Multimodal Mobility Packages – Concepts and Methodological Design Approaches

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Abstract. With the increased need to pursue the climate protection goals much more intensively efforts in many countries are directed towards a perceptible change in the mobility behavior of citizens. The main priority here is to reduce the private car ownership significantly making transport as a whole more environmentally friendly. A great variety of mobility providers are entering the market and complete the network around public transport with a wide range of services such as car sharing, bike sharing, e-scooter sharing, ride hailing, ride pooling, car rental, taxi, on demand shuttle or bus services, booked and paid via electronic platforms and smartphone apps. The comprehensive approach to combine these different mobility services into bundled subscription packages with special pricing schemes is one of the most important features of the MaaS concept.

First of all, the article considers the definition and general concept of MaaS. Afterwards, a step by step conceptual approach for designing mobility flat rates and subscription packages to support multimodal transport behavior will be presented and its possible effects will be discussed.

Keywords: Urban mobility · Multimodal mobility · Mobility-as-a-Service · Product bundling · Mobility packages · Subscription behavior · Conceptual design · Product pricing · Willingness of pay · Flat rates · User requirements

1 Background and Motivation

According to the United Nations World Urbanization Prospects 55% of the world's population today live in urban areas, a proportion that is expected to increase to 68% by 2020 [1]. This drives transport demand because more people require more mobility associated with considerable burdens on urban regions (see Fig. 1).

Actually, 1,32 billion cars (multi-track vehicles such as cars, buses and trucks) are registered worldwide, and their number will more than double to 2,7 billion by 2050 [3]. Even taking into account that 9,8 million cars are being taken out of service each year, these significant growth rates of road vehicles mean a tremendous increase of road traffic worldwide with the well-known environmentally harmful consequences. Private cars and taxis are currently used for nearly 75% of urban passenger transport in OECD countries and over 60% in non-OECD countries [4, p. 28]. Private vehicles will remain the preferred mode of personal travel worldwide. But whereas the private urban

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Fig. 1. Land consumption in cities by road traffic [2]

passenger transport will be slightly reduced in the OECD countries till 2050, it is expected to grow in the Non-OECD countries by 67% (Fig. 2).

Therefore, it is a primary concern of many megacities worldwide to reduce the number and usage of private cars significantly. Extensive measures are being taken in the capitals of many European countries to move toward this goal.

Madrid will be banning non-residents cars and heavy vehicles within a 500 acre perimeter in its core area. They are also repurposing 24 main arteries exclusively for bike and pedestrian use.

Copenhagen has pledged to become carbon neutral by 2025. The city currently has over 200 miles of bike lanes and 39 bike "Superhighways". Already half of the population bikes to work.

In Oslo all cars will be banished from the city center by the end of 2020. A country-wide ban of cars of city centers is planned for 2025.

Paris intends to eliminate all Diesel vehicles by 2024 and Petrol vehicles by 2030. By 2020, they will double the amount of bike lanes and make multiple streets exclusive to electric and no-emission vehicles.

In mid-2019, central London implemented zones for vehicles, including zero-emission zones in core business and tourist areas. Additionally, many protected bike lanes and pedestrian-only areas will be installed [5].

Helsinki wants to eliminate the need for private car ownership by 2025 based on plans to create an app-based, multi-modal, on-demand transport network throughout the city.

In Germany it is legally permitted for cities to ban diesel vehicles as a measure for air pollution control if NO_2 limits are significantly exceeded. Furthermore, it is the declared aim of the Federal Environment Agency to reduce the number of cars in cities from 450 to less than 150 per 1000 inhabitants.

All these measures are expected to shift people's travel behavior in cities towards public transport and shared mobility modes. In the current transport outlook scenario of the OECD International Transport Forum, the share of urban passenger kilometers

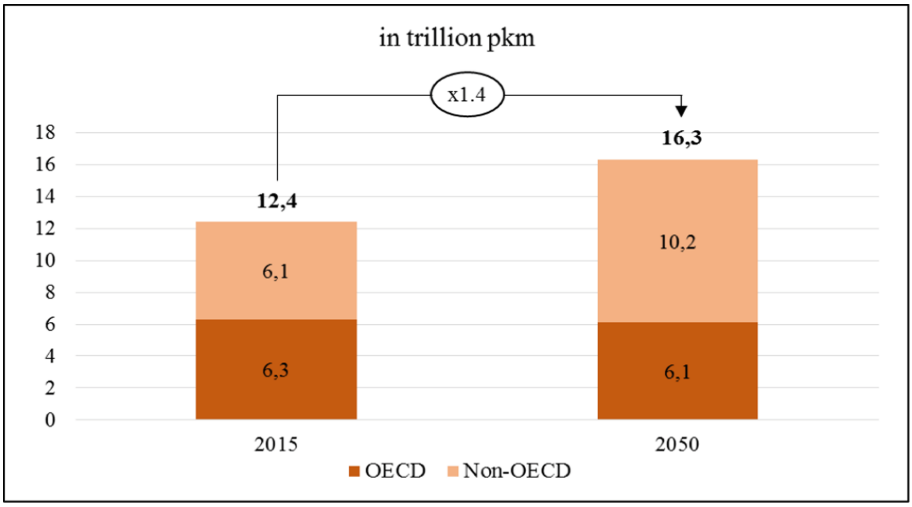

Fig. 2. Increase of urban private passenger transport from 2015 to 2050 [4, p. 28]

travelled in private vehicles (including individual taxi service) is forecasted to decline from around 70% in 2015 to 40% in 2050 [4, p. 77]. The possibilities to redesign the cities into green, low-noise and low-emission environmental friendly areas are very diverse and complex, including a great number of technological and business developments with disruptive potential (see Fig. 3).

