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Intermodal urban mobility: users, uses, and use cases

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Abstract

Cities are growing nowadays and so is their citizens' demand for mobility. On a global scale, motorized individual traffic is hardly capable of meeting this need due to its ownership costs and due to the lack of an accordingly large infrastructure. Besides, motorized individual traffic is responsible for the majority of today's traffic burdens, such as air pollution, traffic jams, noise, and accidents. It is thereby assumed that only a combination of soft transport modes and public and private modes of motorized transport with different capacities, time schedules, and operation times can achieve what is called "sustainable cities". Besides the need for coordinated transport services, their cooperation must be assured to obtain seamless interchanges and consequently undisturbed, fast, and reliable travelling. Such a use of different transport modes within a single journey is called "intermodality" and is a work topic fostered in a national, European, and world-wide context. This report shows the initial results of the project "UrMo" ("Urban Mobility") that is being performed at three institutes of the German Aerospace Center (DLR). The report gives an introduction to the topic by evaluating how socio-demographics and space structure influence intermodal behavior. In addition to this, the subsequent project steps are outlined.

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Keywords: Intermodality; urban mobility; urban structure; surveys; modelling; vehicle concepts

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1. Introduction

A city population's options for mobility highly influence the overall city performance and good transport provision is a major key to assuring the city's accessibility for all citizens, leveraging social inequities (UN Habitat, 2013). Motorized individual traffic (MIT), surely one of the most flexible and convenient ways of travelling, is increasing worldwide (IEA, 2011). But besides being ineffective in terms of energy consumption and emissions compared to other transport modes, MIT requires a lot of space, both during use and while parked. Modern cities lack the necessary space, however, trying to keep or gain effectiveness through high density and subsequently shorter ways (see e.g. TRB (1998) for costs of urban sprawl). Additionally, MIT has high ownership costs that cannot be afforded by all, especially in less developed countries. Public transport is thereby needed for sustainable and socially fair mobility (UN Habitat, 2013). Still, public transport is hardly capable of accessing all of a city's places. The final stretch in many routes between a location like home or a workplace to a public transport station, has to be covered by using other modes, such as walking, cycling, or – in future – by modes that have not been invented yet. What is more, different types of public transport exist, ranging from metros or public rapid transport (PRT) systems, bus and tram lines right up to informal bus routes. As all of these differ in their operation times, cycles and capacities, proper cooperation between them needs to be established in order to achieve seamless journeys.

The mobility in European cities was dominated by MIT for a long time, but there are signs that this is changing. Sharing bicycles or cars is increasing, car ownership is becoming less important and car use is declining in some locations (see Jonuschat, 2015). These sharing opportunities introduce further modes that may be combined. Such a combination of different modes during one journey is called "intermodality" and intermodal travel is a common practice, which will be shown later. The changes in mobility towards using different transport modes are accompanied by an increasing integration of transport services, may it be in the form of ticketing, information, or physical infrastructures such as interchanges and hubs. To summarize, a well-working intermodal supply is assumed to be a key factor for a sustainable and scalable urban transportation system (Jonuschat, 2015).

For this reason, it is not surprising that improving intermodal urban transport has received some degree of attention at city, regional, national, European, as well as at global level. Often, the actions performed introduce or extend technical solutions that support users on intermodal journeys. What is less well studied and not well covered in surveys is intermodality as a daily practice of users, their patterns and their motives. In addition, neither the characteristics of the intermodal supply nor the availability of information, which shape daily decisions concerning transport mode and route choice among intermodal passengers, are yet completely understood. This is also true for the socio-demographic attributes that foster or hinder intermodal behavior.

In fact, not even the term "intermodality" is defined in a completely unambiguous way. Jones et al. (2000) have performed a meta-study on this topic, finally arriving at the definition of intermodality as "the shipment of cargo and the movement of people involving more than one mode of transportation during a single, seamless journey" (p. 349). While this definition is accepted throughout research nowadays, there are differences in how the transport modes "walking" and "public transport" are interpreted. Almost all journeys start and end with walking, either to the next public transport station or to the private vehicle being used, including bicycles, in fact. This means that all journeys other than those performed on foot only would be intermodal. One attempt to distinguish whether walking is used as an own mode or only as a natural bridge to the first / from the last transport mode is to formulate thresholds. E.g. Diaz Olvera et al. (2014) assume that the walking part of a journey has to take at least 5 minutes before being counted as an own mode of transport. With regard to public transport, different interpretations of using different lines of the same transport mode (changing the bus), different modes of transport (e.g. changing from a bus to the local metro), or different operators can be found.

