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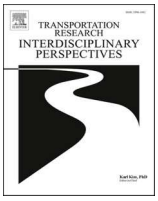

Access over ownership: Barriers and psychological motives for adopting mobility as a service (MaaS) from the perspective of users and non-users

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ABSTRACT

Mobility as a Service (MaaS) can potentially create positive impacts for sustainability and social equity: MaaS could steer user choices away from the private car, and increase access to transport options for all social groups. Though MaaS is not an entirely new concept anymore, in terms of user numbers, it remains a niche phenomenon. We aimed to identify factors that support or hinder MaaS use by focusing on the perspectives of both users and non-users, considering their personal situations, preferences, and needs. Specifically, we investigated under which circumstances MaaS can convince individuals to reduce the use of or discard their private car, using the theory of material possessions which asserts that the motives for (car) ownership are not only of an instrumental nature, but can also be symbolic and affective. We employed a qualitative research approach, focusing on the MaaS case in Berlin, Germany. Data was collected in 12 focus group sessions of 3 to 5 users and non-users, following a semi-structured guideline. The sessions were recorded, transcribed and analyzed using qualitative content analysis. Results show that socio-economic factors play a smaller role than expected, and use cases center around non-habituated trips. The added value of MaaS compared to regular transit apps was often difficult to discern or irrelevant. Even if MaaS provided perfect service and functionality, certain groups of car users would still not consider it, due to the vehement symbolic and affective motives associated with the private car. However, we found that individuals can associate symbolic and affective motives with MaaS as well. The most prominent lever for MaaS to contribute to a more sustainable mobility system seems to be emphasizing these MaaS related motives as well as the car as a burden, a burden which can be lifted by using MaaS.

1. Introduction

The negative effects caused by increasing private car ownership and usage have been widely discussed in academia and politics. Reducing the need of and demand for private car use and ownership is considered a main lever to achieve a sustainable mobility system, particularly in highly urbanized areas. To replace the private car, a single alternative transport mode, such as transit, is not sufficient to serve urbanists' diverse and dynamic transport needs (Matyas, 2020). With multi-modality in mind, the concept of 'servicing mobility' has emerged, aiming at providing functionality and access to diverse mobility options and thus reducing the need for actual ownership of transport means (Spickermann et al., 2014).

Installed as an application on a mobile device, Mobility as a Service (MaaS) schemes facilitate individual transport paths by combining different transport modes and presenting them to users in a convenient, integrated manner. To qualify as a MaaS scheme, the application needs to be able to perform trip planning, booking, and payments through one single interface, including a registration requirement and tariff options (Jittrapirom et al., 2017). Even when these definition criteria are met, the design of the application and additional available functions can differ.

MaaS schemes are typically available in larger cities, usually developed and offered in cooperation with local authorities and transit

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companies. Traditional forms of transit are integrated with additional services such as carsharing, bikesharing, e-moped, or e-scooter sharing, among others. So far, "MaaS may be more of a niche product than a 'game changer' in urban mobility" (Reck et al., 2021, p. 2), because MaaS schemes register a relatively small user base and constitute a minor share in the overall modal split.

Although the future impact of MaaS is unclear, it gives rise to hopes regarding the facilitation of important political objectives, namely equity and sustainability (Schikofsky et al., 2020). Regarding equity, the convenience for the user is central: everyday travel with MaaS is supposed to be easy, flexible, reliable, user centered, easy to plan, priceworthy, and seamless during the trip. This is supposed to be achieved by an integration of all transport means and systems, by using real-time data, and by responding to a broad range of individual user priorities (Giesecke et al., 2016). Thus, MaaS schemes could simplify and increase access to more transport options for disadvantaged groups of society, thereby fostering more transport equity (Wang et al., 2019). Regarding sustainability, hopes that MaaS schemes could steer user choices towards more sustainable transport modes, leading to greater resource and modal efficiency, have been voiced (e.g. Arias-Molinares and García-Palomares, 2020; Mattioli and Heinen, 2020). Shifting the current ownership-based transport system into a functionality-based system is a commonly named goal of MaaS.

For MaaS to be successful and to achieve these aims, an understanding of barriers and enabling factors, both within the application and resulting from the surrounding policy and infrastructural conditions, is needed. Further, the circumstances that would potentially allow MaaS to reduce private car use and ownership are unclear: MaaS-related research has yet to account for the well-established psychological motives for car ownership (Steg, 2005) based on the Theory of Material Possession (Dittmar, 1992). Similarly, it remains unclear which external, policy induced push measures (Steg, 2007) to dissuade car use could influence individuals' perception of MaaS as a feasible alternative.

While research on these topics has expanded in the past years, studies focusing on user behavior and the shift away from private cars are still surprisingly scarce in the MaaS context (Matyas, 2020). In a recent review, Kriswardhana and Esztergár-Kiss (2023a) summarize that the majority of studies investigating MaaS preferences do not investigate real MaaS cases, but use the Stated Preference technique for data collection. If psychological aspects are considered, these are often integrated through structural equation modeling. However, the inclusion of real life MaaS cases and qualitative insights into psychological aspects on its use is crucial, because it offers a more comprehensive view beyond the limitations of quantitative, scenario-based methods. Additionally, studies using real MaaS cases predominantly focus on the behavior of users, who are a minority (e.g. Reck et al., 2020; Smith et al., 2022). As long as non-users are not considered, conclusions on the barriers for a broad public to use MaaS cannot be drawn.

Thus, including MaaS users and non-users in a qualitative study on a real MaaS case, the aim of this paper is 1) to discern the relevant enabling factors and barriers regarding the use of MaaS; 2) to identify under which (external and psychological) circumstances individuals would be willing to reduce their use of the private car, or discard it altogether in view of MaaS.

2. Theoretical background

2.1. Users' perspective on MaaS

Since the concept of MaaS emerged, numerous studies have generated specific knowledge around MaaS usage, such as potential users' willingness to pay, the difficulties in combining different economic stakeholders, or the effectiveness of mobility bundle designs (e.g. Reck et al., 2020; Schippl and Arnold, 2020; Ho et al., 2018). Taking a holistic perspective, Karlsson et al. (2020) identified barriers and enabling factors for MaaS from the perspective of the providers, and found impacting factors on three levels: from the macro to the micro level, they identified policy and public administration; business models and collaboration among stakeholders; and individual's habits and attitudes. Numerous, important studies deal with policy and public administration, business models, and stakeholder collaboration (e.g. Esztergár-Kiss and Kerényi, 2020; Ho et al., 2018; Schippl and Arnold, 2020). However, concerning the individual user, "little is known about the motivational and psychological determinants that affect users' intention to adopt MaaS offerings - but especially for MaaS with its inherent user need orientation, those insights are of utmost importance." (Schikofsky et al., 2020). User attitude and acceptance is essential for a successful implementation of MaaS (Zhao et al., 2020).

With the aim of increased equity in mind, it is important to consider which improvements or additions would help making MaaS accessible to all sorts of users (Mattioli and Heinen, 2020). With the aim of increased sustainability in mind, nudging could be a promising strategy to incentivize sustainable consumption choices among end-users and has already been employed in other sectors and consumption settings (Thaler and Sunstein, 2008). Nudges are interventions that incentivize certain behaviors by changing the information set individuals are presented with when taking a decision. Thus, nudges exploit the fact that human behavior is subject to limited cognitive resources and bounded rationality, whilst still retaining freedom of choice (Avineri, 2009; Byerly et al., 2018). Examples include default settings with opt-out options or accentuating a group norm (Hauslbauer et al., 2022a). For routing apps, nudging ideas that have been investigated are, e.g., ecofilters (presenting sustainable transport modes more saliently) or green routing (indicating the sustainability of proposed routes) (e.g. Bothos et al., 2013; Bothos et al., 2014; Zhu et al., 2017). However, if and how internal nudges within MaaS can shift users' choices towards public, sharing, and pooled transport means is unclear.