This can be supported by the implementation of IoT-platforms performing an Intelligent Operation Centre (IOC) delivering multidimensional insights into a city from the macro to the micro level. Based on IoT-data the distribution and operating status of the municipal infrastructure and facilities including traffic, parking, power and water supply, heating and gas lines, street lights etc. can be monitored in real time. This also includes the operation of a complete urban mobility suite for vehicle operation and guidance, fleet management, public transport and intermodal trip management, incident management etc. Also traffic avoidance by innovative measures in the world of work, e.g. homeworking, co-working spaces or shared offices belongs to this[1].

In the mentioned overall concept smart mobility services for citizens undoubtedly represent a very significant and promising contribution. Urban areas have the most potential for game-changing mobility and transport innovations. That means to create and implement an app-based, multimodal, on demand mobility network throughout urban areas that makes the need for private cars obsolete. The user enters a destination in the app, then is presented the best door-to-door routing encompassing all possible

[1] In ITF Transport Outlook 2019, pp. 87–91, the impacts of increased teleworking and telepresence activities on urban passenger transport demand were investigated [4]. In the scenarios that simulate a disruptive development pathway for transport, teleworking and telepresence could affect between 3% and 30% of urban trips by 2050 and lead to a decrease in urban passenger-kilometers and related CO_2 emissions of around 2%.

Fig. 3. Possibilities to reduce private car ownership and redesign the cities green

travel modes: buses, trams, underground, trains, shared bikes, ride pooling/sharing, e-scooter, on-demand shuttles, taxis and ferries (see Fig. 4).

The payment for all used transport modes is also handled by the app. That means at least: intermodal transport from A to B has to become as comfortable as the own car. Because the preferences of citizens changes only very slowly towards new mobility services, especially to so-called active mobility modes such as cycling, micro mobility or pedestrian traffic, the question is which measures, offerings, approaches, incentives etc. can lead to effective transitions.

In this context, the term "Mobility-as-a-Service" (MaaS) has recently been intensively discussed in scientific literature and gradually implemented in transport markets, primarily in urban regions. The study "Mobility-as-a-service and changes in travel preferences and travel behavior" [7] provides a very comprehensive summary of the literature on this subject. Based on different definitions and a typology for "MaaS schemes", the preconditions for MaaS potential to challenge travel behavior pattern, the requirements and influencing factors for MaaS offers, the usage design and value contribution, the importance of travelers' characteristics and prerequisites for adoption of MaaS, the costs and willingness to pay are examined and described in detail.

Similarly, a special report by L.E.K. Consulting in partnership with Tourism & Transport Forum Australia and UITP Australia and New Zealand [8] highlights MaaS as the next transport disruption. Mulley et al. [9] elaborate in particular to what extent the Maas concept is relevant for public transport demonstrated in a case study with five Australian Community Transport Operators.

Findings and evaluation results from the UbiGo MaaS project in Gothenburg, Sweden are discussed in Karlsson et al. [10].

In addition to these literature reviews, the study WHIMPACT [11], delivers practical insights into the generated impacts of the world's first MaaS system operated by MaaS Global in Helsinki and several other European metropolitan regions such as Birmingham (UK) and Antwerp (Belgium).

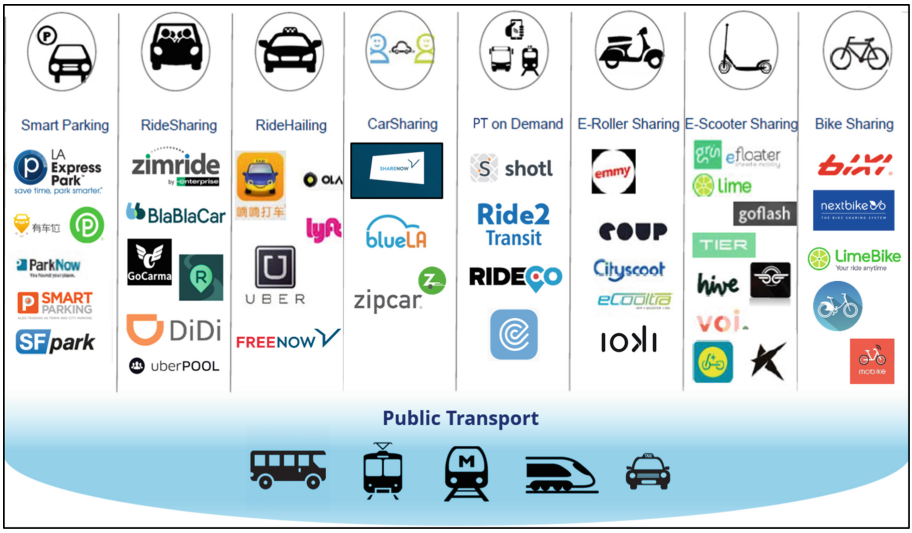

Fig. 4. Smart mobility services for citizens [6]

2 MaaS, Mobility Platforms and MaaS Ecosystem

Durand et al. [7] consider MaaS as "a new transport concept that integrates existing and new mobility services into one single digital platform, providing customized door-to-door transport and offering personalized trip planning and payment options" via a single app. The UITP [12] defines that MaaS is all about the integration of and access to different transport services in one digital mobility offer. This tailor-made service suggests to be the most suitable solution based on the traveler's needs, ensuring a door-to-door service and enabling life without having to own a car. Polydoropoulou et al. [13] see MaaS as a promising concept which aims at offering seamless mobility to the users and providing economic, societal, transport-related and environmental benefits to the cities of the future. A lot of similar definitions and explanations of the term MaaS can be found in [14–22]. The most important MaaS features are summarized in Fig. 5.

Moreover, MaaS requires a comprehensive ecosystem where multiple market players, transport companies, institutions, authorities and service industries act in collaboration leaving behind their traditional boundaries. That needs a high-performance mobility platform in the background, operated by a MaaS operator and MaaS integrator in the frame of a comprehensive MaaS ecosystem (see Fig. 6).