"UrMo" ("Urban Mobility"), a collaborative project by three transport institutes at the German Aerospace Center (DLR), intends to extend knowledge about urban structures and personal habits that influence intermodal travelling. The combination of quantitative and qualitative empirical methods of social science and the modelling of intermodal travel will deliver insights on the factors that influence intermodal route and mode choice. The influence of the city shape, including its built environment, of the available modes of transport, and of transportation hubs will be studied. An evaluation of given socio-demographic data, data on city structure and infrastructure, and existing national surveys will therefore be carried out, as well as conducting own surveys. Further knowledge will be gained by interviewing experts. The subsequent microscopic (activity-based) modelling of intermodal behavior will allow investigations beyond evaluating the current intermodality by enabling the simulation of scenarios that reproduce how intermodality changes under changing economic or societal conditions. Furthermore, new vehicle concepts for urban mobility will be developed that support individual users in intermodal travelling. The results obtained from the empirical and simulation-based investigations will be used to identify potentials and barriers for introducing or improving intermodal mobility within urban areas.

The research performed in “UrMo” focusses on two German cities, Berlin and Hamburg, but will investigate the development in selected cities from other countries as well. Experts and practitioners, such as urban planners, associations and service providers will be invited to discuss the researched findings. Together, new potentials and concepts as well as obstacles will be identified and discussed.

The project has started in 2015 and will continue until the end of 2018. In a first step, national surveys as well as socio-demographic data and data on the city structure was evaluated to determine the numbers and characteristics of intermodal users. These results, including the preparation of supplementary surveys and of including international trends, will be presented first. Then, the simulation and vehicle design activities that will be performed in subsequent project steps are outlined. This report ends with a summary and an outlook.

2. Intermodality in urban areas

2.1. Intermodality in Berlin and Hamburg

The findings on intermodal mobility behavior in Berlin and Hamburg presented in the following rest upon analyses of two different national travel surveys. Both surveys were conducted on specified sample days. For Berlin the “Mobility in Cities 2008 – System of Representative Transport Surveys (SrV 2008)” database was used. Only weekdays from Tuesday to Thursday are covered in this survey. The analyses for Hamburg are based on the survey “Mobility in Germany 2008 (MiD 2008), Increase Hamburg Region”, in which all weekdays as well as weekend days are taken as sample dates. However, we only consider weekdays in parallel to SrV.

Intermodality can be analyzed with both surveys, operationalized as trips with more than one mode of transportation on a single trip (referring to the definition of Jones et al. (2000) and Chlond (2013)). However, the general framework of the two surveys as well as variables influencing intermodality are different so that a direct comparison is not possible. Central similarities and differences between the two datasets SrV and MiD are outlined by Follmer et al. (2010) for the example of Berlin and Brandenburg. Apart from this, there are differences in operationalizing intermodality. For example SrV lists every single mean of public transport whereas MiD groups the use of tram and subway on the one hand and commuter and local trains on the other. Consequently, there is a different number of means of transport that are counted for an intermodal trip with two means of public transport. These differences in methodology have to be taken into account, when comparing the data from Berlin and Hamburg. The following analyses consider different means of public transport as different modes, e.g. a trip conducted with bus and tram is an intermodal trip. On the other hand, walking is not counted as a single mode in intermodal trips, because the length of the partial trips is not clear in the database. Due to our focus on everyday mobility we only consider trips shorter than 100 kilometers in this analysis.

2.1.1. Results on intermodal trips

First, we want to quantify and characterize intermodal trips. Percentages of intermodal trips are quite high in large cities. According to the definition given above, two or more modes of transport are used on 6.6% of trips in cities with 500,000 and more inhabitants, whereas it decreases to 2.8% in cities with 100,000 to 500,000 inhabitants (database: MiD 2008). Relatively high percentages are also found in Berlin and Hamburg. Based on the SrV dataset, 9.4% of all trips in Berlin are intermodal trips. Most of them (7.6% of all trips) are combinations of different means of public transport. Car transport and public transport are only combined in 0.6% of all trips, whereas combinations of bike and public transport are at least twice as many (1.2%). In Hamburg, based on MiD increase dataset, 7.9% of all trips are intermodal trips. Again, the highest amount is in the combination of different means of public transport (5.0%). However, combinations of car use and public transport (1.0%) and bike and public transport (1.1%) exist in nearly equal frequency.