The attitude toward and use of MaaS is dependent on local infrastructural and policy-related characteristics, which need to be considered to enable a successful implementation of MaaS (Butler et al., 2021). It is well known that the surrounding external transport and infrastructure conditions impact individual mobility behavior and decision-making (Schlag and Schade, 2007). An attractive transit system and suitable infrastructure for active mobility, for example, are a necessity for MaaS to be practicable (pull measures). Regulatory measures like the enforcement of car parking rules, car-free zones, parking tariffs, or congestion pricing tend to increase the likeliness for individuals to give up their car and be open to offers such as MaaS. Sometimes, such measures are used deliberately by municipalities to achieve behavioral change (push measures) (e.g. Fürst and Dieplinger, 2014; Langbroek et al., 2016; Wang et al., 2017).

2.2. The move away from the private car

One goal of MaaS providers is to convince private car users of sustainable alternatives. Alyavina et al. (2020) found five factors that influence the use of MaaS, one of which is private car dependence, and claim that the success of MaaS is dependent on, among other factors, a change of attitude toward the private car. Indeed, the individual's strong reliance on the privately owned car has been described as the biggest social barrier for a successful implementation of MaaS (Alonso-González et al., 2020; Polydoropoulou et al., 2018), and people's willingness to reduce car use on account of MaaS has so far been described as low (Kriswardhana and Esztergár-Kiss, 2023b).

While it has been stated repeatedly that "multimodal options are needed to service the unique travel requirements of each individual" (Matyas, 2020), we believe that it is not sufficient for MaaS to fulfil instrumental mobility needs. In other words, for MaaS to provide a fully functional, convenient alternative way of achieving one's mobility goals is not sufficient. The traffic psychology literature has long established that the functionality of car use and ownership is only a part of the private car's appeal. Next to these instrumental motives (e.g. the (in)

convenience caused by car use like speed or flexibility, to get from A to B), it is well known that possessions, such as the car, are highly associated with symbolic (e.g. expressing one's social position) and affective motives (e.g. feeling at home in the car; feeling excited at high speeds) (Dittmar, 1994; Steg, 2005).

We conclude that moving from car ownership to access-based mobility necessitates a detachment from all motives of ownership, not just a car's functionality (instrumental motive). It remains unclear how MaaS could serve affective and symbolic motives in a different form (e.g. offering flexibility and independence). To understand how possession motives influence the use of MaaS, we integrated this theory into the present study.

2.3. Research aim and questions

The first aim of this paper is to discern the relevant enabling factors and barriers regarding the use of MaaS, both within the app (e.g. nudging) and external (e.g. policy measures). The second aim of this paper is to uncover under which psychological circumstances individuals are willing to reduce their use of or discard the private car on account of MaaS, using possession theory as a theoretical underpinning. Taking a qualitative approach, we address these research questions:

I. MaaS from the perspective of users and non-users
a. Users and use cases: who are the users (and non-users) of MaaS, which situations are suitable to use it and which are not?
b. Advantages and barriers: what are perceived advantages and barriers regarding the use of MaaS?
c. Improvements and additions: are there improvements or additions needed within the application to potentially overcome the mentioned barriers?
d. Internal sustainability nudging: to what extent can environmental nudges within the app convince MaaS users to choose sustainable travel?
e. External context: how does the infrastructural and political context influence the use of MaaS?
II. Psychological motives for car possession and MaaS use
a. Instrumental motives: can MaaS offer the same instrumental needs as the private car?
b. Symbolic motives: which symbolic motives do individuals associate with MaaS, and can these offer a counterpoint to those associated with the private car?
c. Affective motives: which affective motives do individuals associate with MaaS, and can these offer a counterpoint to those associated with the private car?

3. Method

3.1. Case study: MaaS in Berlin

To answer our research questions, we selected a real world MaaS case ("Jelbi" in Berlin). The urban area of Berlin, the capital and biggest city of Germany, has a population of roughly 3.8 million and a well-developed transit system. Since, June 2019, the application "Jelbi", offered by the main transit provider in Berlin ("BVG"), is available to inhabitants.

The platform qualifies as a Mobility as a Service application according to our definition criteria inspired by Jittrapirom et al. (2017). It offers access to numerous transit and sharing options, including the underground, busses, trams, ride hailing, or sharing services such as e-mopeds, e-scooters, bikes and cars. While the availability of these is much higher within the city core, there are "hubs" throughout the city where different modes can be found (though the density of the offer decreases toward suburban areas). After a single registration (including verification of ID and, for certain sharing services, verification of a driver's license), journey planning, booking, and payment are available through the application. Possible routes and modes are compared by duration and price, using real-time traffic information.

According to the provider, the goal of the MaaS service available in Berlin is to trial a multimodal and intermodal mobility platform.[2] To do so, BVG cooperates with numerous mobility providers. The service was developed in cooperation with Trafi Ltd., who also built MaaS solutions for Munich, Basel, Bern, Zurich and Vilnius.[3]

3.2. Qualitative approach: Focus groups

To address our research questions, we chose a qualitative research approach, which allows for the collection of data in a partly exploratory fashion. To understand the subjective relevance of factors that lie below observable mobility behavior, qualitative methods have been described as particularly suitable (Gebhardt, 2021).

The focus group method was deemed appropriate because it is especially suited for fields of research that are characterized by the relative novelty of their subject, and as such it allows in-depth understanding of new phenomena and free exploration of a topic (Polydoropoulou et al., 2018). Morgan (1996) defines three basic components of focus groups: they are a research method devoted to data collection, they pinpoint group interaction as the source of the data, and the researcher occupies an active role in creating the group discussion. Focus groups are usually recorded or taped to subsequently allow for the analysis of the reactions displayed by the participants.

In a thematic analysis, Guest et al. (2017) showed that six focus groups typically suffice to capture 90 % of themes on a topic. However, it is more difficult to capture themes with increased sample heterogeneity and increased complexity of the topic. To sufficiently saturate all themes that may emerge, we doubled the recommendation of six focus groups and employed twelve.

The focus groups were conducted online, a format which holds several advantages over traditional formats, such as lower cost, easy recording, an informal characteristic which allows participants to be more open than face-to-face, and draws a richer participation in general (Stewart and Shamdasani, 2017).

3.3. Sampling strategy

To recruit and select participants, a theoretical sampling strategy was chosen. The idea of theoretical sampling is to increase the overall heterogeneity and diversity of perceptions and views (Glaser and Strauss, 2017) across the focus group discussions. The theoretical sampling strategy was based on selection of participants to include MaaS users and non-users, and to cover each of the following mobility types: car individualists, pragmatic transit users, environmentally aware type, multioptional type, bike affinity type, and forced mobile type (adapted from Schäfer and Quitta, 2016). For a tabular overview and details on each type's mode use, attitudes, mode availability, routes and distances, please see Appendix A.

It should be emphasized, however, that the goal of this sampling approach was not to later compare mobility types (which would require representative sampling and quantitative analysis), but, in line with the idea of theoretical sampling, to ensure that the entirety of perceptions, attitudes, and reasonings are included (Glaser and Strauss, 2017).