In the backend it is necessary to operate a central multimodal B2B platform that optimizes trip allocation, routing guidance, payment and tracking handling the data from the different transport companies and mobility service providers. The front-end application offers the customer interface with integrated functionalities (see Fig. 5) and additional services from other stakeholders.

In this context, we can distinguish between MaaS integrator and MaaS operator (see Fig. 6). The MaaS integrator is a company or organization that builds and manages the technical infrastructure shaping a comprehensive platform with standardized API's

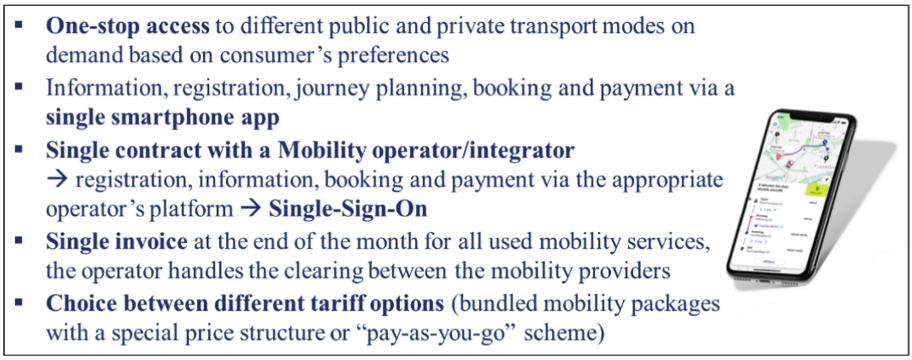

Fig. 5. MaaS features

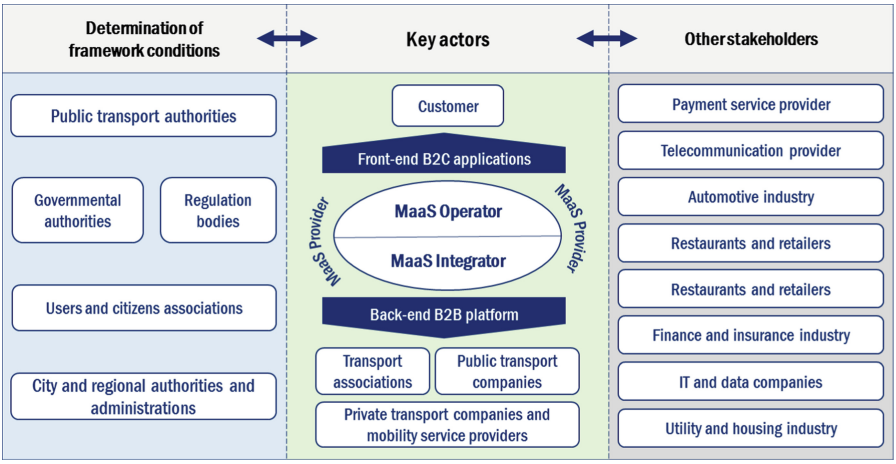

Fig. 6. Relevant stakeholders in the MaaS ecosystem [based on 35, p. 16]

for access and data exchange between different public and private transport companies and other mobility service providers offering on demand services, shared or value added services (see Fig. 4). On the one hand, the Maas Integrator must have access to all data concerning the vehicle availability or real time traffic data, and on the other hand, it must also be able to communicate the customers' request to the executing transport companies. This includes, for example, the booking of on-demand offers or the check of the allowance to open and use a vehicle in case of car sharing.

In summary, the Maas Integrator is responsible for the integration of data from multiple transport operators and infrastructure data and the MaaS operator builds the solution on the top of the integrated layer [12, p. 4].

The task of the Maas operator is to offer the customer different transport services from a single source. This includes, among other things, a user-friendly platform, usually in the form of a mobile application, for entering the customer's request and

setting the best route suggestions, booking and paying. The app allows the customer to use various mobility services but it does not mandatorily include multimodal mobility packages when each trip is billed individually. With regard to MaaS the supply of mobility packages in a subscription scheme will be in the responsibility of the MaaS operator. In order to make the business model profitable for the MaaS operator, the revenues must exceed the costs. The revenue per customer is calculated from the prices for the multimodal mobility packages and other revenues for additional services. On the cost side, in addition to overheads (e.g. IT, marketing, sales, administration), the main factor is the purchase of transport services from the transport companies. There are three ways for operators to purchase transport services: Purchase of transport services before demand, standard settlement when the transport service is used or lump sum payments to the transport companies without exact offsetting, that means purchase of fixed contingents without single accounting. The latter is a higher risk for the MaaS operator because the demand is volatile. Frequently, the operator receives an additional volume discount, although this is not the main aspect that makes the business profitable. This is primarily given in case of mobility bundles with fixed monthly subscription respectively flat rates because of the difference between the package price and the level of utilization of the mobility package quotas by the users. In a large number of cases customers do not use their packet budgets or flat rates in the full range as they could. This difference is one of the most important sources of profit for the MaaS operator [24].

In practice we can see that the role of MaaS integrator and MaaS operator can be taken over by one and the same company as a general MaaS provider. Smith et al. [23] have a deeper look at the role of MaaS integrators as the intermediaries between transport companies and Maas operators.

In the MaaS ecosystem other business oriented stakeholders originated from different sectors are integrated. These are technology-specific actors, e.g. from the IT and telecommunications industries, offering support to the key MaaS providers, internet access etc. But also industries delivering value added services to extend the MaaS offerings belong to this stakeholder category, such as the utility and housing industry, finance and insurance industry, the media, local restaurants and retail industry, delivery services and logistics (see Sect. 6).

