Mobility as a Service (MaaS) Based on Intermodal Electronic Platforms in Public Transport

Ulrike Stopka(✉), René Pessier, and Christian Günther

Technische Universität Dresden, Dresden, Germany
ulrike.stopka@tu-dresden.de

Abstract. Driven by megatrends such as globalization, urbanization, climate change and technological progress, the mobility sector is undergoing a strong process of change which is characterized in particular by the intermodal cross-linking of various public and private mobility services. The aim is to make transport as a whole more environmentally friendly. To meet this challenge "Mobility as a Service" (MaaS) concepts are introduced in the market which offer individualized one-stop access to several bundled travel services based on customer's needs. The supply of so-called mobility packages requires very close cooperation between the various players on the transport market who use electronic platforms for this purpose. First of all, the paper gives an overview about the research activities and the implementation status of MaaS concepts in different countries. In the following chapters, the general approach and methods for the development of mobility packages are discussed and first results of related research projects in Germany are presented.

Keywords: Urban mobility · Mobility as a Service · Intermodal transport
Mobility platform · Mobility packages · User requirements
Van Westendorp analysis · Conjoint analysis

1 Introduction

Mobility behavior in Germany is currently undergoing rapid changes. Especially in urban areas, people choose the means of transport much more pragmatically and flexibly then years before. As a result of the advancing technological development and the increasing demand of customers, more and more providers are entering the market and complete the network around public transport with a wide variety of mobility services such as car sharing, bike sharing, ride selling, ride pooling, rental cars, shuttle services, intermodal routing and ticketing apps and so on. This comprehensive approach to integrate the different forms of mobility and bundling various private and public transport services on an electronic platform is known as Mobility as a Service (MaaS). The core idea of MaaS is to offer individualized product packages for the integrated use of mobility services consistent with the current needs of the users.

First of all, the article considers the definition and general concept of MaaS and gives a short overview of the implementation status of such offers in different countries. After this, the scientific approach and first empirical research results from two research

M. Kurosu (Ed.): HCI 2018, LNCS 10902, pp. 419–439, 2018.
https://doi.org/10.1007/978-3-319-91244-8_34

projects are presented. Within the research projects “INTER-mobil” and “Regional Cooperation and Mobility Platform”, both funded by the Federal Ministry of Transport and Digital Infrastructure, the prototypical provision of MaaS in Leipzig and in the area of the Rhine-Main Transport Association is investigated and tested in the period 2017/2018. In both projects, the Technical University of Dresden is responsible for the analysis of user requirements, the conceptual development of the intermodal product bundles (mobility packages) and during the implementation phase for the evaluation of usability, user experience and customer acceptance.

2 Definition and Concept of “Mobility as a Service” (MaaS)

Both the term and the concept “Mobility as a Service” are still quite new, but are becoming increasingly important. Therefore, the MaaS Alliance, formed by various companies, research institutions and state authorities, was founded during the ITS World Congress in 2015.

Until today, there has not been a common definition of the term “Mobility as a Service” (MaaS) in the literature. Many different opinions exist concerning the services which fall within the scope of MaaS and the extent of the integrated modes of transport.

For example, the transport service provider Uber itself is sometimes referred to as Mobility as a Service [1, p. 20]. Taken MaaS literally, this is certainly true, but it does not go far enough for the original idea of MaaS as a business model and mobility platform. According to this, MaaS is intended to bridge the gap between private and public transport, i.e. to link public transport with different sharing and hailing services, taxis as well as rental cars and integrate them in an organized way for the user [2, p. 2]. This understanding is also called “Combined Mobility Service” [1, p. 7].

Kamargianni et al. [3, p. 3294] underline “MaaS stands for buying mobility services based on consumer needs instead of buying the means of mobility”.

In a paper from RailNewcastle 2016 [4], MaaS is defined as “a shift away from personally owned modes of transport and towards mobility solutions that are consumed as a service. This is enabled by combining transport services from public and private transport providers through a unified gateway that creates and manages the trip which users can pay for with a single account. Users can pay per trip or a monthly fee for a limited distance”.

For this paper, the understanding of the term MaaS is the following: the customer makes a contract with a MaaS operator, also called “transport broker service”, who then offers him or her different transport services bundled in a mobility package with a special price structure and makes them accessible via a single smartphone app. The requested transport service itself is provided by various transport companies. Billing and the communication with the customer are handled solely by the MaaS operator. The billing between the MaaS operator and the actual carrier or mobility service provider takes place in the background which is very convenient for the customer. This approach also enables a user-friendly roaming between various mobility service providers. The customer has access to an extensive mobility system from a single source. The mobility package includes quotas for public transport as well as car, bike, scooter and ride sharing, rental cars and taxis. The integration of further mobility services, such

as long-distance buses and regional rail services, but also smart parking, charging of electro vehicles and usage of autonomous driving cars, could be considered in the future. Figure 1 shows the way in which MaaS will be implemented within the framework of the two above-mentioned research projects.