3.4. Recruitment

Initially, participants were recruited via social media. A link led individuals to a website hosted by Dresden University of Technology, which asked for demographic information, mobility related information, and contact details. Afterwards, the researchers called these individuals

[2] https://www.jelbi.de/, last accessed on February 25, 2023.
[3] https://www.trafi.com/, last accessed on June 20, 2022.

and, if necessary, collected more information on the mobility behavior to identify their mobility type and to verify that the participant is in a fact resident of Berlin. From 56 initial sign-ups, we were able to recruit 42 participants. After a time and date for the focus group was confirmed, participants received an e-mail with the focus group information and Zoom link. If necessary, the researchers aided the participants in downloading Zoom and practicing its use. After participation, each participant was compensated with a gift voucher (wunschgutschein.de) of 50€ sponsored by Trafi Ltd.

Through this self-selecting sampling strategy, both users and non-users enlisted in the study, but no car individualists were recruited. To compensate for this, the professional recruitment platform TestingTime[4] was hired. Three screening questions were used to select suitable applicants: applicants had to indicate that they live in Berlin, had to own a car that they used for more than 50 % of their daily travel, and indicate among a number of statements that they associate their car with prestige and/or with a status symbol and/or agree to affective statements, such as "my car is my baby that I take care of". TestingTime reimbursed the four participants that they recruited according to their own rates.

3.5. Participants and groups

Twelve focus groups were conducted online via the web-conference platform Zoom. Each focus group consisted of three to five participants and two moderators, resulting in a total of N = 46 participants. Participants ranged from age 18 to 70, averaged 39.9 years of age (SD = 16.7), and 58.7 % were female. An overview of participants, including basic demographic data, residential area (inner or outer city[5]), car access, awareness of the MaaS service and the mobility type is provided in Appendix B. The mobility types were represented as follows: pragmatic transit users (26 %), multioptional type (37 %), car individualists (24 %), forced mobile type (9 %), bike affinity type (2 %), and environmentally aware type (2 %).

3.6. Procedure

Participants were informed that the meeting was recorded for the purpose of later analysis, but that all data was anonymized upon transcription. The researchers introduced the concept of MaaS (using the example of the application available in Berlin) with a short video (introduction to the app available in Berlin) and PowerPoint slides, and answered questions should the participants have any. For the actual focus group discussion, the researchers followed a semi-structured discussion guideline that covered the topics as described in the introduction (Table 1), while leaving room for additional topics.

Table 1
Focus group content (rearranged to follow the order of research questions).

Block	Content
I MaaS from the perspective of users and non-users	
a.	Users and use cases
b.	Advantages and barriers
c.	Improvements and additions
d.	Internal sustainability nudging
e.	External context: policy and infrastructure
II Psychological motives for car possession and MaaS use	
a.	Instrumental motives
b.	Symbolic motives
c.	Affective motives

For block I d, two proposals for nudges were shown to participants as illustrative mock-ups on the MaaS app screen: An "eco-filter", which filters and presents sustainable transport modes before the booking, and a carbon footprint ("green route"), indicating the sustainability of the proposed routes, which was associated with a bonus or premium for the users once s/he books the route. Though details of such nudges would need to be worked out precisely, the general attitudes of participants regarding these additional information features were of interest.

3.7. Analysis

The twelve resulting recordings were transcribed word by word, including unambiguous nonverbal gestures such as fervent nodding or thumbs up or down. The transcripts were fed into the software MAXQDA,[6] in which the qualitative content analysis was performed.

Qualitative content analysis is a widely used technique to derive meaning from textual data. Words or expressions are not merely counted, but themes are coded into explicit categories. Resulting patterns can then be analyzed and interpreted, to better understand the phenomenon in question (Hsieh and Shannon, 2005). This is achieved in seven well established steps (Kaid, 1989), the first three of which ([1] the formulation of research questions, [2] the sample selection, and [3] the definition of applied categories) we described in the introduction and method sections.

The next step of qualitative content analysis is [4] the definition of the coding process and coder training. For this step, two researchers underwent coder training and jointly defined the coding process. The directed approach was combined with the conventional approach, meaning that initial codes were directed by the pre-defined topics of the guideline used in the focus groups (see Table 1) and additional themes were coded as they appeared in the text (Hsieh and Shannon, 2005).

Lastly, qualitative content analysis requires [5] carrying out the coding process, [6] a determination of trustworthiness, and [7] the analysis of results. Both researchers coded the emerging themes in a complementary manner to ensure trustworthiness. The analysis of the resulting thematic codes is described in the next section.

4. Results

The following table (Table 2) displays an overview of the coded result categories following the order of our research questions. The text below shortly summarizes the results and features selected quotes from participants. This section is meant to give a pragmatic, comprehensive overview of the results. In the discussion section, we derive meaning and implications from these findings, integrate them with previous research and draw conclusions.

During the focus groups, we aimed to generate knowledge in the frame of the integrated, multimodal MaaS service. However, participants sometimes discussed only partial aspects of the MaaS system, for example the specifics of different transport modes, losing sight of the meaning encompassing the MaaS scheme as a whole. It seemed difficult for participants to stick to the *meta*-level of the MaaS scheme: facilitating transport paths by combining modes and presenting them in an integrated manner.

4.1. MaaS from the perspective of users and non-users

4.1.1. Users and use case situations (Fig. 1)

Participants deemed younger individuals the primary target group, assuming that digital natives would be enticed by MaaS. In contrast, some older focus group participants claimed that as long as tech-savviness suffices and the modal offer is broad, MaaS usage could be age-independent.

[4] https://www.testingtime.com/en/, last accessed on June 27, 2022.

[5] Inner and outer city were divided by the Berlin „S-Bahn Ring", a closed-loop circle railway surrounding Berlin's inner city area.

[6] https://www.maxqda.com/, last accessed on June 20, 2022.

Table 2
Result categories per content block.

Block	Content	Codes
I	**MaaS from the perspective of users and non-users**	
a.	Users	Age, income, employment status, multimodal habits, residential location, car-less, tourists
	Use cases	Uncommon trips (unknown routes, moving people/goods, transit failure) downtown, leisure trips (joy, excursions, nighttime).
	Uses for which MaaS is unsuitable	Habituated trips, daily commute
b.	Advantages	Simplicity, pragmatism, integration of mobility providers, flexibility, overview
	Barriers	Missing added value, unattractiveness of transit and sharing modes, distrust in functionality of app, insufficient service area and vehicle availability, data security
	Prerequisites	Convincing design, reliable information, pricing
c.	Improvements and additions	More real-time information, additional routing information, filter, increased sharing options, assisted parking, increased MaaS service, further "nice-to-have" functions
d.	Internal sustainability nudging	Diverging views, question of effectiveness, of methodological reliability, of use cases, of business integrity
e.	External context (pull measures)	Improvement of cycling/pedestrian/transit infrastructure, subsidized mobility budgets
	External context (push measures)	Congestion pricing, car-free zones
II	**Psychological motives for car possession and MaaS use**	
a.	Instrumental motives	Instrumental functionality
b.	Symbolic motives (+)	"Zeitgeist[1]", modern, prestige due to access, innovative, smartness
	Symbolic motives (-)	Not comparable to car symbolism, invisible to outside
c.	Affective motives (+)	Curiosity, fun in trying new modes, connection to city
	Affective motives (-)	Difficulty in finding affective connections to MaaS
	Ownership as burden	Relief from parking and associated fees, tax and mechanic costs, and from worry about break-ins

[1]Zeitgeist can be defined as "the general intellectual, moral, and cultural climate of an era" according to merriam-webster.com on February 12, 2023.