Furthermore, in the MaaS ecosystem, regulators, policy makers and governmental authorities are responsible to set market rules and support level playing field. But also the institutional coordination between different authorities in charge of the mobility system in cities or regions is an important prerequisite for the breakthrough of MaaS.

Polydoropoulou et al. investigated different prototype models for MaaS business ecosystems in three study areas (Budapest, Greater Manchester and Luxembourg) based on the generic business model Canvas [13, p. 160]. The results indicated that especially the public transport operators along with local/regional public authorities appear to be the best positioned players to fulfil the role as MaaS integrator/operator. Nevertheless, in the study areas they were not able to take this responsibility because of structural and resource constraints. There is a strong need for policy interventions to support the successful MaaS deployment with respect to create a truthful environment between the involved market players, to establish standards for compatible data formats and standardized open APIs or to foster the cooperation of all stakeholders.

3 Mobility Packages

Product bundling is a well-known strategy of marketing products or services in particular combinations for which a special bundle price is offered. Service and price bundling plays an increasing role in many industries, e.g. banking, insurance, software, automotive or telecommunications. Bundles are very often composed of complementary products which should augment the benefit for customers by delivering value-added features or services.

A distinction is made here between pure and mixed bundling as well as a variety of other special forms. In case of a pure bundle, the user is offered a completed predefined bundle. In the case of mixed bundling the user can either purchase individual products outside the bundle/package or single components of the bundle separately.

The motivation for providers of bundled products is more or less to increase the profit by using a discount to induce customers to buy more than they otherwise would have.

In addition, the topics of cross-selling, the concealment of the real unit product prices, the price image and customer loyalty plays a significant role. The customers profit from the higher functional benefits by price discounts and for convenience reasons. Often, bundling is also referred to as a win-win situation, although this is not generally valid [25–27].

In case of bundled mobility packages, the motivation is somewhat different. The most essential moment is not profit maximation but to support the market diffusion of new or underutilized transport modes which are much more environmental friendly than to use the private car. When we look on a single trip, the different transport modes can have definitely a substitutive character. For example, the user can decide to use bike sharing when the weather is good, while car sharing is preferred when the weather is bad or when larger items need to be transported.

With regard to product bundling, Reinders et al. [28] came to the conclusion that the combination of well-known and from the customer already used products or services and lesser known new products in a bundle makes it easier for customers to choose a bundled offer instead of single products, as the risk of a wrong decision is considered to be lower. According to this, Matyas and Kamargianni stated that “in case of MaaS, even though shared services are gaining wider acceptance, their use could be accelerated by bundling them together with more popular modes such as public transport or taxi” [29, p. 1955].

As shown in Fig. 5, mobility bundles are an essential component of the MaaS concept. The term “mobility package” or “mobility bundle” used to describe an integrated offer of various mobility services which vary in terms of different attributes and characteristics, such as number of rides, travel time or distances. They can have a flat rate character but with allowances for special transport modes or be offered as a pay-as-you-go variant. The contractual relationship between user and provider of mobility packages is usually based on monthly subscription.

Caiati et al. understand by subscription and bundling that various transport modes and services are converted into service packages, stimulating customers to buy these

packages at a discounted price against different access prices for every single transport mode [30, p. 126].

Different studies and investigations tried to find out whether people are willing to use and to subscribe to mobility packages, how the bundles have to be designed, what pricing schemes are preferred, whether monthly subscription plans could be a promoter to change the mobility behavior of people towards the usage of more innovative environmental friendly transport modes, especially shared ones and so on [29, 30].

Therefore, in the following chapter a general step by step approach how to design mobility packages based on the MaaS concept is discussed.

4 Conceptual Approach for Designing Mobility Packages

For the conception of the design and pricing of mobility packages, numerous aspects have to be considered such as the determination of target groups, their mobility behavior, demand and preferences, type and scope of the mobility services included in the bundle, willingness to pay, ease of use and transparency or social influences.

The methodological approach to determine mobility bundles comprises in general two domains: The design-oriented aspect that helps to identify which among a feasible set of transport modes and complementary services should be combined in the bundle and the pricing-oriented aspects typically assume a service portfolio and propose the prices of the offered bundles [31, p. 18].

Figure 7 gives a more detailed overview about the sequential steps to determine the not independently existing partial aspects in the designing process of mobility packages.

With regard to *target groups and type of packages*, the mobility operator has in general three options for designing its products: a uniform product, target group-specific product variations or the user can assemble itself an own product from different allowed components (Create-It-Yourself) [32]. In the past, all customers were provided with more or less the same product. This reduces complexity and purchase prices due to high standardization but it severely limits demand, because the mobility needs and willingness to pay of the consumers are different. With the help of user segmentation into target groups, it is possible to counteract this problem by differentiating the products according to the customer's demographic, socio-economic, physiological and, in particular, behavioral characteristics [33, 34], but also regional or local specifics. This allows it to offer the customer freedom of choice without having to design an individual product for each customer. Finally, it is also possible to provide packages according to the modular principle where the customer can assemble the bundle himself (Create-It-Yourself). Here, the customer selects the preferred means of transport, the desired attributes and levels, while in the background the total price for the product is calculated. Such a high level of customer centricity reflects the mobility behavior of each individual best but is accompanied by a high degree of complexity. Nevertheless, different MaaS studies have shown that these offers do not in any case have the desired effect. For example, Ho et al. [32] conducted a stated choice survey in Sydney with 252 respondents, in which the users had to choose between various preselected and self-assembled choice sets. While 36.2% of the participants opted for a predefined package