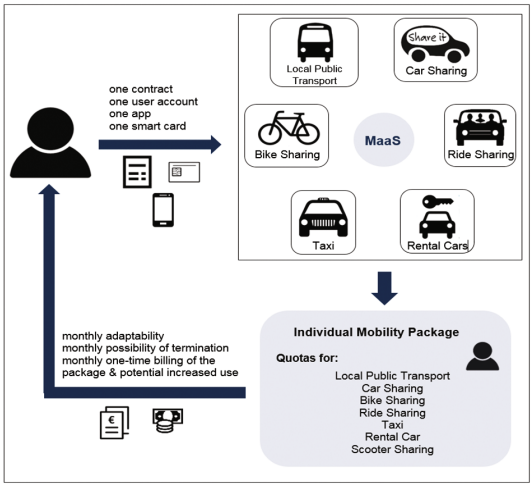

Fig. 1. Operating and using mode of MaaS [5, p. 21]

3 Brief Overview of International Research Activities and the Implementation Status of MaaS Concepts in Different Countries

MaaS research activities are mostly focused on supplier issues and the practical implementation of new mobility concepts. Business models between the individual transport companies and the MaaS operator, technical requirements as well as harmonized standards for data interfaces, access to data or infrastructure are of particular relevance for industry and science. Holmberg et al. [1] gives an overview of research activities in the Nordics and other European countries relating to MaaS until 2015/2016. The most research projects in this area have been conducted in Sweden and Finland, but also in the UK, USA and in Austria. For example, the "Mobility as a Service for Linking Europe" (MAASiFiE) project (2015–2017) was financed by the Conference of European Directors of Roads in its Transnational Road Research Program on Mobility and ITS. Objectives of the project included the future trends analysis of MaaS including multimodal traveler information services, ticketing/payment systems and sharing concepts, development of business and operator models as well as the evaluation of the social-economic and environmental impacts of MaaS. This MaaS Roadmap 2025 project was coordinated by the VTT Technical Research Centre of Finland Ltd. with the partners AustriaTech and the Chalmers University of Technology Sweden [6].

In 2017, Greater Manchester became one of the first regions in the UK to implement a business model around MaaS, delivered by Atkins Intelligent Mobility UK & Europe. As a part of Transport for Greater Manchester's vision to make travel easier for all residents, the project investigated smart technologies for planning and payment of door-to-door journeys – trams, buses, bike hire and ride sharing – in one transaction. The benefits for the region comprise a more comfortable travel experience for users and fewer cars on the region's busiest roads i.e. less congestion and pollution [7].

In Asia, a MaaS testbed and research was started in 2017 by the Nanyang Technological University (NTU) Singapore together with the Jurong Town Corporation (JTC) and the SMRT Corporation, one of the largest public-transport companies in Singapore. The testbed on the NTU campus and in the JTC CleanTech Park is focused on introducing new mobility services such as autonomous vehicles, shared personal mobility services, on-demand ride sharing, integration of MaaS mobile apps and developing parameters for data analytics, transport optimization and MaaS business models. The MaaS app "jalan" is the first of its kind in the region aimed at improving commuters' travel experience by seamlessly integrating train and bus networks with next generation transport modes, including self-driving vehicles, bike sharing systems and personal mobility devices such as e-scooters [8].

In the context of international research activities, the Maas4EU project within the EU's framework program for research and innovation, Horizon 2020, should be mentioned in particular. The main goal of MaaS4EU (2017–2020) is to provide quantifiable evidence, framework and tools to enable an interconnected EU transport market based on the MaaS concept by defining sustainable business models, supporting the cooperation between transport stakeholders, understanding user needs and choices, implementing the required infrastructure in the form of a MaaS mobility hub and identifying the adequate regulatory conditions. The project will quantify MaaS costs and benefits in three complementary real-life pilot cases by demonstrating the concept for urban, intercity and cross-border mobility services in three EU areas (UK, LU-DE, and HU). The project consortium consists of 17 partners from nine countries, among them leading industrial partners, research institutions and consultants, transport authorities, ministries and operators [9].

Although Helsinki with the Whim app may be the forerunner of the arising MaaS movement and introduction of pilots in practice, it is not alone. A lot of other cities around the world, such as Paris, Eindhoven, Gothenburg, Vienna, Hannover, Las Vegas, Los Angeles, Denver, Singapore or Barcelona, have launched local versions of MaaS in order to plan and pay for all modes of public, private and intermodal transportation (train, tram, taxi, bus, car-/bike sharing and ride hailing). Table 1 illustrates the implementation of selected MaaS pilots around the world. Some of them did not go beyond the test phase or are undergoing continuous further developments.

The research projects and the selected pilots in the different cities all over the world show very clearly that MaaS is still in an early stage with much experimentation underway. In general, they can be differentiated according to the integration level of various transport systems, the scope and type of payment systems, the offer of mobility packages and the level of ICT integration.

Table 1. Selected Maas pilots around the world

Project	Description	Operated by	Scope	Level of integration
Helsinki Model – Whim [10, p. 122]	Through its subscription-based integrated mobility app Whim, MaaS Global offers users access to a variety of transportation options, from taxis to rental cars, Helsinki public transport, and bike share. The users can choose between three mobility packages from "Whim to Go" (pay per ride) to "Whim Urban" (49 € per month) to "Whim Unlimited" (499 € per month). With the flat rate rules, customers can themselves assemble the above mentioned means of transport to varying proportions. The Whim app will be launched in Singapore in 2018	MaaS Global	Helsinki	Advanced with mobility packages
UbiGo [2, p. 2] [10, p. 122]	With this fully integrated mobility service, it is possible to use the regional public transport services as well as car and bike sharing, rental car and taxi services from a single source. Customers can combine household-based quotas for individual transport services within pre-paid packages. The booking of the contingents for rental cars, taxis, car and bike sharing is made on a time-based basis with variable additional costs if the contingent is exceeded or the unused contingents are credited for the next month. The service is accessible from the user's side via a smartphone app, in which, for example, the packages could be assembled and adapted,	Part of the project Go:Smart by Lindholmen Science Park, with partners from industry, academia, and government, co-funded by Vinnova	80 households; approx. 200 users in the city of Gothenburg	Advanced with mobility packages

(*continued*)

Table 1. (*continued*)