On longer trips there is a higher possibility as well as a higher necessity to combine two or more different modes of transport. As a result, it is not surprising that intermodal trips are longer than monomodal trips, in terms of both distance and time. This applies for both Berlin and Hamburg. Additionally, intermodal trips are characterized by different proportions of trip purposes than monomodal trips. A great amount of intermodal trips are trips to work or school whereas monomodal trips are more often to pursue shopping or recreational activities.

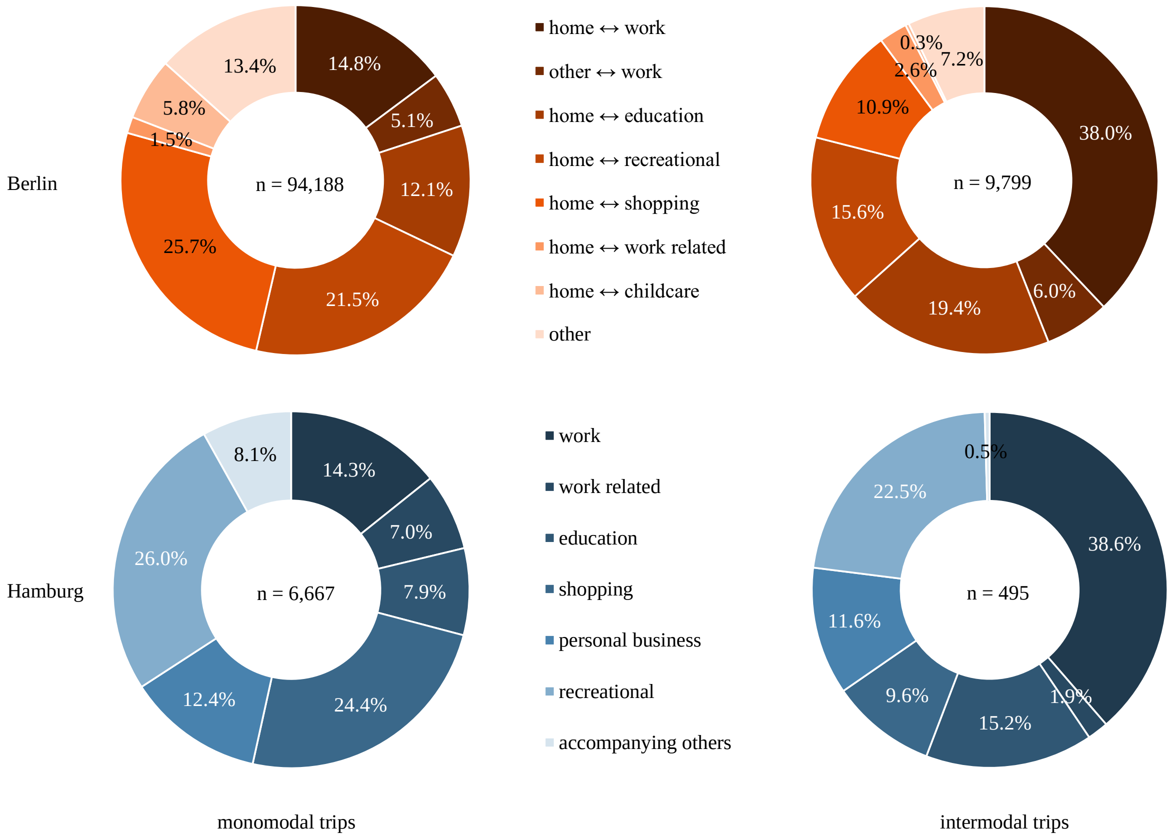

Fig. 1. Trip purposes of monomodal and intermodal trips in Berlin and Hamburg. (Source: own analyses based on "Mobility in Cities – SrV 2008", sample Berlin, Senatsverwaltung für Stadtentwicklung und Umwelt Berlin, Abteilung Verkehr and „Mobility in Germany – MiD 2008", Increase Hamburg Region, Amt für Verkehr und Straßenwesen der Behörde für Wirtschaft, Verkehr und Innovation (BWVI) Hamburg).