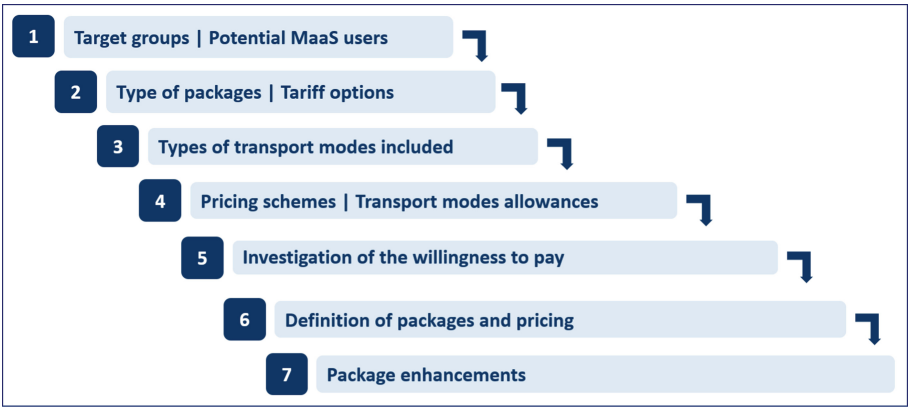

Fig. 7. Conceptual approach for the design and pricing of mobility packages

and 11.0% for a pay-as-you-use plan, only 32.1% chose a self-developed Choice Set. Ho et al. see reasons for this in particular in the fact that the respondents overestimated their mobility needs, leading to very high prices and that the predefined choice sets generally describe the requirements in a sufficient manner.

Conversely, MaaS providers that are already on the market for a longer period, such as MaaS Global with its Whim offer, see an urgent need in the near future to launch more target group-specific mobility packages better suited to the individual mobility behavior and the different requirements of users than it is the case today. Exemplarily MaaS Global communicates five different personas that can purchase different bundles with added service options according to their specific needs (e.g. family package, business world package, 15 min package) [36].

In terms of *package types and tariff options*, the question has to be answered whether multimodal transport services should be offered in bundles with a pure flat rate[2], i.e. without limits, as packages endowed with certain budgets for the included transport means or as mixed packages. Pure flat rate bundles allow the customer unlimited use of the integrated services [41]. Especially products with high fixed costs and marginal costs tending towards zero are predestined for flat rates.

In the mobility sector, which offers physical transport services, the circumstances in the provision of these services are completely different from those in telecommunications, for example, which offers virtual products in the form of the transmission of digitized data and is therefore more tending towards flat rate models. With regard to mobility bundles, the risk for pure flat rate tariffs is definitely too high for the MaaS provider because on demand taxi or car sharing services e.g. are not suitable for it due to considerable fuel and personnel costs. Therefore, mobility packages with budgets are preferred. There can be made a distinction between the possibility to divide the budget among several means of transport or to budget each mobility mode separately [35].

[2] An example for a pure flat rate is the classic monthly or yearly ticket for public transport in a city or limited region.

In practice, mixed bundles with a fixed monthly subscription fee are usually offered. In numerous studies [16–18, 29, 30, 32], the results indicate that the unlimited use of public transport must be an inherent part of the package whereas the other transport modes can be budgeted defining limitations for kilometers, time, number of rides or other parameters. Typical examples for this approach are the Whim packages from MaaS Global [37], the swa Mobil-Flat offered by the Public Utility Company in Augsburg (Germany) [38] or the SBB Green Class launched by the Swiss Federal Railways since 2017 [39]. On the other hand focus group interviews [17] and practical experiences from the MaaS markets indicate that offers in the "pay-as-you-go" scheme (no subscription fee, no surcharges) are highly preferred by users. From the currently signed more than 100.000 Whim users in Helsinki, Antwerp and Birmingham 90% use pay-as-you-go and only 10% subscribed monthly packages [24].

The reasons for this are manifold. Pay-as-you-go schemes guarantee the users a maximum flexibility without having to worry that the mobility services already paid in the subscribed package are not fully used. But they still have the comfort to invoice and pay all flexibly used services in a one-shop manner via their MaaS provider. Furthermore, the planned usage frequency of the transport modes included in the mobility package and the level of the user's monthly income play a significant role. While pay-as-you-go in particular is preferred by subjects without a fixed monthly income, subscription based packages have been more useful for the professionals.

The step of *product bundling* comprises selection of the various transport modes can be included in the multimodal mobility packages, such as bus, light rail (tram, underground etc.), regional train, bike sharing, car sharing, taxi, car rental, on demand transport services and micro mobility. This decision should be made primarily from the user's perspective to provide a real benefit for the customer.

Studies on this topic have been conducted, for example, in Leipzig (Germany) [42], London [29, 43, 44], Sydney [32], Helsinki [45], Amsterdam [46] and Switzerland [47]. The result of these studies is that in any case public transport is perceived as the backbone. For example, 96% of the respondents in Leipzig described the flat rate based public transport as very important or important within the mobility package that provides the greatest worth-part utility [42]. The studies conducted in London, Helsinki and Sydney have also shown that public transport has a significant positive influence on the decision whether the customer chooses MaaS or not [29, 32, 43, 44].

With regard to the evaluation of shared transport modes, such as car or bike sharing the findings diverge strongly. Whereas in Leipzig 52% and 41% of respondents consider respectively flexible or station-based car sharing as an important component of a bundled mobility tariff, it is not mentioned as an important component by the respondents in the other studies.

Furthermore, the results in [29] show "that even though respondents do not prefer shared modes in their MaaS plans, a significant number of them are willing to subscribe to plans that include these modes. Once they have subscribed, over 60% of them indicated that they would be willing to try transportation modes that they previously did not use if their MaaS plans included them" [29, p. 1951]. This can be seen as a strong promoter for changing the people's mobility behavior towards more traffic-reducing, private car abandoning transport modes and more sustainable ways of travelling.