Project	Description	Operated by	Scope	Level of integration
	and a smart card that could be used to open the car sharing vehicles, for example			
Moovel [10, p. 122]	Enables users to search, book, and pay for rides with a single app - book and pay for car2go, mytaxi, and Deutsche Bahn in a single experience. Public transportation mobile payments are available in Stuttgart and Hamburg	Daimler	Germany; also testing in Boston, Portland, and Helsinki	Partial
EMMA [3, p. 3299]	EMMA is an integrated personal transport platform in Montpellier, France. Customers can purchase a monthly or a yearly mobility contract, including the usage of all services that TAM operates. These mobility contracts are tailored towards various user groups and differ in their payment structure. As the bike sharing service and the parking services include hourly rates, these can be paid after usage by cash or direct debit. TAM also cooperates with Montpellier's car sharing service "Modulauto" by offering users multimodal subscriptions. For a fixed annual or monthly fee, users have free access to the city's public transport network, car and bike parks and can also rent Velomagg bicycles and Modulauto cars	TAM public transport operator	Montpellier	Advanced with mobility packages
HannoverMobil [3, p. 3299]	Hannovermobil is the advanced integration of public transport, car sharing, and taxi and has a cooperative relationship with long distance rail and	Großraumverkehr Hannover Ltd. (GVH) – transport association of six transport companies and the region Hannover	Hannovermobil subscribers	Higher complexity

(*continued*)

Table 1. (*continued*)

Project	Description	Operated by	Scope	Level of integration
	car rental operators. Hannovermobil subscribers access Stadtmobil car sharing vehicles and get discounts for taxi services operated by Hallo Taxi, car rental by Hertz and long distance rail. Customers receive an integrated mobility bill at the end of each month that includes all basic cost as well as taxi and car sharing usage fees			
SMILE App [10, p. 122]	SMILE provides cooperation not only bet-ween urban public transport, rail, car sharing, bike sharing, car rental, and taxi but also between other interested partners such as software companies, engineers and environmental protection groups. It is an intermodal integrated solution delivering information, booking, and payment. A standardized interface enables all mobility partners to link their technical systems via specific adaptors to provide all their data, including ticketing	Wiener Stadtwerke in cooperation with Wiener Linien; Austrian Federal Railways; private car sharing, taxi, bike sharing, service providers	1,000 pilot participants in Vienna	Higher complexity
Communauto/ Brixi [10]	In Quebec, some municipal transport authorities have offered mobility packages that include bike sharing by BIXI and car sharing provided by Communauto. For example, a user can save on the regular price of a public transport pass and bike sharing by subscribing to the BIXI-AUTO-BUS package	Communauto	Cities in Quebec, Canada	Advanced with mobility packages

(*continued*)

Table 1. (*continued*)

Project	Description	Operated by	Scope	Level of integration
SHIFT [3, p. 3300]	SHIFT provides services including shuttle buses, bike sharing, car rental, car sharing as well as a valet service. It does this by owning all of the vehicles in its fleet and not by partnering with other service providers. The user chooses the destination in the journey planning tool and the SHIFT app will make a choice of transport modes for the user. One minute of travel time on bikes, cars or SHIFT's Valet + service equals one minute of trip time. As monthly trip time is determined for total usage, customers have the flexibility to divide up the time among the services in a way that best suits their lifestyle. These pre-paid monthly packages allow customers to pay for all their usage beforehand at once. If the customers run out of trip time, they can buy more à la carte	Las Vegas Transportation Startup SHIFT	Las Vegas	Advanced with mobility packages

4 Prerequisites and Stakeholders in the MaaS Ecosystem

MaaS needs a comprehensive cooperation between different players and components on the mobility market (see Fig. 2).

To the infrastructure aspect belong the customers' mobile devices (smartphones, tablets, phablets etc.), the needed 3G/4G/5G mobile phone networks and other radio technologies (WLAN, Bluetooth Low Energy, ZigBee etc.) assuring a high level of connectivity, secure real-time travel information, and cashless payment as well as different IT platforms from the various market players, application programming interfaces (APIs), apps and other software modules. Conditio sine qua non for sophisticated MaaS is a very thoughtful integration of both physical and virtual infrastructure components.

Data providers include a wide variety of public and private companies responsible for assembling, delivering and updating all the scheduled and real-time traffic data, navigation and whether data etc. users can access through a MaaS app or webpage.

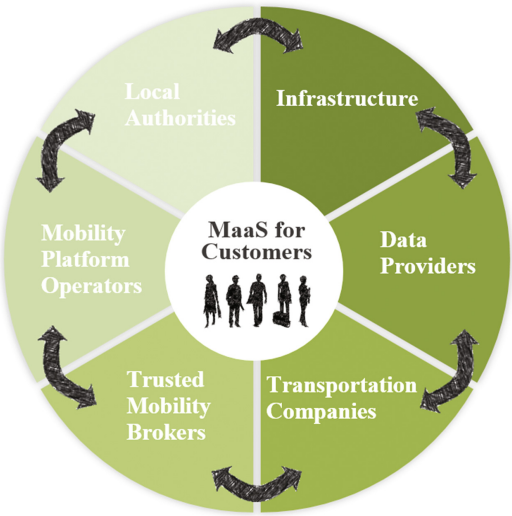

Fig. 2. MaaS ecosystem

The most important stakeholders in the MaaS ecosystem are the transport companies providing a broad range of travel modes – from public transport to a diverse spectrum of complementary services such as car sharing, bike sharing, shuttle services and on-demand bus rides. They are the owners of transportation assets.

Mobility platform operators perform the intermediary layer between the transport companies and users or amongst the transport users themselves. They collect data on customers' movement across the different transport networks in order to understand travel behavior and discover travel patterns. On this base, mobility platforms (e.g. CityMapper, Moovit, Ally, BlaBla Car, Flixbus or trainline.com) run on a fierce level of competition matching and calibrating mobility demand and supply.

