



# Towards an Integrated Mobility Service Network

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**Abstract.** The approach of a linear mobility chain changes to a network-based mobility. Mobility not only consists of interactions with transport services. The transport services are enhanced by a variety of services concerning ticketing, information, refreshments, or entertainment. These services are used in parallel with transport and form an individual service network of travelers' journeys. This paper introduces the method of mobility service diaries to collect data about the usage of diverse mobility services. Based on the data analysis, the results present a classification of mobility services, typical patterns of the interplay of mobility services, and a framework of an integrated mobility service network. The aim of this research is to support the user-oriented development of human-computer interactions for mobility services.

**Keywords:** Mobility service · Mobility experience · Mobility service diary

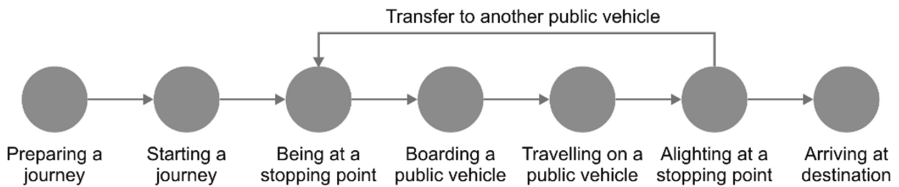
## 1 Introduction

A major trend in the mobility market is the shift from private ownership of mobility vehicles to the use of mobility services. Besides to the rather traditional sector of public transport sector, other mobility services from multiple mobility providers are available, such as sharing services for cars and bikes, long distance bus services or self-driving car services [1]. This development changes the approach of a linear mobility chain of transport services to a network-based mobility, which creates a holistic mobility experience of the traveler [2]. The state of the art of these current results in mobility research are presented in Sect. 2. Based on these trends, the aim of this paper is to systematically describe this network-based mobility. Therefore, the method of mobility diaries is adapted to mobility service diaries and tested in an empirical pre-study, which is described in Sect. 3. Resulting from this data, the derived framework is presented in Sect. 4. The framework consists of a suggestion of standardized mobility service categories and touchpoints, typical mobility service pattern and a holistic description of an integrated mobility service network.

## 2 State of the Art

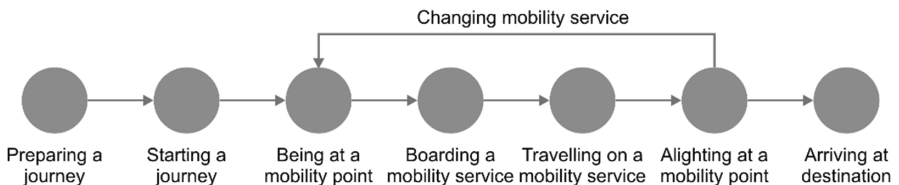
### 2.1 Mobility Services Chain

According to the European Standard “Public Transport Reference Data Model” [3] a trip consists of the “complete movement of a passenger (or another person, e.g. driver) from one place of any sort to another”. This approach focuses on the traveler’s change of location. This change of location is caused by a typical sequence of traveler’s actions, which are represented in the travel chain [4]. In the travel chain, the tasks are structured in terms of content and place from the user’s point of view. Figure 1 represents the linear travel chain starting with the preparation activities such as planning and booking. Furthermore the travel chain includes the ways to the stopping point as well as the orientation and waiting times at the stopping point. After travelling with the public vehicle and alighting, the journey might include either a further public transport trip or ends with the arrival at the destination.



**Fig. 1.** Linear travel chain in public transport [5]

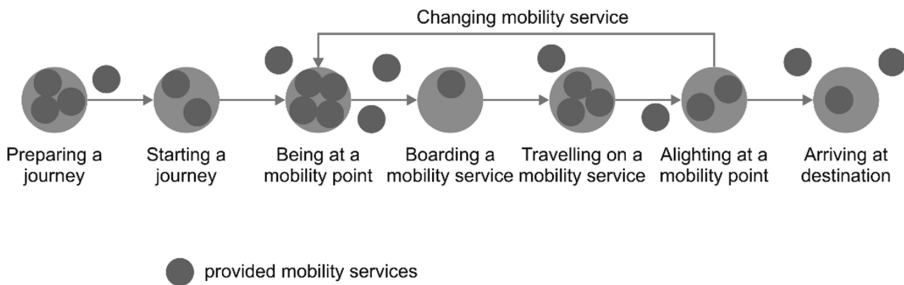
The travel chain for public transport can be transferred into a travel chain for mobility services in general (see Fig. 2) by replacing public vehicles to mobility services and replacing the stopping points by mobility points, which are any locations, where the use of a mobility service can be started or terminated. Therefore, mobility points include stops for several mobility providers, for example bus stops, train stations, sharing stations and any parking places for free-floating services. Mobility points may also consist of combinations of more than one mobility provider.