2.1.2. Results on intermodal users

In the "UrMo" project the intermodal user is central. Hence, based on the findings on intermodal trips, we now want to take a closer look at the mobility behavior of intermodal users. In this analysis we consider intermodal users as persons who took at least one intermodal trip on the sample date. In contrast, monomodal users took no intermodal trips at all, but only monomodal trips on that day.

In Berlin, 17.2% of the persons surveyed are intermodal users. Some differences between the group of intermodal users and the group of monomodal users can be mentioned. Concerning gender, the percentage of females is higher in the group of intermodal users (55% female, 45% male) whereas it is quite equal in the group of monomodal users and in the total sample (51% female, 49% male). Concerning age, the percentage of intermodal users is highest in the 21-30 age group at 34% and the 11-20 age group at 27%. In higher age groups, the percentage of intermodal users is much lower. As a consequence, the group of intermodal users is on average younger compared to monomodal users.

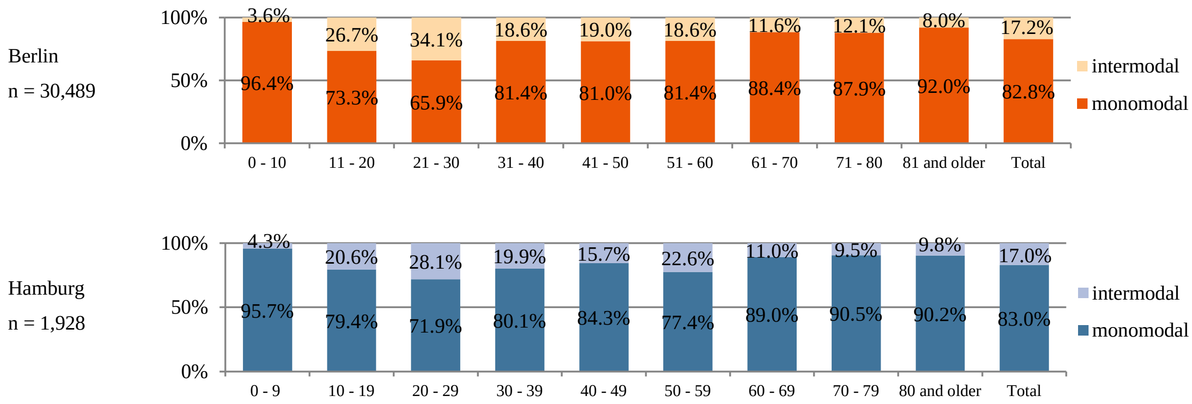

Fig. 2. Percentage of intermodal users per age group. (Source: own analyses based on "Mobility in Cities – SrV 2008", sample Berlin, Senatsverwaltung für Stadtentwicklung und Umwelt Berlin, Abteilung Verkehr and „Mobility in Germany – MiD 2008", Increase Hamburg Region, Amt für Verkehr und Straßenwesen der Behörde für Wirtschaft, Verkehr und Innovation (BWVI) Hamburg).

In Hamburg 16.9% of the persons surveyed are intermodal users (n = 1,931). The same tendency found in Berlin concerning gender and age can also be found in Hamburg. Again, in the group of intermodal persons, women are more represented than men (intermodal: 53% female, 47% male; monomodal: 51% female, 49% male). Furthermore, in Hamburg too, the 20-29 age group shows the highest ratio of intermodal persons (28%), whereas higher age groups have a much lower percentage of intermodal users.

The high relevance of trip purposes for intermodal trips is reflected in the occupation of intermodal persons. In both cases, Berlin and Hamburg, intermodal mobility behavior is more common in the working (including people in education) than in the non-working population. Additionally, intermodal users can be characterized by a higher amount of resources and skills in comparison to monomodal users. For example, the percentage of persons with a higher school education is much higher in the group of intermodally mobile persons. In Berlin 53% of intermodal persons and only 41% of monomodal persons have a final high school qualification. Data for Hamburg shows the same tendency on a higher level at 61% and 50% respectively.