Trusted mobility brokers are also a kind of intermediary. They manage the data exchange between the multiple mobility service providers, facilitate the APIs and gateways, link the offerings of the various private and public operators and arrange bookings and payments through a single point of sale. These third-party aggregators help to overcome the data sharing barriers amongst the heterogeneous mobility service providers and support their cooperation.

Whereas the transport companies and other business partners on the MaaS market search for profit, local public authorities create the framework conditions for Maas in their regions, seek the public benefits that stem e.g. from reduced congestion, less environmental pollution and reduced space for parking in order to improve the peoples' quality of life.

5 General Approach and First Results for the Creation of Mobility Packages Within the Framework of MaaS Concepts

Within the research projects "INTER-mobil" and "Regional Cooperation and Mobility Platform", the prototypical provision of MaaS in Leipzig and in the area of the Rhine-Main Transport Association will be investigated and tested in the period 2017/2018. In this context, the question arises in which way reasonable incentives for less private cars can be created through the conceptual design of MaaS, e.g. through a sophisticated price-performance structure and quality of service. In other words: What user requirements should a MaaS concept meet in order to ensure that people are willing to adjust their mobility behavior to such a multimodal mobility scheme in the long-term?

In the following sections, we would like to address a specific aspect connected to the above mentioned question, namely the investigation of the user acceptance for differently designed mobility packages. For that purpose, the results of a user survey are presented as a pretest for a more comprehensive mixed method approach in order to evaluate various product bundles.

5.1 Pretest: Focus Group Discussions

The first consideration was that the MaaS service provider take the position of a "virtual" broker combining the physically available mobility offers of the transport companies and bundles them, including a new price structure. This can facilitate the intermodal use of different means of transport for the customers considerably. The general approach for the focus group interviews is shown in Fig. 3.

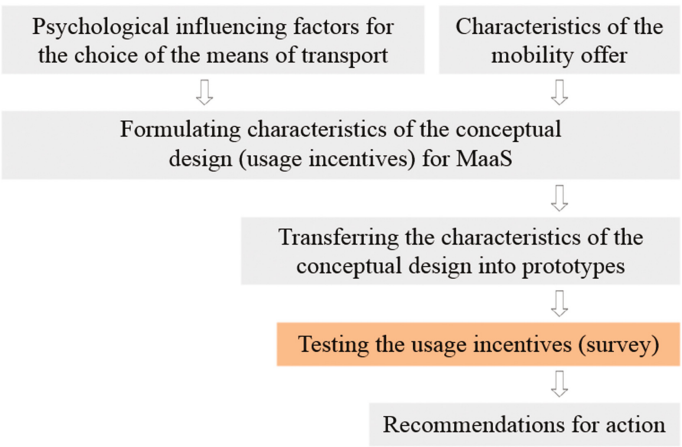

Fig. 3. Research design for the identification and testing of MaaS usage incentives

The guideline-based interviews were conducted in July 2017 with 15 subjects in Dresden and Frankfurt/Main. In accordance with psychological factors of influence on the users' mode of transport choice, such as control of mobility expenditure, situation-specific demands, emotional and affective attitudes, habits and personal norms, three MaaS concepts were presented to the subjects[1] for selection. A quantifying content analysis made it possible to transform the subjects' verbal answers into nominal scaled numerical data. Therefore, a four-categorical nominal scale (−2, −1, 1, 2) with an additional score of "0" for indifferent statements was used. The scale is to be interpreted in the sense of "bad" (−2), "rather bad" (−1), "indifferent" (0), "rather good" (1) and "good" (2).

Light	Medium	Medium Extra	Premium
89 € / month	**169 €** / month	**249 €** / month	**389 €** / month
local public transport subscription (city rate until airport) + 1.000 mobility points	local public transport subscription (city rate until airport) + 3.250 mobility points	local public transport subscription (city rate until airport) + 5.500 mobility points	local public transport subscription (city rate until airport) + 10.000 mobility points
Use your mobility points just as you like!	Use your mobility points just as you like!	Use your mobility points just as you like!	Use your mobility points just as you like!
For example, for:	**For example, for:**	**For example, for:**	**For example, for:**
2 cab rides or 60 min car sharing + 100 min bike sharing	4 cab rides + 1 day rental car or 2 cab rides + 1 day rental car + 200 min car sharing or 300 min bike sharing	8 cab rides + 2 days rental car or 4 cab rides + 1 day rental car + 300 min car sharing or 400 min bike sharing	10 cab rides + 5 days rental car or 6 cab rides + 4 days rental car + 300 min car sharing + 400 min bike sharing

Fig. 4. MaaS prototype concept 1: mobility package according to Whim [5, p. 63]

Prototype 1: Mobility Packages (principle Whim – ideal concept)
Users can choose between different packages that contain a different contingent of "mobility points" in a prepaid scheme. Mobility points[2] are used to pay for mobility services. The scope of services includes taxi, rental car, public transport, car sharing and bike sharing. A monthly season ticket for public transport ticket is always

[1] In the sample were nine male and five female subjects in the age between 18 and 56 years, nine subjects employed, four in training and one unemployed, eleven subjects lived in urban areas and four in suburban areas. 40% of subjects were not intermodal and 33% showed a strong intermodal mobility behavior. 27% were car sharing users and 7% bike sharing users, 27% owned a car and 67% owned a public transport season ticket, i.e. they were regular public transport users.

[2] Since July 2017, the Whim concept has undergone changes. The packages are now "Pay per Ride", "Whim Basic" and "Whim to Go". Also, a price unlimited business package ("Whim Business") has been added. In addition, the Whim Points in the new system are worth one Euro. This means that the value of the Whim Points is better perceptible for the users.

integrated. One mobility point equals one Euro. The entire service chain (registration, booking, payment and billing) is bundled in one product. Four different mobility packages are available (Fig. 4).