**Fig. 2.** Linear travel chain for transport mobility services [2]

The term of “mobility service” can be even applied more general. When providing a service, the customer is at the same time a part of the service provision [6]. This is not only the case for the service of transport, but also for other services along a journey,

e.g. information on an individual travel request on a website is also a service. Other services that are often used during a journey include the sale of meals or drinks as well entertainment services. Furthermore, a lot of services have evolved, which support the trip with private-owned vehicles, e.g. parking service or e-mobility infrastructure. From that point of view, all mobility services, both transport services and extended services, support the tasks of the users and are orchestrated along the travel chain, as shown in Fig. 3. Some of the extended mobility services are independent from specific locations at the journey, such as information and navigation providing websites and mobile applications. Instead of location, time and individual restrictions became further criteria of provided mobility service touchpoints.



**Fig. 3.** Travel chain for transport and extended mobility services

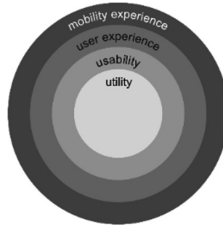
## 2.2 Mobility Experience

Customer experience within the mobility context can be analyzed in different terms, such as travel experience [7] or mobility experience [2].

Based on a literature review Wienken [2] mentions the following key elements mobility experience:

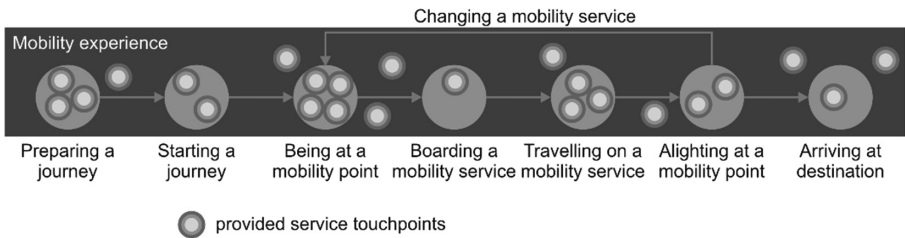
- Mobility experience is the sum of all experiences of the user with the provider and his mobility services.
- Mobility experience is generated directly and indirectly at all touchpoints between provider and user and over the entire duration of the relationship.
- Mobility experience has a holistic and subjective character.

In addition, the interaction of the utility, usability and user experience [8] of each individual mobility service is an essential component of the conceptual model of mobility services, which is shown in Fig. 4. In general, the mobility experience comprises the perceptions and reactions of a mobility user resulting from all actual and/or expected contacts of direct or indirect nature with a service provider along a journey.



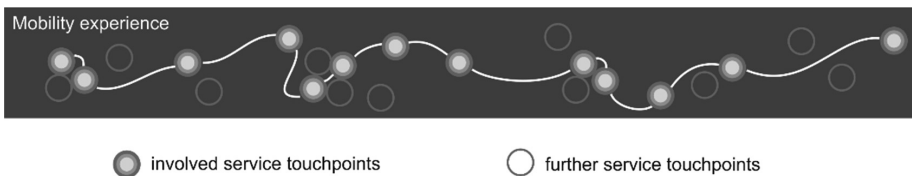
**Fig. 4.** Conceptual model of mobility experience [2]

From this point of view, each mobility service presents a possible touchpoint for mobility experience during a journey (see Fig. 5). These touchpoints include not only transport services but also extended mobility services, which are supposed to influence the mobility experience in addition to the transport services [2].



