authors underline the importance of MDMS targeting a specific segment of users and the necessity of developing services in line with the demand and the expectations of the chosen group. In this context, the importance of adequate packaging, simplicity, improved access, flexibility and economy is essential to promote a behavioural shift in users and should not be underestimated.

Another relevant aspect to take into account in the design of MDMS is the complex interaction between public and private actors. For example, the authors argued that car sharing and car rentals are profitable for the MDMS providers, but that extensive use of such modes will clash with the objective of reducing car use, which is relevant for the public stakeholders.