Prototype 2: Pay-as-you-go (principle Leipzig mobil)
Basic fee of nine Euros per month including 300 min bike sharing contingent; the mobility services are individually bookable, no monthly package (Fig. 5).

Local Public Transport	Rental Car	Car sharing	Bike sharing
Monthly ticket (city rate until airport) 65 €	**Fixed price**	**Normal car** 0,29 € / min	**Fixed price** 300 minutes / month inclusive, then 0,50 € / minute
Seven-day ticket (city rate until airport) 20 €	***Small car*** 25 € / day (incl. 400 km, then 0,21 € / km)	**Deluxe car** 0,32 € / min	
Day ticket (city rate until airport) 6,50 €	***Mid-range car*** 45 € / day (incl. 400 km, then 0,24 € / km)		
Single ticket (city rate until airport) 2 €	***Luxury-class car*** 80 € / day (incl. 400 km, then 0,29 € / km)		

Fig. 5. MaaS prototype concept 2: basic fee and pay-as-you-go [5, p. 63]

Prototype 3: Reduced Mobility Packages (principle Whim simplified)
Like prototype 1 but less choice and less premium focus (no rental car) (Fig. 6).

Light	Medium	Medium Extra
89 € / month	**129 €** / month	**199 €** / month
local public transport subscription (city rate until airport) + 1.000 mobility points	local public transport subscription (city rate until airport) + 2.500 mobility points	local public transport subscription (city rate until airport) + 5.500 mobility points
Use your mobility points just as you like! **For example, for:** 100 min car sharing + 200 min bike sharing	Use your mobility points just as you like! **For example, for:** 250 min car sharing + 500 min bike sharing	Your carefree package! **Including:** 600 min car sharing + unlimited bike sharing

Fig. 6. MaaS prototype concept 3: reduced mobility packages [5, p. 64]

The price calculation in the prototype concepts is based on the price structures of Whim in Helsinki with a discount between 6% und 20% depending on the package, the tariffs in the city of Leipzig and Frankfurt/Main as well as car rental and car sharing providers in Germany. In comparison to the former original price structure of Whim Helsinki (Light Package 89 €, Medium 249 € and Premium 389 €), an additional price level was introduced in the prototype concept 1 since a 2, 8-fold price jump between the first two price levels in Whim does not seem to be appropriate.

The evaluation of the guideline-supported interviews showed that all three concepts were evaluated clearly positively by the test persons on a scale of "−2" (poor, refusing, unfavorable) to "2" (good, favorable) (see Fig. 7).

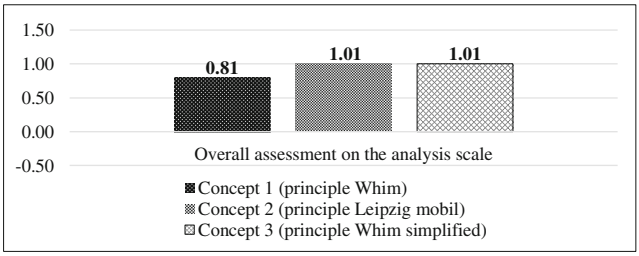

Fig. 7. Overall evaluation of the presented/proposed concepts (n = 15) [5, p. 73]

The basic idea behind MaaS was generally well accepted. The user can choose individually from a pool of mobility solutions at any time. It has been shown that the potential availability and the easy access to the most appropriate means of transport give the customer, in each case, a feeling of mobility insurance. Furthermore, it was evaluated positively that the services are all available via a smartphone app. Nevertheless, the ideal concept (concept 1), which guarantees the highest degree of flexibility, did not receive the best marks as to be seen in Figs. 7 and 8. On the one hand, this is partly due to the fact that the subjects were very price-conscious. In the interviews had to be emphasized again and again that the prices in the fictive packages should only give a better imagination for the subjects. On the other hand, 67% of the subjects owned public transport season tickets (semester ticket, student ticket, social ticket) so that the ideal concept 1 met their needs only to a limited extent.

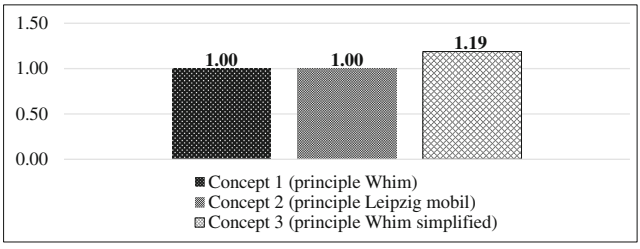

Fig. 8. Evaluation of the willingness to use the three presented concepts (n = 15) [5, p. 77]

In the context of price consciousness, the very different evaluation of the MaaS packages depending on the income of the subjects is very interesting (see Figs. 9 and 10).

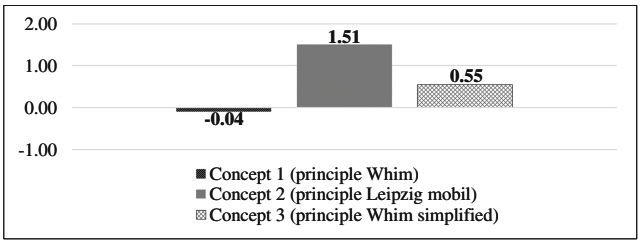

Fig. 9. Overall rating of the MaaS concepts among subjects without a fixed income (n = 5) [5, p. 79]

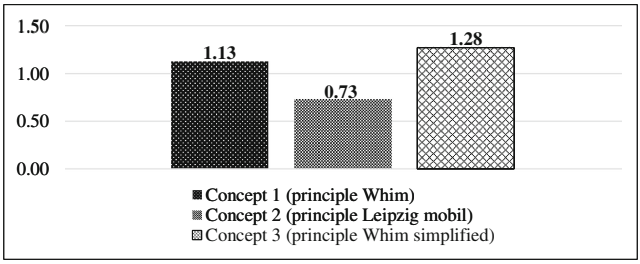

Fig. 10. Overall rating of the MaaS concepts among subjects with a fixed income (n = 10) [5, p. 79]

People without a fixed income prefer mobility services that are charged according to the pay-as-you-go principle. Persons with a fixed income see the plannable, pre-determined expenses as a significant advantage (flat rate character within the package budget).