> *"When I'm 75, I'm not going to pick a pedal scooter (…), and maybe I won't be able to ride a bike anymore. But the [modal] range is wide, so I think there'll be the right thing for me."*

When discussing the role of income and employment status, participants focused on the affordability of sharing vehicles. MaaS was seen as a solution for those who have a lower income to access a car when needed, whilst avoiding the general high cost of car ownership. In their view, MaaS was developed for those who do not currently own a car (this does not reflect the reality of why MaaS was developed), instead of being an alternative to the car.

> *"If you already own a car, you don't need that, it would just be additional costs."*

As a consequence of low income, some participants excluded students from the MaaS user group, and shifted the focus to young professionals with a higher income. Using sharing vehicles, especially e-mopeds and e-scooters, was regarded as high-end and a leisure activity.

> *"Only when you have an income do you use many of these services. I've noticed this (…): [people] really cheerfully take an e-moped or a scooter just to get somewhere faster."*

Participants deemed individuals who already display multimodal habits as a suitable user group. Consequently, MaaS was perceived as useful for residents of the inner city, where multimodal service is offered extensively. On the outskirts, where vehicle pick up and return hubs are sparse and the distance toward these is potentially far, using MaaS was not perceived as an ideal solution.

Regarding use cases, unknown routes were mentioned for which the easy access to different modes via MaaS would be helpful. In line with his, participants voiced that multimodality offered by MaaS would be especially suitable for tourists, who do not know the city, would profit most from simple access to a diversity of mobility services, and flexible switching between modes.

> *"I could imagine that [tourists] are a good target group. Especially for people who are in Berlin for (…) a week and don't want to deal with what kind of transport services are available here. They'll get the app and say, 'Cool, today we're taking the bike! But now we're taking the bus! And tomorrow we'll take the S-Bahn!'"*

The flexibility of MaaS was recognized as useful for special occasions: For example, when spacious vehicles are needed to move large objects such as furniture, or when a group of relatives or friends needs to be transported. Transit disruptions due to construction work, or unexpected train or bus cancellations were also mentioned in this context.

> *"…if somehow the train breaks down (…), then I'm at the station and don't know what I should do, should I take a bus, or substitute transport, and then such an app would perhaps be quite cool, if you could find alternatives quickly."*

MaaS was perceived as a "savior" solution for trips during the night, such as clubbing or bar-hopping, when the operation of vehicles is not an option due to intoxication and waiting times for transit are extended. In such cases, easy access to ridehailing or ridepooling was appreciated.

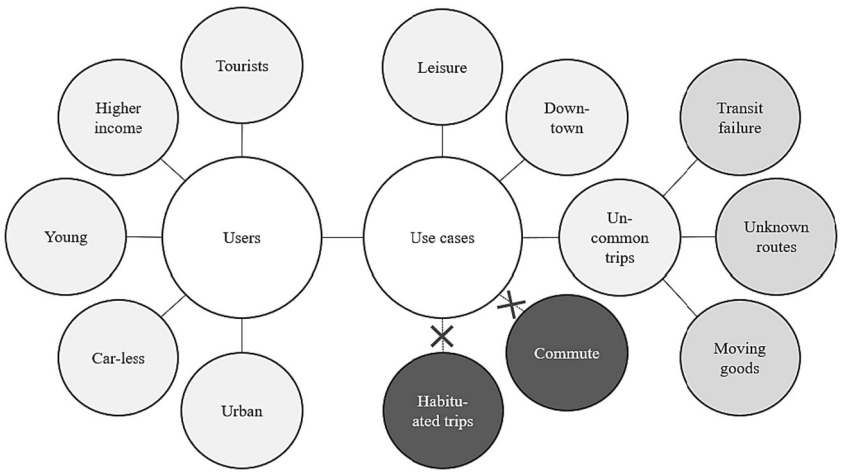

Fig. 1. Visualized results for content block I.a.: Users and use cases.

During the summer, different options for using bikes, e-mopeds or e-scooters were considered for hedonistic reasons within the city, and for excursions and leisure trips beyond the city borders.

„Just into the countryside. There are destinations and small lakes where you just can't get to with [transit], only to a certain end point. Of course, you would need to know whether there would be vehicle availabilities (…).”

In the other direction, trips to downtown were named as use cases, where driving the private car is perceived as high-end but inconvenient due to e. g. parking issues, which could be solved by using a sharing car of the MaaS scheme.

“It's also a question of what kind of appointment you have. I find it totally relaxing to drive into the city center using carsharing, then just park the car there, not having to pay anything for parking fees, and arrive relaxed.”

MaaS was not seen as useful for the daily commute to and from the workplace, or generally for well-known routes. However, if existing transit subscription tickets could be integrated, transit could be accessed through MaaS, whereas sharing options were not seen as useful for the commute.

“So I would not use the app for my commute I think but rather for leisure trips, especially if you are in places you do not know well.”

4.1.2. Advantages and barriers (Fig. 2)

Before discussing advantages and barriers, participants outlined what prerequisites had to be met for them to consider using the app. Among those are a convincing design and reliable information. Additionally, the services need to be budget friendly and the cost comparable to those of individual provider applications.

The main advantages were the general simplicity and pragmatism of using different mobility services and transit, facilitated by the integration of mobility providers into a single interface. Hence, MaaS was deemed capable of increasing individual flexibility. The benefit of an extensive overview in terms of route, transport means, and price comparison was highlighted.

Numerous potential barriers and disadvantages that complicate the use of MaaS were described. On a *meta*-level, many individuals had trouble identifying the added value of MaaS compared to either their private bike or car, or compared to other transit or routing apps. The value of having all mobility applications and services integrated into one application was not convincing or necessary to most, and only after the moderators' repeated mention of possible tariff options and integration of payments was the service part of MaaS acknowledged.

“If anything, I use google maps or the BVG app because I just do not need more features. I haven't used these e-scooters and rental cars for a long time, I do not have these apps anymore and I do not need to switch to those.”

Especially car individualists categorized MaaS as inferior to their own car, and found no convincing reason to consider using MaaS instead. The rationale for this was manifold, including e. g. the speed and convenience of the private car, flexibility in the case that goods need to be transported spontaneously, that the car is known and familiar, or for other purely symbolic and affective reasons (as discussed later).

“To go shopping, you can't easily carry those goods, you need a car.”

Compared to the private car, some services available withing MaaS were rated as especially unattractive by some, and thus rendered MaaS itself unattractive. Especially during the COVID-19 pandemic, some participants disliked being close to strangers in crowded transit, and voiced concerns about the quality and hygienic state of sharing vehicles. Additionally, sharing vehicles such as e-mopeds, e-scooters, and bikes were perceived as littering sidewalks and bike lanes.

One major concern was that MaaS is not sufficiently available in suburban areas. For example, sharing vehicles cannot be parked or rented in walking distance from a person's home. Taking the private car or bike to reach a MaaS station wasn't seen as sensible. Within some parts of the service area, a lack of offer availability was noted. In this case, using MaaS was seen as complicated and stress inducing instead of relieving. The insufficiency of included services was commented on, since popular services such as Uber (ridesharing) or Lime (e-scooter sharing) had to be accessed using a different, specific app anyway.