**Fig. 5.** Mobility services as mobility experience touchpoints along the travel chain

This variety of mobility services creates an unmanageable number of possibilities for the individual combination of mobility services, within the network of mobility service. Travelers select only some mobility services, according to location, time and personal restrictions, along an individual journey, which creates the mobility experience, shown in Fig. 6.



**Fig. 6.** Individual mobility service chain

Therefore, the challenges of the user-oriented development of mobility services are the integration of diverse mobility services into an individual journey and the conception of user-oriented supporting tools. In order to address these challenges, an empirical data base about the usage of mobility services is required.

## 2.3 Mobility Diaries

National travel surveys are an established international method for the analysis of mobility [9–13]. Next to an inquiry, all studies include the method of mobility diaries for the participants' documentation of their ways of one or more days. The key categories of these mobility diaries include the purpose, the length and the means of transport per way. The aim of these studies refers to the long-term quantification and development of mobility, in order to support strategic decisions for the mobility infrastructure and mobility market. Therefore, the modal split, which represents the share of each means of transport by volume of the national mobility, is a key result of mobility diaries. In relation to the demographic data about users and household even mobility user types may be derived [14]. In contrast, data about the use of extended mobility services is not included. Hence, there is a lack of data basis for a systematically analysis of the interdependencies of the mobility service network.

## 3 Empirical Study

### 3.1 Method of Mobility Service Diaries

The aim of this mobility service diary study is to identify service categories, touch-points, and their typical combination. Concrete names of providers, institutions or locations are not collected. Therefore, the diary for a journey consist of the following four categories for each mobility service use:

- Category “time” represents the start time of a service use on the day of travel with an accuracy of about 5 min. Services which are related to the journey and were used before or after the day of travel, e.g. travel planning or billing, are marked as “before the day of travel” or “after the day of travel”.
- Category “location type” documents the generalized description of the place of service use e.g. at home, bus stop, train station, airport, sharing station, etc. without specifying the place.
- Category “service type” means the general extent of the service used e.g. information, transport, food, drinks, hygiene, or entertainment without further details.
- Category “touchpoint” contains the general name of the service provider, e.g. restaurant, bus, sanitary facilities or websites.

According to the explorative character of the study the category input is not a standardized selection but open input fields, in order to find new indicators for mobility services along a journey.

Next to demographic information, the following information about the journey is collected in standardized items:

- “Length”: less than 15 min/15 min up to less than 60 min/1 h up to less than 3 h/3 h up to less than 6 h/6 h and more
- “Motivation” (multiple responses possible): work/shopping and errands/free time/vacation/other

- “Companions” (multiple responses possible): one or two persons (older than 12 years)/more than two persons (older than 12 years)/children (less than 12 years)/none
- “Familiarity”: I’m familiar with the whole journey./I’m familiar with the majority of the journey./I’m not familiar with the majority of the journey./I’m not familiar with the whole journey.

### 3.2 Conducting the Survey

The participation at the study is voluntary and is not related to any financial or material rewards. After the acquisition, the mobility service diaries are handed over to 10 participants. Finally, 6 participants took part in the survey. 4 participants are male, 2 participants are female, and all of them are in the age between 20 and 40 years. Each participant documented one up to three journeys in a paper-based form within a range of one week.

The collected data of these participants contains 135 uses of mobility services within 12 journeys. The documented journeys include short- and long-distance journeys, journey with and without companions, journeys for work, free time, and vacation, as well as familiar and unfamiliar journeys.

## 4 Results

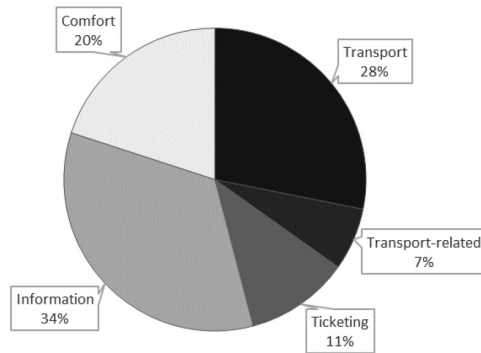
### 4.1 Classification of Mobility Services

In a first step, the data of “service type” is grouped by similar terms. This grouping revealed 15 different service types. In a second step, these service types are categorized by their relation to a journey. This systematization revealed the following five general categories of service types:

- “Transport services” intent the movement of a person from one place to another, e.g. bus, train, plane, or ship as well as elevators and escalators.
- “Transport-related services” intent the movement of luggage, additional help for personal movement, or preparing private or shared means of transport, e.g. refueling.
- “Ticketing services” include the sale, validation and further management of reservations and tickets.
- “Information services” provide requested individualized data about the planned or current itinerary, e.g. mobile applications or information desks.
- “Comfort services” cover all services to ensure viability and well-being of the traveler, e.g. food and drinks, hygiene, or entertainment services.