These differences are also clearly reflected with regard to the willingness of use the MaaS concepts depending on income as shown in Table 2.

Table 2. Willingness to use MaaS concepts depending on income [5, p. 80]

	Without a fixed income (n = 5)	With a fixed income (n = 10)
Concept 1	0	1.38
Concept 2	1.5	0.71
Concept 3	1	1.4

What are the most important results and findings from the pretest for designing potential MaaS offerings in urban agglomerations in Germany?

The subjects consider the centralized access to a large number of bundled mobility services as an essential added value with regard to the ease of access, flexibility of choice and comparability. There is a willingness to pay a basic fee despite high price sensitivity, because it already offers access to a certain contingent of basic mobility (e.g. bike sharing minutes).

The concept of mobility points was misleading for a part of the subjects. The real value of the "point currency" was non-transparent in the direct comparison of mobility offers. The examples on how the mobility points could be used for a self-determined mix of various mobility services (see Figs. 4 and 6) were considered as being "set" or fix. On the contrary, subjects who correctly understood the mobility point concept appreciated the high level of flexibility.

The prepaid mobility packages were on the one hand considered as "cost airbags". On the other hand, they were regarded as a cost trap because the subjects were concerned about the expiry of points that have already been paid.

All in all, the customers could not sufficiently grasp the product in form of a mobility package and therefore, they had no idea of the price they are willing to pay for it. That means that the customers' imagination must be activated much more intensively with regard to the use of mobility packages and their pricing schemes. This can be achieved by testing real mobility packages (no dummies) in practice and possibly integrating them into existing mobility apps of a transport service provider.

5.2 Further Steps in the Research Work/Project

After basic theoretical considerations on flat rates, effects that promote flat rate bias and studies on special flat rates in the context of mobility, the following questions should be answered by further research work until the end of 2018:

- Is there a general acceptance of flat rate-based mobility packages among the population?
- How can the economic feasibility be achieved through restrictions on use?
- How is it possible to communicate the restrictions to the customer?
- Which characteristics of mobility packages should be addressed from both the customer's and the provider's point of view?

For that matter, the study design comprises a mixed method approach as shown in Fig. 11.

The mobility flat rate is a bundle of fixed service components including public transport, car sharing, bike sharing, taxi and rental car. Services that are relatively expensive (taxi, car sharing) must be restricted according to the package price (supply-side restrictions, time, quantity or price limits) or must be coupled with additional costs for the customer.

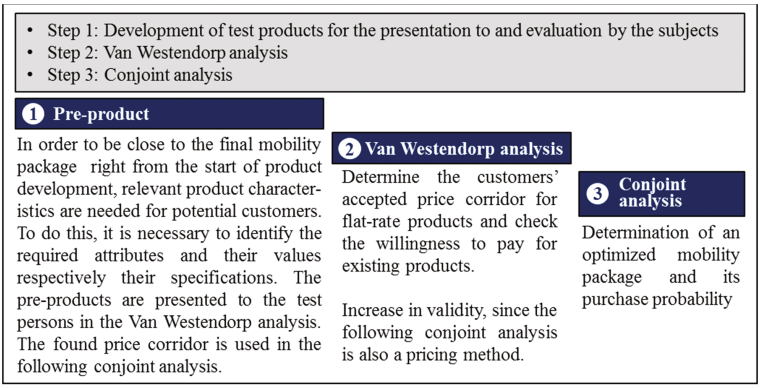

Fig. 11. Mixed method approach for determining optimized flat-rate based mobility packages

Systematics/Approach

In preparation of the Van Westendorp analysis, different user types were regarded in the form of personas. Personas are stereotypical users with different characteristics which make it easier to visualize the needs of customers for transport companies. The personas "professional beginners", "mother with small children", "working father" and "middle-aged workers" were used. School children and students were excluded due to lack of a driving license or low income. Furthermore, it is assumed that pensioners are less willing or able to handle innovative products and that their choice behavior does not change. On the basis of the objectives of the personas, the budget limits of the Leipzig Transport Services and estimated budget limits of the customers (see Fig. 12), full flat rate products will be developed and tested which should come as close as possible to the results of the future conjoint analysis.

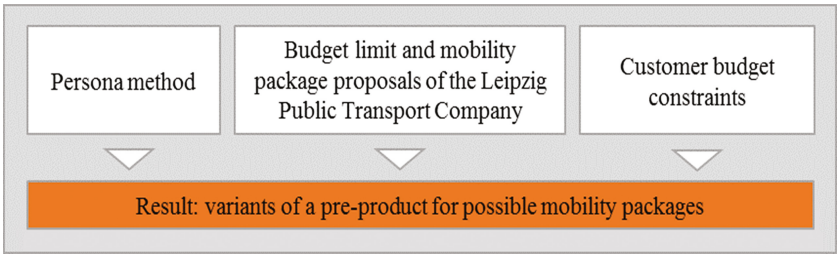

Fig. 12. General methodology of the Van Westendorp analysis

Within the framework of the Van Westendorp analysis, the subjects (n = 300) first will be divided into different mobility types. For this purpose, a questionnaire with the following contents has to be answered:

1. Is there a car available for private use? (always, occasionally, never)
2. Is there an own bicycle available in your household? (always, occasionally, never)

3. Do you have a public transport subscription?
4. Do you have a driving license?
5. How often do you use the following means of transport: private car, car with driver, private bicycle, free floating car sharing, station-based car sharing, bike sharing (daily, once a week, several times a week, once a month, several times a month, less, never)?