Besides the decision what kind of transport services should be included in multimodal mobility bundles it is necessary to determine the *pricing scheme*, that means in what way and to what extent these services can be used within a certain package price. Therefore appropriate attributes and their attribute levels or values have to be defined, as shown in Table 1 exemplarily.

Table 1. Examples for transport modes pricing schemes [17, p. 436]

	Attributes and attribute characteristics					
Transport modes	Free floating car sharing*	flat rate (unlimited) < 30 min	10 rides < 60 min	up to 15 h or up to 150 km	300 min	pay per ride with 50% discount
	Station-based car sharing	48 h with 500 free km**	10 × 3 h incl., 20 km/ride	3 × 3 h incl. 15 km/ride	1 × 3 h incl. 15 km/ride	30 h without limit of km
	Bike sharing***	12 h flat rate****	flat rate, <1 h	10 ×30 min	5 × 1 h	pay per ride with 50% discount per ride
	Taxi (within the city area)	flat rate from 9 pm–5 am	50% discount on every ride	5 rides	1 ride	taxi outside the city area 30 km included
	Public Transport	Subscription	50% discount on a single ticket	10 rides	4 rides	unlimited rides in one zone, outside the zone pay per ride

* every additional minute 0,30 €/min
** minimum lending time 1 h
*** every 30 additional minutes 1€
**** 0–6 am do not count to the 12 h

Additional attributes in case of station-based car sharing could be the vehicle type (petrol, diesel or e-vehicle) or vehicle category (mini, compact, luxury, van/minivan, SUV).

Caiati et al. included in their comprehensive investigations to get insight in customers MaaS subscription decision seven different transport modes with each four different attribute levels [cf. 30, p. 131]. As can be expected, the estimated utility of the bundles increases significantly for the subjects when public transport is offered in a flat rate manner with unlimited rides and it reduces in case of pay per ride with a certain discount on standard fare. Contrary, the characteristics for e-bike sharing were assessed completely differently. The subjects preferred to include this service in their bundle when e-bike sharing was offered with a two part-tariff, pay per ride with a 50% discount. Contrary again, the respondents decided to integrate the mobility service e-car sharing in their bundle when it offers a certain amount of included travel allowances (e.g. 120 min) instead of pay per ride or pay per ride with a discount, whereas if taxi is offered with a relative high amount of travel distance (e.g. 50 km) the utility for MaaS

subscription tends to decrease [30, p. 138]. Regarding pricing schemes of car rental Caiati et al. found out that 4 days of rental included in the package has positive and significant effect on the probability of car rental to be chosen in a self-configured bundle. For the transport modes ride sharing and on demand bus the pricing schemes indicated that unlimited rides (e.g. flat rates) are most appropriate for the respondents.

With regard to *the willingness of pay* the consumers make their decision rationally, i.e. they weighs the benefits against the costs (homo economicus). Rising prices generally reduce the probability of the purchase decision. Many different studies in the MaaS environment (Ho et al. 2018 [32] and 2020 [40], Matyas and Kamargianni 2017 [44], 2018 [29], Ratilainen 2017 [45], Stopka et al. 2018 [17], Stopka 2020 [48], Caiati et al. 2020 [30]) have shown how strong the likelihood of a purchase at a certain price level is influenced by the disposable income.

As part of the "INTERmobil" research study for optimized pricing and product design of mobility packages conducted in 2018 by a research team of the Technical University of Dresden [42], approx. 300 subjects from the city and the district of Leipzig had to evaluate in a survey[3] various mobility bundles (S, M, L, XL) at monthly prices between 50 and 200 €. The calculation of the part-worth utilities (cf. Fig. 8) shows that the respondents were willing to accept a price up to a little more than 100 €. The strongest decline of the part-worth utilities for the attribute price, which means a decrease of the subjects' individual benefit, was observed in the case of a hypothetical price increase from 75 € to 100 €. For this reason, a subscription price of 75 € per month was favored for further studies and the intended market launch of the mobility package. In addition to an urban public transport flat rate, the package includes a bike-sharing flat rate for rides of less than one hour, 30 min of flexible and three hours of station-based car-sharing including 15 km, and one taxi ride per month in the city of Leipzig. 27.7% of the respondents would opt for such a multimodal mobility package [42, p. 18].

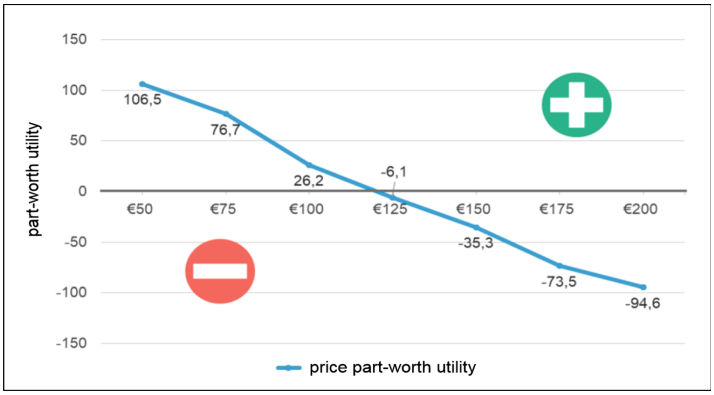

Fig. 8. Part-worth utilities of the monthly subscription price [42; p. 17, 35, p. 44]

[3] The investigation was designed as a stated preference survey and evaluated by a conjoint analysis.