Another barrier was the lack of trust in and reliability of the application. Especially those participants who had made negative experiences with transit applications before, worried that the app would provide incoherent or wrong information. Some were also concerned about a potential higher cost due to using various mobility services through a second provider.

“My fears are that the app somehow doesn't work. For example, BVG isn't even able to read the barcode correctly when I'm at a stop, which is simply unreliable and not right.”

Connected to the design of the MaaS application, a few participants voiced concerns regarding data privacy and security, and were surprised that data protection was not addressed in the semi-structured guiding questions. They worried about (real-time) tracking and processing of personal mobility data by the transit company and other integrated mobility operators.

“What I miss is the data protection aspect. It's not really clear: What happens to the data? What are they used for? Are movement profiles created? Will the data be sold?”

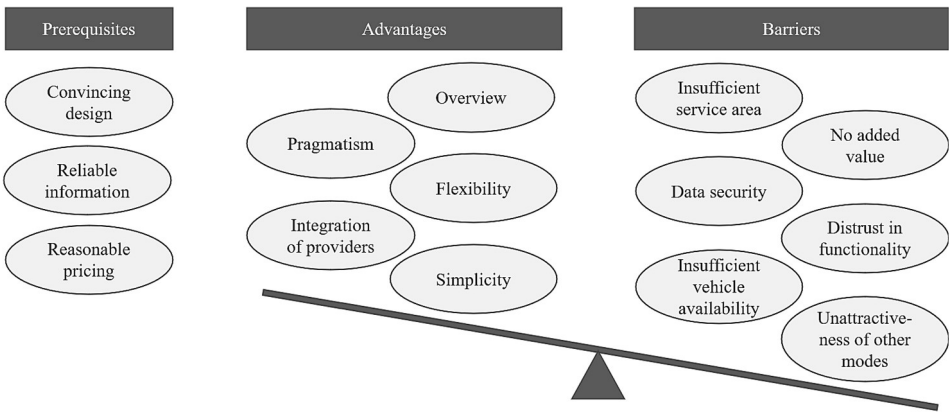

Fig. 2. Visualized results for content block I.b.: Advantages and barriers.

4.1.3. Improvements and additions (Fig. 3)

Next, improvements and additions were discussed. Naturally, these are specific to the implementation of the application Jelbi in Berlin, yet results could give valuable pointers toward other MaaS applications.

Regarding transit, real-time information metrics on transit capacity via the MaaS application was wished for, in order to avoid crowded buses, trams or subways, along with information of delays or cancellations. In general, a filter for mobility options – e.g. the exclusion of e-scooters – and advanced personalization options would be appreciated. For rental and sharing vehicles, participants would enjoy the rental of several vehicles with a single MaaS account to enable trips with friends or visitors. An increase of the service area and more MaaS mobility stations to make MaaS attractive for the outer city residents was a theme, though some participants voiced concerns about the economic feasibility of such an endeavor. Further, the integration of additional, if not all, mobility services available in Berlin was wished for, such as ride hailing services like Uber. Transit fans mentioned that MaaS would be more attractive if they could integrate their subscription tickets (e.g. student semester tickets) and allocated discounts in the app. Similar to Google maps, participants wished for additional information on the surrounding area, to simplify the finding of e.g. drug stores or pharmacies. The display of certain types of routes was requested, especially safe routes for bikers. Participants wished for support in finding parking spots for carsharing vehicles: MaaS could act as a platform to organize the parking space for sharing vehicles by indicating virtual stations in which they may be deposited.

> *"This could be solved through Jelbi, exactly! (…) if someone thinks he has to leave a bike or scooter somewhere where it doesn't belong, then it just costs. Then the clock keeps running. That would already be some form of organization (…)."*

In general, participants' brainstorming was very fruitful. Remaining themes that came up but were not discussed further are the addition of a calorie counter within the app (which tracks the calories that were burnt when walking or using sharing bikes), special offers and gift vouchers, a prepaid system (which allows charging one's account, instead of deducting from bank accounts), and CO_2 information of the different mobility options (as discussed below).

4.1.4. Internal sustainability nudging (Fig. 4)

Participants were asked about their opinion of an "eco-filter" nudge (filtering sustainable transport modes) and a "carbon footprint" nudge (indicating the sustainability of a route). Views on the matter diverged. Some deemed these nudges useful and interesting.

> *"I find this appeal or invitation to think again for a moment very helpful."*

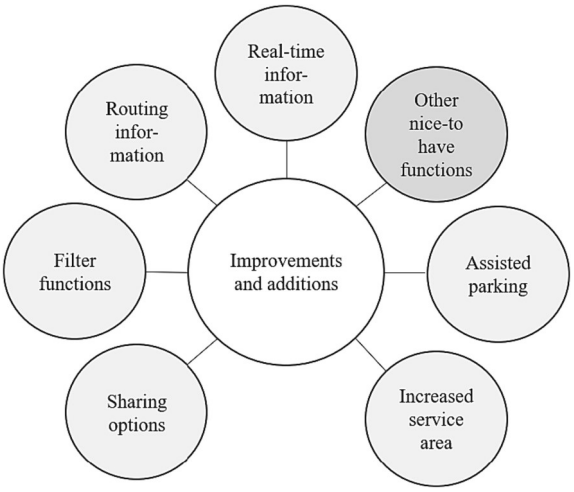

Fig. 3. Visualized results for content block I.c.: Improvements and additions.

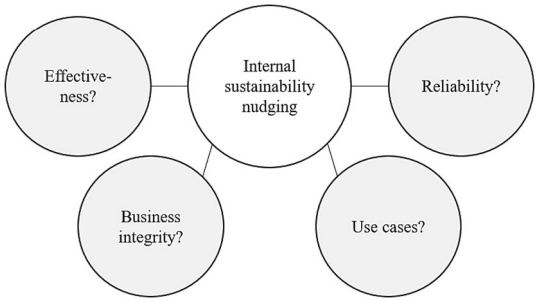

Fig. 4. Visualized results for content block I.d.: Internal sustainability nudging.

> *"I think it's actually important that you can filter according to the shortest, fastest and, for my sake, also the most CO_2-neutral route. In fact, I expect that [from an app] when so many means of transport are offered."*

Other participants questioned the underlying assessment method and true purpose by which certain transport means and routes are described as more sustainable than others. The results seemed obvious to many, for example that using a bicycle was more sustainable than using a fueled car.

> *"Somehow I've become so ingrained with skepticism when it comes to these things, because the greenwashing light is flashing again."*

The general effectiveness of such nudges onto the actual mobility behavior remained questionable. Some participants indicated that such information would play a role in their decision-making. However, they would only rely on those in certain circumstances, for example concerning trips for leisure purposes, after considering the trade-off with cost and time. Others highlighted that they would choose actual routes and transport mode combinations based on cost and time only.

> *"I don't believe that anyone walks for 30, 40 min and uses the app. I want to get from A to B as fast, cheap, and easy as possible!"*

Some focus group participants also questioned if such nudges can be viable and feasible from the provider's standpoint. Even though the MaaS provider, a public service-oriented company, could nudge its users towards transit, participants speculated about a conflict of interests among the various mobility providers and the risk of business cannibalization.