Another interesting feature characterizing intermodal users are their mobility resources. In comparison to monomodal users, persons who are intermodally mobile far more often have no car available for use (Berlin: 54% to 34%; Hamburg: 53% to 24%) or have to arrange themselves with other household members (Berlin: 19% to 15%; Hamburg: 10% to 7%). As such, monomodal users more often have no constraints in car availability. On the contrary, intermodal users own transit passes for public transport far more often than monomodal users (Berlin: 85% to 32%; Hamburg: 69% to 23%). This is due to the important role of public transport in the characterization of intermodal trips.

Taking into account that the data from both surveys is based on sample dates, the total percentage of persons who are intermodally mobile is supposed to be higher. Additionally, intermodal users are not equally spatially distributed in the cities. In Berlin the percentage of intermodal users per district of residence ranges from 11.5% to 25.0% (24 districts). In Hamburg there are 13.3% to 19.5% intermodal users per district (7 districts). However, it has to be taken into account that numbers of cases are quite low on that spatial level and further spatial analysis is required.

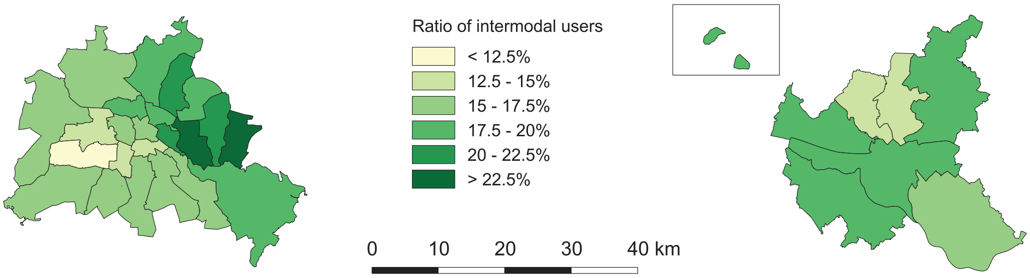

Fig. 3. Ratio of intermodal users by districts for Berlin (left) and Hamburg (right). (Source: own analyses based on "Mobility in Cities – SrV 2008", sample Berlin, Senatsverwaltung für Stadtentwicklung und Umwelt Berlin, Abteilung Verkehr and „Mobility in Germany – MiD 2008", Increase Hamburg Region, Amt für Verkehr und Straßenwesen der Behörde für Wirtschaft, Verkehr und Innovation (BWVI) Hamburg)

Analyses show interesting results for both case studies Berlin and Hamburg. However, some questions remain unanswered by these databases. Thereby, further studies on intermodality are necessary and will be performed using surveys and expert interviews within the project as outlined later.

2.2. Intermodality and urban structure

Another central aspect of the "UrMo" project is the focus on the role of spatial urban structure on the existence or non-existence of intermodal behaviour. Therefore, an analysis of the spatial determinants and infrastructural features that act as catalysts or obstacles for the combination of multiple modes within one trip is conducted to identify their connection to intermodal behaviour. The "UrMo" project uses a strongly quantitative research approach, both in terms of the identification and development of the aforementioned attributes, and in their operationalisation. The latter also ensures the usefulness of the findings for the upcoming modelling propositions. Besides generating new views at intermodality, it helps in identifying suitable study areas for the quantitative and qualitative surveys that will be introduced in the following section.

A number of researchers have contributed to the identification of spatial structural and infrastructural determinants of mobility behaviour in an urban context. Most notably, in their meta-analysis Ewing and Cevero (2010) provided an overview of over 200 studies on the topic. This attempt finally leads them to the definition of six variables, the six "D"s: density, diversity, design, destination accessibility, distance to transit, and demand management, plus demographics as a seventh, confounding influence. This approach is not without criticism, especially for its US-American perspective on transportation, and a number of shortcomings the authors admitted themselves, such as the "*variation in modelling techniques, independent and dependent variables, and sampling units*" (p. 4), and a publication bias. Yet, in order to place the analyses of the "UrMo" project on a sound quantitative and statistical foundation, a similar approach and categorization was chosen.

In the beginning appropriate data sources were identified and said data collected. Due to the heterogeneity of the data, great efforts were made to transform the data into a common spatial resolution, which involved a number of computationally intensive aggregation and disaggregation processes. The resulting data was then stored in a spatially enabled PostgreSQL database accessible to all project members.