In a study conducted in Helsinki in 2017 Ratilainen [45] compared the willingness to pay for mobility services included in bundles with the prices actually available on the market. The results of this comparison can be seen in Fig. 9.

means of transport	Quantity	Willingness to pay	Current price	Difference
Public transport	15 rides	56,50 €	32,70 €	+ 23,80 €
	Flat rate	117,14 €	52,40 €	+ 64,74 €
Bike-Sharing	6 rides	1,20 €	5,00 €	- 3,80 €
	Flat rate	6,65 €	4,20 €	+ 2,45 €
Taxi	3 x 10 km	11,57 €	63,00 €	- 51,43 €
	6 x 10 km	16,00 €	126,00 €	- 110,00 €
Car-Sharing	4 hours	-21,71 €	40,00 €	- 61,71 €
	8 hours	-24,93 €	80,00 €	- 104,93 €

Fig. 9. Comparison of willingness to pay for package included mobility services with actual prices [45, p. 59; 35, p. 45]

Remarkable are the differences in all involved transport modes. While the willingness to pay for six bike sharing rides per month is significantly lower than the prices actually available on the market (€1.20 vs. €5.00), the subjects are willing to pay a higher price for bike sharing when it is offered as flat rate (€6.65 vs. €4.20). This obviously shows the benefits the customers associate with a flat rate. The same can be observed for public transport. Contrary to bike sharing and public transport, the accepted reservation prices differed from the actual prices for taxis and car sharing significantly. Due to the high variable costs for these transport services, these offers are budgeted. For taxis, the willingness to pay varied depending on the number of included trips by a factor of five to eight from the current prices car sharing. Like some other studies revealed [29, 32, 43, 44] the benefit of car sharing within mobility packages is often evaluated negatively. Also in this case, the willingness to pay is far away from the actual prices on the market.

In summary, the studies have shown very clearly that the willingness to pay for each means of transport varies strongly. Only the diminishing benefit with increasing prices is generally valid.

In terms of *mobility package enhancements* a comprehensive range of additional features has been examined in various studies. Table 2 provides an overview about the analyzed features and their influences on the subjects' assessment of MaaS bundles.

Table 2. Impact of product enhancements on customers' purchasing decisions [cf. 35, p. 47f.]

Product expansion	Impact
Digital travel authorization (e-ticket) [49]	+
Compensation payments in case of malperformance (e.g. delay) [45]	+
Expansion to long-distance traffic [45]	+
Monthly changes/updates [45]	+
Discount for exclusion of rush hours (e.g. 9 o'clock ticket) [45]	+
Roaming [24, 50]	+
Guarantee of the pick-up time [24]	+
Telephone support/hotline [49]	+
Transferability (outside the household) [45]	+
Transferability of unused credits to the following month [45]	+
1st class transition [51]	+/o
Selection of different vehicle categories [45]	+/o
Combination with the residential rent [24]	+/o
Rewards for the use of environmentally friendly means of transport [24, 49]	+/o
Child seat included in the vehicle [45]	+/o
Transferability to household members [45, 52]	+/o
Real time alerts and notification about travel events (e.g. delay, disruption etc.) [30]	./.
App synchronization with personal agenda [30]	./.
Parking payment [30]	./.
Free non-renewable trial period [30]	./.
Subscription cancellation with no cancellation charge [30]	./.

+… positive, o… neutral, -… negative, ./. … not available

It may be remarkable that all product enhancements have been evaluated positively or neutrally. An exception is the list of additional features that have been examined in the study by Caiati et al. [30, p. 132 f.]. Some of them are listed in Table 2. The total of 11 selected features with 30 different characteristics were offered to the respondents with extra costs of between 5–40% of the monthly basic subscription price. In the context of this study of Caiati et al. [30] based on a web-based survey conducted in the Netherlands (mainly in the Amsterdam and Eindhoven region) the respondents were asked to choose among two possible combinations of additional features supplementing to their chosen bundle leading to a price surcharge. The analysis and evaluation results of the collected data giving insights in the respondents' willingness to pay for their bundle enhancement are not yet available.

In general, an increased performance of mobility packages is appreciated by the customers. Some of the enhancements are associated with low or no additional costs for the MaaS provider and should be taken into account in the product design for an attractive MaaS bundle.

5 General Methodological Approaches to Determine the Demand for Multimodal Mobility Packages

In order to be able to launch multimodal MaaS packages on the market it is necessary to determine the demand for such offers, the product design and pricing. Therefore a distinction can be made between

- objective measurements of the customers real observed selection behavior
- surveys of realized decisions (revealed preference) and
- surveys of hypothetical preferences (stated preference) or decisions (stated choice) [40, 53, 54].

The first two survey methods can be deduced either from previous transport usage data without MaaS or from the results of pilot projects. MaaS concepts such as Whim, UbiGo, swa Mobil-Flat, SBB Green Class etc. [55–60] have been scientifically accompanied, so that first insights into the usage behavior as well as the willingness to pay are possible. But the number practical examples are not enough for generally valid conclusions and recommendations.

Many of the studies mentioned in the previous section of this paper used stated preference data collection methods to investigate individual requirements for different MaaS bundles and the subjects' configuration choice with regard of the included transport modes, various pricing schemes, willingness to pay or additional features and services. Matyas and Kamargianni [29] and Ho et al. [32, 40] conducted corresponding stated choice and stated preference studies in London, Tyneside (UK) and Australia. For the evaluation and interpretation of a stated choice or a stated preference survey design the conjoint analysis is used in the most cases.

The conjoint analysis is a multivariate method in which various alternatives (choice sets) are presented to the interviewee and the interviewee decides for one alternative (stated choice) or has to make an assessment (stated preference). Each choice set consists of a combination of attributes (e.g., means of transport included, travel allowances or budgets, packet price etc.). In each round, several choice sets are presented to the survey subjects. By repeating the rounds with different choice sets, the benefit of individual attributes for the subjects can be statistically determined and conclusions can be made for the design of the packages [35].