> *"Would Jelbi suggest that you take the subway or the bike, and then they would give you Eco-Points if you took the bike? That would be more of a promotion from the bike rental company, wouldn't it? Or isn't that contradictory for the companies that participate there? If Jelbi decides, 'we send the customers there and there?'"*

4.1.5. External transport policy conditions and scenarios (Fig. 5)

Suiting external conditions were seen as a necessity for many services to be attractive (e.g. sharing, transit). Here, participants often dived into describing what made individual modes attractive, dismissing the MaaS scheme as a whole. But, as these individual modes are a major part of the

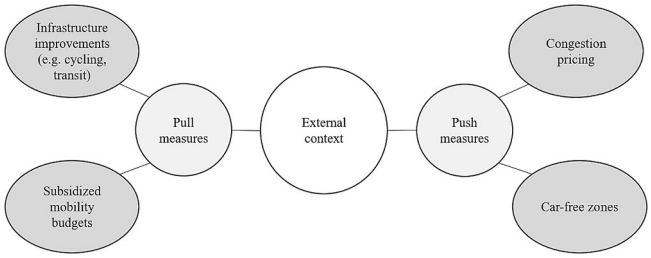

Fig. 5. Visualized results for content block I.d.: Internal sustainability nudging.

MaaS service, the external conditions are essential for MaaS to ever be successful.

Regarding pull measures, participants highlighted the need to improve the infrastructure for cyclists and pedestrians, which at the moment encourages dependence on and use of private cars. Further, the frequency and service area of subway, bus, and tram lines needs to be improved, particularly in the outer districts. Some participants also highlighted that the insufficient and chaotic parking situation and infrastructure for sharing cars, bikes, e-mopeds and e-scooters. MaaS's attractiveness would improve if sharing vehicles could use separate parking spots.

> *"Regarding parking spaces, it should be the case that, if I use the cars of carsharing companies, that I can park for free and that there are more parking spaces available."*

Another discussed pull measure was the introduction of subsidized mobility budgets (i.e. financial support for using transport modes via the MaaS application) to be offered to MaaS customers. The overall social fairness of such subsidies was controversial, since mainly inner-city residents who have good access to transit and new mobility services would profit. If mobility budgets were introduced, MaaS may increase the divide between inner and outer districts.

Regarding push measures, a major theme was the introduction of congestion pricing in the inner city. In view of the (at the time of the focus groups) upcoming Berlin federal elections, several participants were aware of this controversial policy proposal, and regarded the MaaS concept as a response by the Senate to disincentivize private car use. Support for or opposition against a congestion pricing policy was discussed among participants and may be traced back to the different multimodal mobility types and their dependence on private car use. Proposals such as car-free zones in the inner city were less frequently mentioned. A potential introduction of road pricing schemes was identified as a window of opportunity to increase MaaS adoption. In general, several participants were doubtful about the public's acceptance for push measures.

> *"If a city toll is implemented, and driving becomes more expensive, you gain a completely different group of people: those who have always traveled by car and never used transit. And they have not really thought about how to get around in the city center using public or sharing transport before. Then this app becomes interesting […]."*

4.2. Psychological motives for car possession and MaaS use (Fig. 6)

Our second research aim centered on the psychological motives for car possession (Steg, 2005), and how MaaS could potentially compensate for these. Specifically, we raised the question if MaaS can serve the same instrumental needs as the private car, and further, which symbolic and affective motives individuals associate with MaaS, and if these can offer a counterweight to those associated with the private car.

4.2.1. Instrumental motives

Participants explained that they appreciated the instrumental function of MaaS, as long as it was available near an individual's frequently visited locations, predominantly close to home. It was agreed upon that MaaS could potentially offer everything that is needed in terms of mobility. Reliability, flexibility, and independence were mentioned.

> *"It's practical and it meets the need to be mobile and to be independent of certain modes of transportation because it allows you to use a wide variety of modes."*

4.2.2. Symbolic motives

Participants mentioned numerous symbolic motives that MaaS could potentially fulfill: going with the "Zeitgeist", being modern and innovative, prestige due to the access to different, expensive cars, and a symbol of smartness and cleverness.

> *"I'm one of the people of tomorrow (…), even I get that."*

However, many participants mentioned that those who take pleasure in the symbolism of their private car could hardly be convinced to see positive status symbols in using MaaS, as it is invisible to the outside world. Using MaaS has symbolic value – those of a fresh, tech-savvy, independent and progressive person – but this symbol is perceived entirely differently from car ownership, which was mostly connected to a contrasting value system, and judged by most participants (but not by car individualists) as snobbish, gaudy, and conservative.

> *"So then I have the feeling with the app that it's a great solution, but that's not something that I show to the outside. Like my house, my boat, my car, and my trophy wife."*

4.2.3. Affective motives

Regarding affective motives for MaaS use, participants mentioned curiosity (i.e. trying something new) and fun connected to riding different scooters on sunny days. In contrast to the private car, MaaS may offer a better possibility to emotionally connect to and experience the city (similar as to why participants judged MaaS as a good option for tourists).

> *"…leave this personal shelter [car] and see what makes Berlin tick"*
> *"…beneficial, practically, but that doesn't trigger any emotions"*

In the discussions, participants – including car individualists – mentioned with considerable emphasis that they despise the burdens of car ownership, such as cost (mechanics, taxes, insurance fuel, parking), expenditure of time for finding parking and getting to mechanics, being stressed that the car is broken into or stolen. "Use it and leave it", was seen as a relief, connected to the feeling of freedom (from this burden).

> *"…because possession also burdens you, and does not necessarily give you freedom. You have to take care of a car."*

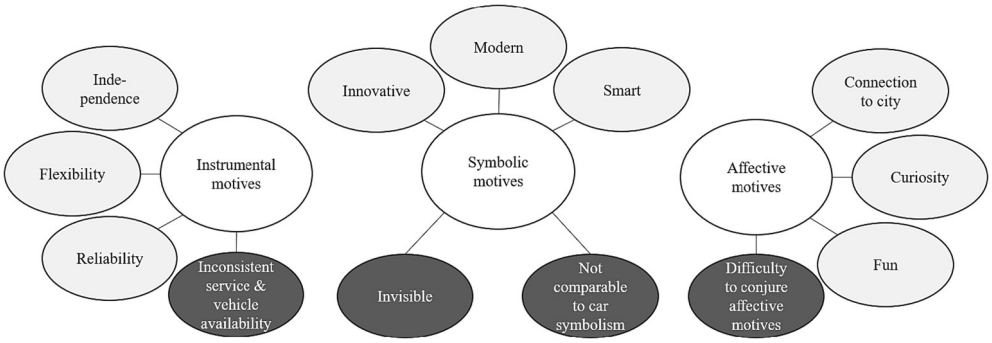

Fig. 6. Visualized results for content block II: Psychological motives for MaaS use.

5. Discussion

In this paper, we aimed to discern the relevant enabling factors and barriers regarding the use of MaaS (considering internal as well as external factors), and to uncover under which psychological circumstances individuals are willing to reduce the use of the private car (or discard it altogether) on account of MaaS.

Beyond the individual themes described below, an overarching finding is a lack of clarity regarding the service aspect of MaaS. MaaS was often perceived as "just another" transit ticketing and routing application. The fact that the application is provided by the local transit company increased this perception. For many individuals, the idea of servicing mobility was hard to conceptualize. Thus, the use of individual mobility services and circumstances was predominantly discussed, less so the concept of servicing mobility itself.