Within the three overarching topics of socio-demographics, accessibility, and urban structure, a number of descriptors were identified, e.g. the overall age distribution, the age distribution of the households' main breadwinners, the proportion of foreigners, the household structure operationalized using household size and the presence of children, as well as the distribution of the monthly net income; the number of available public transport lines, the average walking distance to the closest public transport stop (both for the six modes of bus, tram, subway, commuter train, regional train, and ferry), the proportion of availability of driving licenses and public transport season tickets, as well as the availability of free floating or station-based car or bike sharing systems; population density, average site occupancy rate and floor space index, average density of amenities catering short-term needs, health care needs, as well as schools, and information on the land use as well as the various types of structure of the built-up urban environment.

For the case study of Berlin it was decided to employ the administrative level of "planning areas" (PLR) as the basic spatial reference system. These 447 units vary between 0.13 and 23.73 km^2 in size and 2,738 and 33,719 inhabitants; they tend to be smaller in area and more densely populated near the city centre, as Fig. 4 (right) shows. The availability of a large number of attributes for all PLRs allows for a multi-dimensional comparison, as well as the search for similar and dissimilar areal units. This helped greatly in the process of selecting study areas for the empirical studies introduced in the upcoming section.

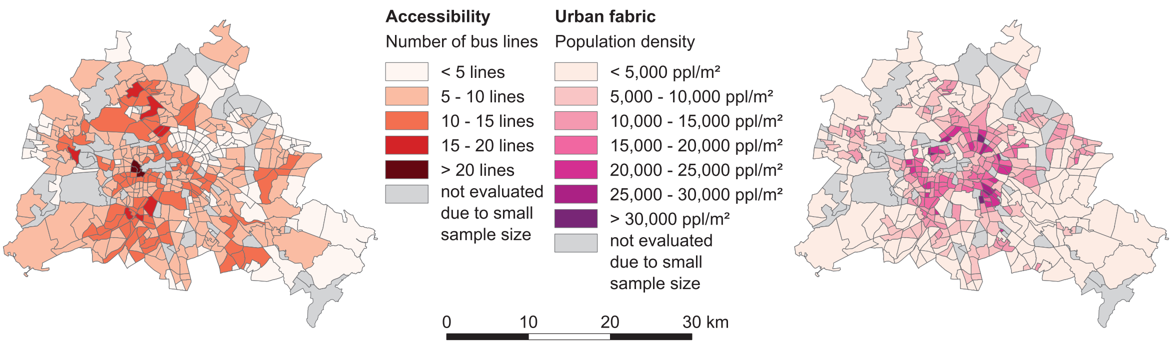

Fig. 4. Maps of the 447 planning areas (PLRs) constituting the study area. The colors show, in an exemplary manner, the spatial variation in accessibility (left) and urban fabric (right) for the city of Berlin, operationalized using the number of available bus lines per PLR and the population densities, respectively. These are just two examples of more than 50 variables used in the final data model.

2.3. Empirical Approach

In order to analyze the relationships between intermodal behavior, new mobility concepts and spatial structures, it is necessary to consider the micro-level. As already mentioned, the territorial unit in the empirical studies of the "UrMo" project will be the "planning areas" (PLR). Conducting quantitative and qualitative surveys in different structured urban areas in Berlin and Hamburg aims to expand the empirical basis of intermodality. One focus of the surveys lies on intermodal user groups – their behavior, motives and preferences. The targeted questions should be answered by a quantitative questionnaire and qualitative interviews: How do people move in the city? Which modes of transport are used and combined? What characterizes an intermodal person? What factors or individual motives and preferences explain the mobility decisions taken?

Besides the "classic" criteria such as time and cost, it will be investigated which "soft" motives are relevant: Are people aware that they have different options to combine different modes of transportation? What does it take to switch the mode of transportation – what are the obstacles? In addition to individual factors, the spatial structures at the place of residence and along the way will be investigated: How important for mobility decisions are the facilities of the living environment, the design of interchanges and the availability and accessibility of transport modes as well as the parking space?