Caiati et al. applied a slightly different procedural method in the Netherlands study [30] to estimate customers' preferences for MaaS plans. They focused on a customized bundle approach where respondents configure their most suitable mobility package by picking the preferred set if items from any of the available transport modes, service attributes and characteristics, each presented with varying prices [30, p. 145]. It can be expected that this kind of menu-based bundling (Create-it-Yourself) will provide comprehensive support for the market penetration of multimodal mobility packages.

6 Further Development Needs and Outlook

MaaS and mobility service bundling is still in its infancy with a very low market penetration. The mentioned studies in different countries and regions indicate that the most transport users are not yet disposed to subscribe to this new service in a large

number [30, p. 145]. To overcome this situation the following further development paths should be considered:

1. Extended range of customized MaaS packages

In future is needed a paradigm shift towards mobility bundling according to the modular design principle and calculating the total price for the packet in the background system as mentioned above. One of the early examples for this approach is the Green Class product of the SBB Swiss Federal Railways. It has a consistently modular structure with two fixed modules, named by SBB Public Transport and Electric Car Rental, which must be included in all cases. However, the customer can still select from a number of different attributes and characteristics of each module. Within the public transport module e.g., he can choose between a General Abonnement 1st or 2nd class includes the use of all classic public transport modes in Switzerland, a Half Fare Travelcard reduces travel costs by 50% or an individual public transport subscription. The second fixed module is the electric car rental. The customer can choose between three electric vehicle models including different mileages [59, 60].

In addition to the fixed components, the customer can optionally book further modules. These include the parking module, the Swisscharge 3000 module, which gives the customer an annual credit for charging his electric vehicle with a charging capacity of 3,000 km. The car sharing and bike sharing modules allow customers to use the vehicles at a reduced rate or to use PubliBike bicycles free of charge for the first 30 min of each ride. It can also be supplemented by bike sharing with e bicycles. The taxi module comprises 10 taxi vouchers worth CHF 25 per year [39]. The duration of the subscription package can be individually set by the customer between 12 and 48 months. Using an online configurator provided by SBB, interested customers can create their own desired modules and receive information on the respective prices. Due to the large number of different configuration options, the price varies greatly, but is at least CHF 699 per month and at most CHF 2,351 per month (as at September 2019) [39].

Such a high level of customer centricity reflects the mobility behavior and needs of each individual in the best way, but it also implies a hardly manageable complexity for both the MaaS providers and the customers. To reduce complexity, MaaS Global in the past used whim points for its MaaS packages depending on the size of the package. The customer could dispose of these points freely and allocate them to the most preferred transport modes. But nevertheless this approach was not very successful. According to Hietanen [24], the idea of whim points is being revived in order to actively influence the customer's travel choice. The user can earn Whim points by choosing environmentally friendly, sustainable means of transport and convert them into various rewards. This, in turn, closes the circle on the background and motivation of MaaS (see Sect. 1).

2. Roaming functionality

Roaming is a worldwide offered service mode at the telecommunications industry allowing the mobile subscribers the use of mobile phones outside the range of their home network. Such a functionality is also very attractive for users of mobility services if they could use the transport modes included in their bundles also in other cities or regions, offered by the own MaaS provider or other mobility service providers

integrated into a cross-regional MaaS platform. The customer can be debited for roaming as follows: no additional charges, surcharge on the costs in the home region or purchase of special country packages, as common in the mobile phone market. MaaS Global already offers roaming without extra charging. This includes - as of the end of 2019 - the cities of Antwerp, Birmingham, Helsinki and Vienna [61]. The attractiveness for the customers grows exponentially with the number of the included regions.

3. Mobility package upgrading by industry-related services and products

Cross-selling in cooperation with companies from other industries offers numerous upgrading possibilities. These can lead to additional revenues for the MaaS providers or the third-party companies, but also to more convenience for the customer.

Utility Industry and Real Estate Sector
Due to the fact that municipal transport companies are usually part of the municipal public utilities (e.g. responsible for energy supply), there are certain synergies can be exploited in the context of MaaS. The integration of mobility packages into the rent and the elimination of mandatory parking spaces as a result of less private car ownership seem to be possible [35, p. 87]. For example, MaaS Global is testing such a pilot with the housing provider SATO in Helsinki, where residents can purchase mobility packages at reduced prices [24].

Media Industry
The demand to consume digital media on the move such as newspapers, videos and music can also be used in the context of MaaS by offering on-board entertainment in the vehicles of the participating transport companies. Regardless of whether this is provided to customers free of charge, limited or as a premium it represents an additional comfort for customers. The billing can be done by the MaaS operator across all means of transport or directly included in certain mobility packages [35, p. 89].

Local Gastronomy and retail
Vouchers, discounts and other marketing activities connected with the mobility packages can ensure a higher number of customers in local businesses such as shops, restaurants, cultural institutions tec. This leads to more traffic demand, which usually takes place outside peak hours, and generates additional revenue for the MaaS operator [35, p. 90].

The design of multimodal mobility packages based on MaaS concepts requires a consequent step by step customer-centric approach. Many different aspects have to be taken into account particularly customer behavior, regulatory, commercial and technical issues. Public transport in a flat rate scheme is seen as an indispensable component of any kind of mobility bundles. MaaS should be built around public transport. This is particularly noteworthy in the context that Luxembourg is the first country in the world offering all public transport (bus, tram and train except 1st class) free of charge since the end of February 2020, with the aim of making public transport as attractive and reliable as possible. For the Luxembourg state, this means additional expenditure of 41 million euros per year [62].

The creation and implementation of multimodal mobility packages on the market are a relatively new topic and we are in an early stage to understand what this special

offer might mean for mobility demanders and suppliers. A great number of studies provide theoretical investigations to estimate demand, the main factors influencing purchasing behavior, customer preferences, business models, environmental impacts, etc. By presenting and linking experiences from these studies and practical examples, this paper tries to present promising approaches for the design of mobility bundles and to give recommendations for the implementation in practice.

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