5.1. MaaS from users' and non-users' perspective

5.1.1. Users and use cases

Our content analysis revealed age as a proxy for tech-savviness and openness for new experience, rendering age a correlating, and not a causal factor for MaaS use. Identifying tech-savviness as the true causal factor, we assume that age as a constricting factor will decrease in importance in the following decades, given that today's middle aged population is already significantly more tech-savvy than their parent generation. Our findings further suggest that MaaS may be a solution for all income groups, noting that it can provide lower income groups with access to a car when required. The urbanity of a potential user's residential area (as a proxy for service density) was also identified as a predictor for MaaS use. Additionally, individuals with preexisting multimodal habits were described as a potential user group. These habits have been shown to partly correlate with urbanity and younger age (Nobis and Kuhnimof, 2018). While previous research summarizes attributes of the proposed MaaS user base as younger, higher income, tech-savvy, and without a car (Loubser et al., 2021), we argue that there is a case for MaaS to be used by all age groups (if tech-savviness suffices) and for all income groups.

The classification of tourists as a target group stems from the perception that MaaS is rarely an option for habituated trips. In our data, business-related travel or the commute were predominantly ruled out as relevant trip purposes. The main perceived use cases for MaaS were uncommon trips and situations in which regular transit service is not available or disrupted. This finding conflicts with previous theoretical considerations, asserting that work-related trips are a major use case (Jittrapirom et al., 2017). The impact of this finding is considerable, since work-related trips make up about 42 % of miles traveled in Germany (Nobis and Kuhnimof, 2018), and work is the main trip purpose for individuals that travel extensively (Hauslbauer et al., 2022b). If acquiring commuters as a user group and work-related trips as a use case for MaaS is the goal, extra effort needs to be dedicated to this end. This could be done, for example, by providing mobility bundles or packages that target commuters specifically, and more research in this direction may be helpful (as shown by e. g. Kim et al., 2021).

5.1.2. Advantages and barriers

Seamless functionality was identified as a prerequisite for MaaS to be considered as an option. This underlines the importance of technical effort and design considerations for the application. The mainly identified advantages of the service were ease of use and simple access to modes, pragmatism, and flexibility. However, residents of the outer districts voiced regret that due to the lack of access to these services, they would not benefit from these advantages.

While the advantages of simplified access and flexibility appear repeatedly in MaaS studies across countries and cities (e.g. Schikofsky et al., 2020; Alyavina et al., 2020), we found a fundamental constraint regarding their persuasiveness: Even though these advantages were perceived independently of the mobility type, they are subject to the limitation that car individualists found MaaS a good idea – *for others*, not for themselves. They categorized their own car as superior, and found no convincing reason to consider using MaaS instead, despite acknowledging its advantages. This points toward the issue of symbolic and affective motives (to be discussed later), indicating that functionality alone does not suffice to make MaaS successful.

App-specific distrust in the functionality, insufficient service areas, and vehicle availability (especially in the suburban areas) were identified as relevant barriers. Data security concerns and transparency was discussed seldomly, but if so, a strong emphasis was placed on it. Remaining issues concerned external infrastructural factors, such as the unattractiveness of transit or sharing modes, which are outside the reach of MaaS provider platforms. This indicates that, unsurprisingly, MaaS cannot operate in its own bubble, it is dependent on external factors, as discussed below.

5.1.3. Improvements and additions

A plethora of ideas was produced when discussing possible improvements and additions. These included real-time information, increased sharing options, assisted parking, and more. However, the resulting list does not serve as direct advice to providers, because participants were not asked to consider and were likely unaware of usability factors, such as that cluttering of functions can easily decrease attractiveness of services. More detailed ideas were predominantly voiced by those participants that already used MaaS, as they already had extended knowledge about the app (e. g. "calorie counters"), whereas non-users described more basic features (e. g. real-time information). This substantiates the importance of including both users and non-users in the data collection when the aim is to achieve a holistic view. Importantly, none of these potential additions convinced the car individualists of our sample to reconsider MaaS use. Again, the lure of the private car is unbeatable, untouched by whatever alternative options may be available.

Potential bundle designs, mobility packages, or smart contracts, which are partly available in other MaaS cases but not in the Berlin case, were not discussed. However, offers like these may have an impact on individual's attitude and use intention toward MaaS, and could thus be included in future (qualitative) research (Karinsalo and Halunen, 2018; Nguyen et al., 2019; Chinaei et al., 2023).

5.1.4. Internal sustainability nudging

The positive impact of environmental nudges within MaaS was questioned repeatedly, due to distrust in the accuracy of information about the sustainability of options, and due to the importance of cost and time. It is beyond the scope of this article to report on the effectiveness of nudging in this context, but the doubts voiced by participants do curtail hopes in that regard. This, however, corresponds to recent findings indicating that nudging in the transport sector has proven difficult (e.g. Hauslbauer et al., 2022a), and that the usefulness of nudging in general is questionable (e.g. Maier et al., 2022).

Beyond nudging, Bieler and Maas (2018) propose that adding game design elements may be constructive, and benefits from gamification approaches in the transport sector have been noted (e. g. by Yen et al., 2019). To further help cities promote sustainable mode choice within MaaS, results from a recent mode choice model that showcase the role of trip-related variables, fleet sizes, and associated policy recommendations, may be useful (Narayanan and Antoniou, 2023).

5.1.5. External transport policy conditions and scenarios

Our results suggest that, unsurprisingly, the surrounding transport and infrastructure conditions are extremely important, and should therefore be taken into account. Our main take-away here is that pull measures and a perfect MaaS service alone would not be sufficient to convince all car users to switch. Only if using the car was maximally inconvenient, individuals may consider looking into alternatives. Thus,

targeted push measures to reduce the desirability of the private car are essential.

5.2. Psychological motives for car possession and MaaS use

The discussion on psychological motives further supports the introduction of push measures: results show that MaaS can cover almost all instrumental functions of the privately owned car. But, according to the theory of material possessions (Dittmar, 1992; Steg, 2005), car ownership does not only fulfill instrumental functions (e.g. the (in)convenience caused by car use like speed or flexibility), but also symbolic functions (e.g. expressing one's social position) and affective functions (e.g. feeling at home in the car; feeling excited at high speeds). Predominantly the car individualists argued fervently that no matter how excellent the MaaS service, they would never give up their private car. Reasons for this can be attributed to private car-specific symbolic (e.g. pride to be able to afford it) and affective motives (e.g. feeling independent [from transit], identification with the car/group of car drivers, "by nature, I am a passionate car driver").

In that regard, our study is the first to demonstrate that analogous to car ownership, MaaS can cover specific symbolic and affective motives. Symbolic motives predominantly center around showing one's innovative spirit and cleverness, but are as diverse as the MaaS offer itself. A striking unique example here was the need to arrive elegantly for a job interview, using an extravagant sharing car. Affective motives may be activated by MaaS with regards to hedonism or fostering an emotional connection to the city by making different modes like open-air sharing modes or overground transit available. However, these MaaS related motives are less obvious and not as readily accessible than those associated with car ownership.

Additionally, many discussions steered to the inconvenience and burdens connected to car ownership (e.g. anxiety regarding break-ins, stress about managing reparations, frustration due to parking difficulties, concern for insurance cost, etc.), which could be intensified using push measures such as road pricing or parking restrictions.

A fruitful strategy to incite behavior change thus appears to be increasing the emphasis on symbolic and affective motives for MaaS use, as well as on the negative affective associations with car ownership which could be solved by MaaS.