The results of the questionnaires will provide the basis for describing the behavior forms of mobility of intermodal users in terms of individual factors and spatial-structural characteristics. The goal is to identify profiles of intermodal user groups, specified as a set of personas. A persona is a generalization, a holistic view of a user with his behavior, his attitudes and his motives (Mayas et al. 2012, 2014; Cooper et al. 2007; Pruitt/Adlin 2006; Baumann 2010). A persona does not have a correlation with any real person, but rather represents a typical user, who is constructed out of different behaviors and characteristics, determined by the data gathered (Hörold et al. 2011). Additionally, subsequent in-depth interviews with people who are assigned to one of the user types / personas will help us to understand more precisely for what reasons and under what conditions people are intermodal. The results are incorporated into the conceptual design of a new urban vehicle and operation modes. Furthermore, the results will be used as a basic input for modelling intermodal behavior, as outlined in Chapter 3.

2.4. International perspective on intermodality

In the international context, mobility is exhibiting considerable dynamics and shows a broad spectrum of trends. Thereby, in order to address the ongoing developments beyond UrMo's national scope, the project takes international reference cities into account. The main motivation for this is to collect new ideas and developments in the field of intermodality, to understand how it is being fostered and used, and which concepts work – and which not. Special care will be taken to acknowledge each case's specific context for understanding the various conditions under which intermodality develops.

The work will follow four different phases. First, the criteria for the case study selection are defined and the cities selected; second, the cities and their transport system including the user behavior are analyzed; third, the findings are discussed with international experts; and fourth, the summarized findings are linked back into the "UrMo" project. The ongoing process of selecting case studies starts by defining a set of criteria that the sample of case studies shall fulfill. Hence, according to Flyvbierg (2006, p. 230), an information-oriented selection is carried out. For the selection, a bandwidth of different cities, similar to Flyvbierg's definition of maximum variation cases, shall be covered, taking into account various conditions and contexts. Due to practical restrictions, a maximum of three case cities will be investigated. The following criteria guide the selection: variation will be achieved along the size of the agglomerations in terms of inhabitants, where we include one *megacity* on the upper end, one city on the lower end and one in between. Other side conditions include: the availability of data on transport in general and intermodality in particular, the existence of different transport modes to generally allow intermodality and visible changes in transport patterns that suggest that intermodality is developing in the cities to a certain degree. Furthermore, only those cities from OECD-countries are included, where the highest potential for intermodality is being seen. Table 1 shows an initial shortlist of candidate cities.

Table 1. Shortlist of international case study candidates.

Type	Candidates	Represent
International megacities	Tokyo , Seoul, New York	International, high density cities that are paradigmatic for very high demand handling and efficiency
European megacities	Paris, Vienna, Madrid, London, Istanbul	European capitals with high density and a big variety of different modes
Regional cutting-edge cities	Lyon, Copenhagen, Amsterdam	European cities < 1 Mio. inhabitants and forward looking transport policies

3. Modelling current and future intermodality

The empirical findings will be used for modelling intermodal behavior of a city's inhabitants and for designing and evaluating new mobility options – technical, structural, as well as organizational – in the subsequent project steps. A three-tiered simulation system is extended and used to obtain a microscopic (person-based) view of the influences and effects of intermodality. It is presented in the following subsection. The work on new vehicle and operation concepts for intermodal mobility is outlined afterwards.

3.1. Simulation of individual behavior

The empirical findings will be used to extend a set of simulation packages developed by the DLR. Three of them are employed within the project: the traffic demand and activity model "TAPAS" (see Justen and Cyganski (2008) or Mehlin et al. (2011)), the microscopic traffic simulation "SUMO" (see Krajzewicz et al. (2012)), and the location choice model SALSA. The latter replicates long-term decisions in choosing living or working locations. It uses a micro-economic auction model and determines the probability of choosing a location for a private household or a company given a region's sub-area and the building types located therein. It joins three sub-models for demand, supply and rent, respectively.