In addition, the subjects will be asked:

- to what extent they are interested in using car and bike sharing for doing their day-to-day tasks, leisure activities and professional purposes,
- how they basically assess the idea of getting access to different mobility services via a bundled product, and
- how important it is to them that public transport, free-floating and station-based car sharing, bike sharing, taxi and rental car services are components of a mobility package.

The following characteristic values of mobility packages have been developed according to the approach as to be seen in Fig. 12 and the use of the morphological box method. This method is generally applied for exploring all possible solutions to a multi-dimensional, non-quantified complex problem without prejudice (see Table 3).

Table 3. Types of limitation for mobility packages – morphological box – examples

	Supply			Time				Price
Local Public Passenger Transport	Only single tickets			–	Max. 10 tickets	8 am–6 pm and 20 pm–8 am	Ticket purchase only possible every 24 h	Subscription flat rate
Car sharing	Only vehicle category "Minis"	Only on mobility stations	Per booking only 5 free km	Lending time max. 2 h	Max. 10 bookings/month	Moil - Fri free and weekend free	Bookings only every 24 h free of charge	–
Bike sharing	–	Only on mobility stations	Only one bicycle	Lending time max. 1 h	Max. 10 bookings/month	20 pm – 8 am and weekend free	Bookings only every 24 h free of charge	–
Taxi	–	Places	Max. 5 km	Max. 20 min	Max. 3 rides/month	1–5 am	1 ride/week	–
Rental car	Classes	Stations	Free km	Lending time	Booking frequency	Limited hours	Cool down	–

For each of the following products (see Table 4), the subject will be asked for her or his willingness to pay with the following four questions:

1. At what price would you consider the product to be too expensive, i.e. not buying it at all?
2. At what price would you consider the product to be too cheap, i.e. you would have doubts about the quality of the product (dirty vehicles, broken bicycles)?

Table 4. Four characteristic values of a mobility package

	CV-1	CV-2	CV-3	CV-4
Free floating car sharing[a]	Flat rate, < 30 min	10 rides < 30 min	5 rides < 45 min	30 min
Station-based car sharing	48 h with 500 free km[b]	10 × 3 h incl. 30 km/ride	3 × 3 h incl. 15 km/ride	1 × 3 h incl. 15 km/ride
Bike sharing	12 h flat rate[c]	Flat rate, < 1 h	10 × 30 min	5 × 1 h
Taxi (within the city area)	Flat rate from 9 pm–5 am	50% discount on every ride	5 rides	1 ride
Public Transport	Subscription	50% discount on a single ticket	10 trips	4 trips

CV = characteristic value.
[a] Every additional minute 0, 30 €/min.
[b] Minimum lending time 1 h.
[c] 0–6 am will not count to the 12 h.

3. At what price would you evaluate the product to be expensive, but possibly buy it after careful consideration?
4. At what price would you consider the product to be cheap, in the sense of a very good offer (= bargain)?

The general approach of the Van Westendorp analysis is illustrated in Fig. 13. If the individual price requirements of the subjects are aggregated, four lines with four intersection points result as to be seen in Fig. 13. The Y-axis shows the cumulative frequency distribution while the X-axis shows the price to be chosen by the subjects. The interpretation of the results of the Van Westendorp price model is relatively simple because no hidden assumptions are made and all interesting information can be read directly from the distributions in the graphics.

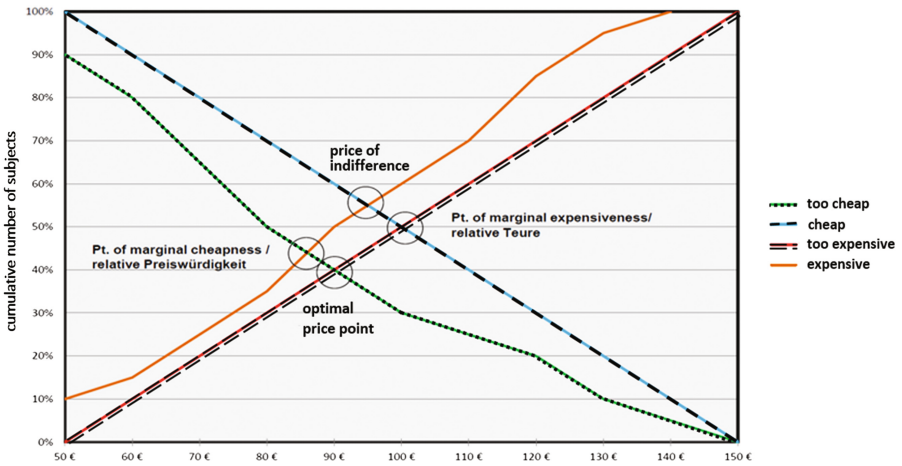

Fig. 13. Possible results of the Van Westendorp analysis

The accepted price corridor is between the points "Point of marginal cheapness" and "Point of marginal expensiveness". The best price results from the intersection of the straight lines "too expensive" and "too cheap". At this price, the smallest resistance should be expected and thus the greatest market penetration should be possible. The point of indifference lies at the intersection of "cheap" and "expensive".