As shown in Fig. 7, the information service is the most used mobility service. Due to the fact, that individual travel information services are ubiquitous via mobile applications, this service becomes a high relevance for all travelers. The next important services are transport services and comfort services, which are used often especially in long-term journeys.

Generalized categories of mobility services



**Fig. 7.** Share of mobility service categories in the mobility service diaries

Furthermore, the data about “location types” is also analyzed by grouping and systematization. The 14 grouped locations are related to the following three categories of location types:

- “Whereabouts before or after a journey”, e.g. home, office, hotel, or other destinations.
- “Mobility points”, e.g. stop, station, airport, harbor, or parking places.
- “Means of transport”, e.g. bus, train, plane, or ship.

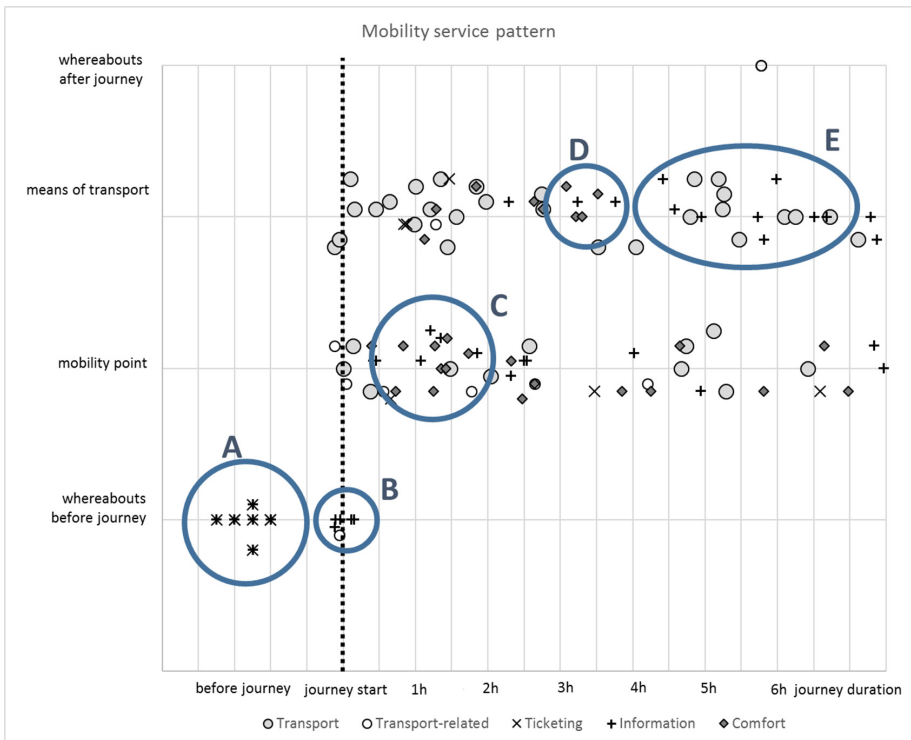
## 4.2 Mobility Service Pattern

According to the analyzed categories, the following analysis assigns each documented mobility service to a time-location-map, grouped by service type. The map, which is shown in Fig. 8, reveals the following five pattern of mobility services:

- Pattern A – “Planning”: Before the start of the journey, there is a close relationship between information and ticketing services. Both service types are often used in a direct sequence. Nevertheless, due to technical restrictions, many participants had to use several touchpoints for the information and ticketing process.
- Pattern B – “Starting”: The participants documented different services at the start of their journey. Using a transport service, using a service at a mobility station, and using information services at the whereabouts before the journey start. This information service is the most documented starting service of journeys, which correlates to the high information needs of travelers especially at the start of unfamiliar journeys.
- Pattern C – “Waiting”: When changing the means of transport, travelers often have to wait for a while at mobility stations for public transport. The data shows, that especially after the first trip section many travelers use several comfort services at the mobility station. This use of a comfort service is often in a direct sequence to the use of an information, probably to check, if the remaining waiting time is sufficient for the comfort use.