5.3. Limitations

It is important to consider that, while these qualitative results paint a detailed picture of the MaaS situation in Berlin, they are not directly generalizable to different cultures and cities. In fact, Butler et al. (2021) found that a one-size-fits-all MaaS solution cannot exist because local characteristics are critical. For example, considering the emphasis that individuals placed on the specifics of the individual transport modes in our study, it is clear that in a city like Kochi, India, where the MaaS transport modes are water ferry, auto-rickshaw, bus, and rail (Singh, 2020), results are bound to differ. Therefore, the present paper and similar studies should be viewed as complementary to each other, and in combination may reveal which aspects of MaaS are context dependent and which are context independent.

The online format and online recruiting strategy could have caused our sample to be more tech-savvy than the average individual. Further, our sample did not include children, who were recently described as a key group of MaaS users (Casadó et al., 2020), and who might have brought additional or diverging views into the discussion.

5.4. Conclusion and implications

Partly, our findings overlap with related studies on MaaS in different countries or cultures. For example, similar advantages of MaaS (e. g. simple access to modes) and prerequisites for MaaS use (e. g. sufficient tech-savviness) were found across studies. This indicates that some factors are relatively context independent.

However, some findings contradict previous research. Specifically, age has been used as a predictor for MaaS use, and while it may technically function as a predictor, our findings suggest that age is a correlating, but not a causal factor. Due to the availability of numerous mobility options, physical or age induced limitations were not seen as a general barrier for MaaS use. Senior citizens may as well use MaaS if they can overcome the bottleneck of tech-savviness. Education offers for older individuals with lower tech-savviness may be a step to increase access and equity.

Therefore, the hope for MaaS to increase transport equity by making cars and other modes accessible to everyone seems rational, as MaaS is a potential option for individuals of every age and education level, provided that the service is extensively available and individual tech-savviness is sufficient.

Another contradicting finding is the use case of commuting. In the present study, habituated trips such as the commute were clearly ruled out as a use case. Research efforts need to be dedicated to integrating those trips as a use case as well. Measures such as the introduction of mobility packages and bundles, or opportunities to integrate existing subscriptions (such as for transit) may be effective.

A novel finding, to our knowledge, is the perceived lack of any added value. To combat this, MaaS providers may need to put extra effort into distancing their product from mere routing apps, accentuating the added value and service aspect of MaaS.

Perhaps the most poignant finding results from investigating the psychological motives for car ownership and comparing them to MaaS use. At least partly due to strong car-specific symbolic (e.g. prestige) and affective (e.g. private space) motives, even a perfect fulfillment of instrumental mobility functions through MaaS will not suffice to convince vehement car users to switch modes. To overcome this predicament, we propose two roads forward. To begin with, increasing the burdens for car ownership using push measures may be able to overrule the strong symbolic and affective motives for car use, so that individuals may switch to more convenient modes (using MaaS, for example). Furthermore, this study showed for the first time that MaaS, too, can be associated with symbolic (e.g. modern, innovative) and affective (e.g. fun, connection to city) motives. For now, providers predominantly stress the functionality of MaaS. Emphasizing these motives, *beyond instrumentality*, and simultaneously stressing (and increasing) the burdens of car ownership, may be MaaS's biggest lever to pull individuals out of the private car.

Our findings are a testament to the importance of considering traffic psychology in transportation: ignoring the impact of psychological motives associated with car ownership and only offering a convenient alternative service is simply not sufficient to induce behavior change.

CRediT authorship contribution statement

A.L. Hauslbauer: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing, Writing – original draft. **B. Verse:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration. **E. Guenther:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing. **T. Petzoldt:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Hauslbauer, A. L. reports financial support was provided by Trafi Ltd.

Data availability

Data will be made available on request.

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Trafi Ltd. (Vilnius, Lithuania) funded participant incentives and the hiring of TestingTime for participant recruitment. Beyond that, Trafi Ltd. had no role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Appendix

Appendix A. Mobility types used for this study, adapted from Schäfer and Quitta (2016)

Typical attributes	Routes and distances	Mode use	Attitudes	Availability
Car individualists	very mobile	mostly car	neg. toward bike/transit	increased car av.
Pragmatic transit user	rather fewer routes and shorter distances	mostly transit	no special affinities, pragmatic	low car av., transit ticket av.
Environment. aware types	shorter distances	mostly transit or bike	neg. toward car	
Multioptional type	many routes, but shorter distances	multimodal, depending on purpose of route	no special affinities	varying
Bike affinity type	varying	bike/public transp. as useful	preference for bike	
Forced mobile type	many routes, long distances, destinations forced	mostly car	neg. toward all modes, incl. car	increased car av.

Appendix B. Descriptive and demographic information on participants

Mobility types coded as follows: 1 = car individualist, 2 = pragmatic transit fan, 3 = environ-mentally aware type, 4 = multioptional type, 5 = bike affinity type, 6 = forced mobile type.

Group	ID	Inner city	Age	Gender	Access to car	Heard of MaaS	Mobility Type
1	T3_1811	outside	63	f	no	no	4
	T2_1811	outside	65	m	yes	yes	4
	T1_1811	outside	65	m	yes	no	4
	T4_1811	outside	57	f	no	no	4
2	T4_2511	inside	25	m	no	no	2
	T2_2511	inside	24	m	yes	no	2
	T3_2511	inside	31	m	no	yes	4
	T1_2511	inside	28	f	yes	yes	5
3	T2_0212	outside	26	m	yes	no	2
	T1_0212	inside	22	f	yes	no	4
	T4_0212	outside	23	m	yes	no	1
	T3_0212	outside	24	f	no	no	2
4	T3_0412	outside	43	f	no	no	2
	T1_0412	outside	45	f	yes	no	1
	T4_0412	outside	44	f	yes	no	2
	T2_0212	outside	46	f	yes	yes	2
5	T1_0912_1	inside	18	f	no	yes	4
	T3_0912_1	outside	22	f	no	no	2
	T2_0912_1	outside	22	m	no	no	4
6	T4_0912_2	outside	25	f	no	no	4
	T2_0912_2	inside	23	m	yes	no	6
	T3_0912_2	inside	25	f	no	yes	2
	T1_0912_2	outside	32	f	yes	no	6
7	T1_1012	outside	53	m	yes	yes	4
	T3_1012	outside	61	m	yes	yes	4
	T2_1012	inside	65	m	no	yes	3
8	T2_1512	inside	33	f	no	yes	4
	T3_1512	inside	30	m	no	yes	2
	T1_1512	outside	32	m	no	yes	4
	T4_1512	outside	54	f	no	no	2
9	T3_1612_1	outside	39	m	yes	yes	4
	T1_1612_1	outside	31	f	yes	no	2
	T2_1612_1	inside	35	f	yes	no	4
	T4_1612_1	inside	37	m	yes	no	4
	T5_1612_1	inside	19	f	no	no	4
10	T1_1612_2	outside	23	f	yes	no	6
	T2_1612_2	inside	19	f	yes	yes	1
	T3_1612_2	outside	23	f	yes	no	1
11	T2_2312	outside	58	m	yes	no	1

(*continued on next page*)

(*continued*)

Group	ID	Inner city	Age	Gender	Access to car	Heard of MaaS	Mobility Type
	T4_2312	outside	70	f	yes	yes	1
	T3_2312	outside	63	f	yes	no	6
	T1_2312	outside	65	m	yes	no	1
12	T1_1301	outside	60	f	yes	no	1
	T2_1301	outside	57	m	yes	no	1
	T3_1301	outside	65	f	yes	no	1
	T4_1301	outside	45	f	yes	yes	1

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