As a result of the Van Westendorp analysis, which will be statistically handled with a software tool provided by the Sawtooth Company, arise acceptable price corridors for the various mobility packages used in the following conjoint analysis. The conjoint analysis is a decompositional method that estimates the structure of a consumer's preferences (i.e., estimates preference parameters such as part worth, importance weights and ideal points), given his or her overall evaluations of a set of alternative products that are specified in terms of different attributes [11]. Preferences and requirements of the customers are analyzed in order to design a product in line with the market and tailored to the customers' needs.

There are several theoretical approaches for conducting a conjoint analysis. The choice-based conjoint (CBC) analysis is currently the most widely used method. However, it is often connected with some disadvantages. For example, the subjects have to evaluate all displayed attributes of the products and evaluate them against each other. Answering many repetitive questions leads to signs of fatigue. There is often a "killer" property for the test person which the product absolutely has to have. Products that do not have this property are immediately excluded. In the choice-based conjoint analysis, however, all product combinations are displayed to the test person and must be evaluated. Therefore, a further type of conjoint analysis will be used in the research project which is known as adaptive choice-based conjoint analysis (ACA)[3]. This consists of four steps:

1. The subject creates his own ideal product. He or she chooses from a modular system and depending on the choice, the price increases.
2. Based on this, the subject is shown several products that are close to his or her ideal product. The subject scores these products. The answers are used to identify minimum requirements or exclusion criteria (the subject confirms this). The subject will then no longer be presented with any products that do not correspond to this. As a result, the survey can concentrate on products that are actually possible. The product combinations thus become more realistic.
3. The subject makes a product selection. However, he will only be shown the products he has considered as an option in the previous steps.
4. The purchase probability is determined by asking the customer the question directly: "Would you buy the presented product?" (very likely, probably, don't know, unlikely, very unlikely).

Overall, the adaptive choice-based conjoint analysis is more intuitive for the subject as he or she can make a pre-selection.

[3] The adaptive choice-based conjoint analysis can only be carried out by computer. This method is called adaptive because the subject's input is already processed by the computer during the interview and used to develop the next questionnaire page.

These studies will be conducted based on an electronic questionnaire in the spring of 2018 so that the results can be presented at HCII in July 2018.

6 Conclusion and Outlook

MaaS services, which are based on mobility packages, especially in urban regions, can have a very strong impact on people's choice of intermodal and multimodal transport. The decision to reduce or even eliminate the use of one's own car and to favor more environmentally friendly means of transport can be encouraged. Our investigations for the city regions of Leipzig and Frankfurt/Main have shown that flat rate-based mobility packages do not only mean potential benefits for customers (insurance, overestimation, taximeter and convenience effects) but are also evaluated critically. Price-sensitive users in particular often prefer pay-as-you-go concepts. Due to the contractual nature of mobility packages with mandatory payment in advance, they fear to lose money and flexibility. The planned Van Westendorp analysis and the adapted choice-based conjoint analysis will provide further insights in this area.

In addition, it would be of great interest to check the findings in long term real field tests since most of the assumptions could only be examined hypothetically in the survey. There could be offered test subscriptions for a few month to the customers or flat-rate mobility packages with a short-term contract. A further option is to integrate mobility packages and their use into already existing mobility providers' apps.

Besides the investigation of the customers' requirements it is also necessary to take a closer look at the economic efficiency of MaaS concepts for the mobility suppliers and their integration into mobility platforms of more and more complexity.

References

1. Holmberg, P.-E., Collado, M., Sarasini, S., Williander, M.: Mobility as a Service - MaaS, Describing the framework. Göteborg: Viktoria Swedish ICT AB (2016). https://www.viktoria.se/publications/mobility-as-a-service-maas-describing-the-framework. Accessed 08 Feb 2018
2. Sochor, J., Strömberg, H., Karlsson, M. A.: Travelers' motives for adopting a new, innovative travel service: insight from UbiGo field operational test in Gothenburg, Sweden. In: Detroit: 21st World Congress on Intelligent Transportation Systems, 7–11 September 2014
3. Kamargianni, M., Li, W., Matyas, M., Schäfer, A.: A critical review of new mobility services for urban transport. Elsevier Transp. Res. Procedia **14**, 3294–3303 (2016)
4. Nemtanu, F.C., Schlingensiepen, J.: New Technologies and ITS for Rail. In: Marinov, M. (ed.) Sustainable Rail Transport. LNM, pp. 225–247. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-58643-4_13
5. Fleischer, T.: Mobility as a Service aus Nutzersicht: Untersuchung psychologischer Nutzungsreize in der Konzeptionierung von MaaS. Master Thesis, Technische Universität Dresden (2017)
6. VTT Technical Research Centre of Finland Ltd. (2018). http://www.vtt.fi/sites/maasifie.fi. Accessed 12 Feb 2018

7. Atkins: New releases 2017 – Greater Manchester signs up for Mobility as a Service (MaaS) research project with Atkins. 20 October 2017. http://www.atkinsglobal.com/en-gb/media-centre/news-releases/2017/oct/2017-10-20c. Accessed 12 Feb 2018
8. Nanyang Technological University Singapore: Mobility-as-a-Service (MaaS) Testbed and Research. 1st January 2018. http://ecocampus.ntu.edu.sg/Current-Projects/Pages/Mobility-as-a-Service%20-MaaS-Testbed-and-Research.aspx. Accessed 12 Feb 2018
9. MaaS4EU, Project ID: 723176, Horizon 2020. 3rd July 2017. https://cordis.europa.eu/project/rcn/210133_en.html. Accessed 12 Feb 2018
10. Goodall, W., Fishman, T. D., Bornstein, J., Bonthron, B.: The rise of mobility as a Service. Deloitte Rev. **20,** 112–129 (2017). https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf. Accessed 12 Feb 2018
11. Green, P.E., Srinivasan, V.: Conjoint analysis in marketing: new developments with implications for research and practice. J. Mark. **54**, 3–19 (1990)