- Pattern D “Long-distance traveling”: When passengers travel with one means of transport for hours, the use of comfort services rises. In contrast to pattern C, this use is not that much related to further information services, because the duration of the travel time in a vehicle is less dynamic.
- Pattern E “Continuous information”: The need for individualized information remains high along the whole journey, independently from the duration of the travel. A continuous information supply therefore might become a key element for mobility experience.

These analyzed categories and pattern provide important indicators for the user-oriented development and improvement of new and existing mobility services.



**Fig. 8.** Overview of mobility services according to location type, service type, and travel time

### 4.3 Mobility Service Network

The approach of mobility experience requires a holistic view of interplay of touch-points and mobility services. The analysis shows, that typical combinations of service types build the basis of the traveler interactions. Nevertheless, all service types should be considered at the different location types and be provided to the traveler, in order to improve the travelers' individual mobility experience. Figure 9 presents an overview of



the derived mobility service network with the focus on creating individual mobility experience.

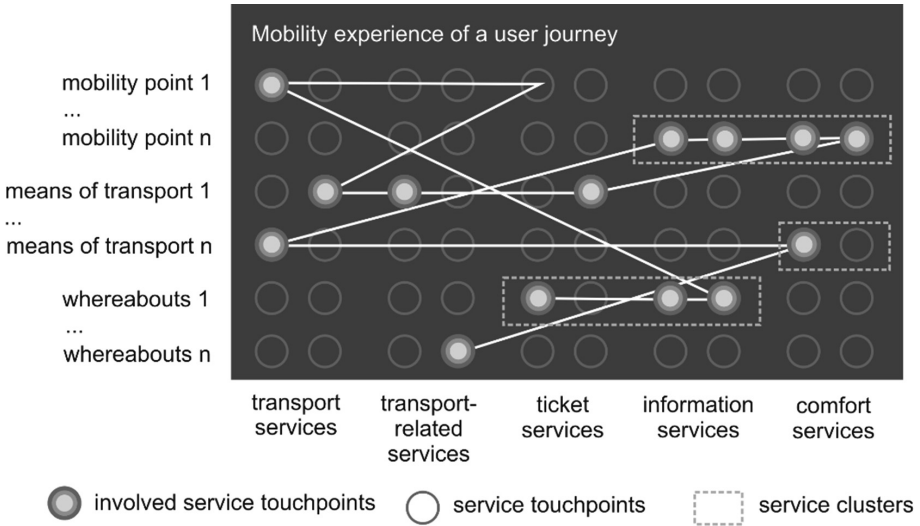


Fig. 9. Framework of an integrated mobility service network

## 5 Discussion

The presented study with mobility service diaries is a pre-study, in order to reveal standardized categories of locations and service types. The quality of the open-input entries is very varying, because the understanding of the variables differs between the participants, instead of clear and exemplary diary instructions. Therefore, we recommend to use standardized variables in further studies with a higher number of participants, in order to improve the results.

Furthermore the study should provide an online diary, which enables the participants to document the use of mobility service directly after the use and reduces inaccuracies by retrospective documentation. Another reason for neglecting some mobility services in the diary might be limited individual perception of the daily interactions as a mobility service. A further sensitization of the participants is therefore recommended.

The further research of mobility service should also analyze the perceived mobility experience of the documented journeys. Correlation between the use of mobility service types and the mobility experience might reveal influence factors for improvement by the service providers.

## 6 Conclusion

The presented method of mobility service diaries is appropriate to detect categories of mobility services and locations. The analyzed mobility service pattern reveal challenges for the user-oriented combination of mobility services, such as individual information and ticketing above all providers of a journey. The results will be integrated in research projects for development of a service-oriented mobility platform, e.g. DIMO-OMP<sup>1</sup>, and consider the revealed typical mobility service pattern.

Further studies with mobility service diaries and a higher number of participants can be used, in order to detect lacks of mobility services and improve the mobility infrastructure in general.

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