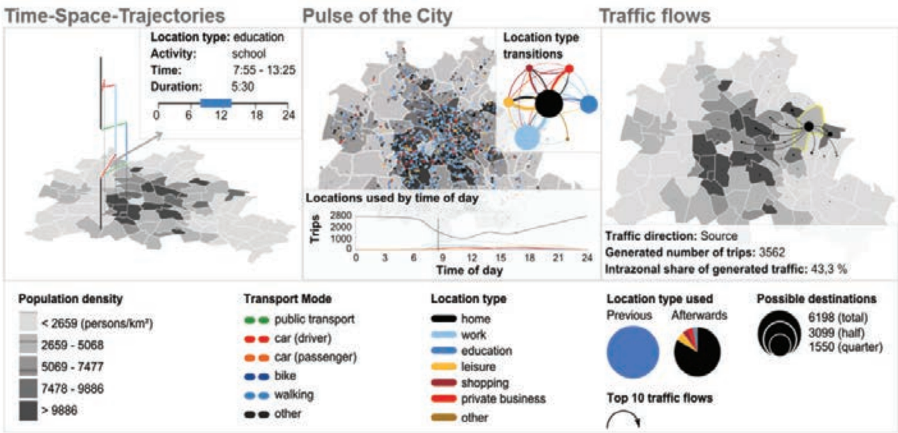

Fig. 5. Some disaggregated and aggregated views at mobility patterns as computed by TAPAS; from left to right: a single person's journeys over a day, activities within the city (sample), aggregated O/D flows from a selected TAZ (from Cyganski et al. (2015)).

Within "UrMo", all three simulation packages will be extended by models of intermodal behavior, based on the empirical findings gained through data evaluation as well as from the performed surveys. The combination of these simulation packages allows for a model-based extrapolation of the empirical findings about intermodal behavior from the survey sample to a region's complete population, making it possible to evaluate a complete region's performance in means of supporting intermodality on a microscopic (person-based) scale. But the major application of these tools is to predict the effects of possible future influences and changes, whether of socio-demographic, financial, technological, or regulative kind. Several of such scenarios are being prepared in "UrMo".

3.2. New vehicle and operation modes

Even when assuming very good public transport provision, some circumstances may lead to the use of a car in urban areas. The transport of luggage, specific trip chains or a special demand for flexibility might be such reasons. Within the project, the motives behind using a private vehicle will be identified and analyzed. Hence, the questions why a car is used and which attributes of a vehicle are paramount when it comes to the decision to use it will be answered. Additionally the vehicles' parameters and attributes are quantified to derive an optimal city car. The constructive implementation will be based on the results from in-depth analyses of customer needs and preferences between different solutions, where surveys within focus groups play a central role.

The requirements on vehicles may change in future. An increasing use of car-sharing concepts can already be observed in some cities and regions. For example, in 2014, Germany had more than 1 million registered car-sharing users (BCS (2015)). Currently, usual series vehicles are operated within those services, but the expanding market can lead to tailored vehicles that satisfy specific needs. Whether such vehicles are necessary and how they should be designed are further questions to be answered.

New operating concepts within the public transport system may change peoples' behavior as well. Such a new concept will be developed, accompanying the research on future vehicle concepts. A demand-oriented service is attempted where some of the main characteristics of conventional public transport are altered. Its operation will be supported by a web-based application allowing individualized stops and thereby abandoning pre-defined routes or schedules. The realization of this concept requires dynamic vehicle routing and real-time calculations of the passengers' trips. The system architecture is based on existing background processes of operations in public transport to ensure compatibility. Developing the concept also involves designing interactions, such as communication channels that need to be adapted to the specific needs of the involved parties.

4. Summary and outlook

The outline and first results of the "UrMo" project carried out by three Institutes of the German Aerospace Center have been presented. The presented initial evaluations of national surveys show that only about 17% of citizens use the possibilities to combine different modes of transport. However, following the trends for a co-use of mobility options, the increasing lack of inner-city spaces for parking, and finally the administrative attempts to foster the usage of soft transport modes to reduce the environmental impacts of traffic and to make cities more attractive, one should assume a growth in the number of intermodal users in the future.

While giving a coarse overview about today's level of intermodality in Berlin and Hamburg, the given data neither explains inhabitants' motives for using/neglecting intermodal offerings, nor can it exhaustively explain the influence of the cities' structure and infrastructure on these decisions. Both subtopics are subsequently targeted within the project by performing further surveys and expert interviews, as well as by collecting and evaluating different data that describes the city. It is expected that this work will deliver further characterization of intermodal mobility, including descriptions of the different intermodal users as well as the relationships between intermodal behavior and spatial parameters. Additionally, the knowledge about user motives and city influences obtained in this way will be used to model intermodal behavior and to design new vehicle concepts and new public transport operation services.

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