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Combining means of transport as a users' strategy to optimize traveling in an urban context: empirical results on intermodal travel behavior from a survey in Berlin

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ABSTRACT

Intermodal travel behavior is becoming increasingly important, particularly in large cities. Using and combining different transport modes flexibly on a single trip is discussed as being crucial to a more efficient and sustainable urban transport system. However, research on intermodality has mainly addressed long-distance traffic or specific combinations. This study analyzes how intermodality is practiced in everyday mobility by looking at relevant mode combinations, trip purposes, spatial differentiation and the requirements of intermodal users. The article presents results on intermodal travel behavior from a survey conducted in different neighborhoods in Berlin in 2016 (n = 1098). The results show that many people use intermodal combinations in their everyday mobility. Intermodal travel behavior is significantly characterized by public transport modes and trips to work. Spatial differences in intermodal use become obvious with combinations of bike and public transport being strong in urban neighborhoods, car and public transport in decentralized neighborhoods and combinations of different means of public transport in well-connected neighborhoods. In addition, the study emphasizes that time efficiency is an important aspect for intermodal users, becoming apparent in the reasons they state for performing intermodal trips and their evaluation of interchanges. Intermodal travel behavior and users' needs must therefore be taken into account in urban planning if the aim is to make the most of intermodal combinations for an effective urban transport system.

1. Introduction

Intermodal travel behavior – defined as the flexible usage and combination of different transport modes on a single trip (Chlond, 2013; Jones et al., 2000) – is becoming increasingly important, especially in large cities (Ahrens et al., 2010b; Infas, 2010; Yeh, 2008). It is also being discussed as key to a more efficient and sustainable urban mobility system (Dacko and Spalteholz, 2014; Gebhardt et al., 2017; Kager et al., 2016). Intermodality is linked to the assumption that combining different transport modes can contribute to reducing private vehicle use, and thus enable cities to better cope with problems like traffic congestion, lack of parking space and emissions (Dacko and Spalteholz, 2014). At the same time, the increasingly complex and dynamic arrangements of everyday life mean that people need a time-efficient way of organizing them (Voß, 1991; Werlen and Lippuner, 2007). The organization of everyday mobility is an essential part of these daily arrangements (Hjorthol, 2001). Thanks to the growing number of mobility offers (Lanzendorf and Hebsaker, 2017), people can choose a suitable means of transport to match the specific situation and the associated requirements. New options as a result of information and communication technologies (such as routing apps) also make it easier to flexibly plan and use different means of transport (Follmer and Scholz, 2013; Lenz, 2011). Against this background, intermodality is being discussed as a trend in large cities and possibly as key to a more efficient urban mobility system (Dacko and Spalteholz, 2014; Gebhardt et al., 2017).

According to Jones et al. (2000), intermodality is the combination of different modes of transportation during the course of a single trip. Basically, intermodality is a special form of multimodality: the use of different means of transport within a fixed period of time (Ahrens et al., 2010b; Chlond, 2013). Considering the use of different means of transport during a seamless, single journey, intermodality focuses specifically on the interchange from one mode of transport to another, whereas this is not relevant for multimodality (Beutler, 2004; Von der Ruhren and Beckmann, 2005). Several different interpretations exist as to whether the combination of different means of public transport

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should be regarded as an intermodal trip. Consequently, the degree of intermodality depends on the applied definition of intermodality (Jarass and Oostendorp, 2017). In line with other authors (Diaz Olvera et al., 2014; Yeh, 2008), the combination of at least two public means of transportation (e.g. bus and metro) is considered as an intermodal journey in this paper, since the process required to change from one to the other is a key element of intermodality.

Based on this definition, the article aims to explore intermodal travel behavior from the user's perspective by presenting empirical results from a survey on intermodal travel behavior in Berlin. Analyses using existing travel surveys from Germany based on single reference dates have shown relatively low shares of intermodal trips (Gebhardt et al., 2016; Jarass and Oostendorp, 2017). As they capture travel behavior only for one specific reference date, we assume that they have a tendency to underestimate intermodal travel. We therefore conducted a complementary investigation for Berlin focusing on intermodality but without reference dates. The aim was to place intermodal travel behavior within the context of everyday mobility, to identify underlying reasons for it and to understand the spatial differences in intermodal choices.

It is also assumed that the efficiency and optimization aspect of intermodality plays an important role in intermodal travel behavior because, although changing from one means of transport to another always constitutes a link, at the same time it also represents a potential disturbance on a trip. On the one hand, the question of efficiency and optimization can be regarded from a systemic perspective (macro level) and on the other hand, from an individual perspective (micro level).

On a macro level (system), intermodality is considered as being efficient in terms of contributing to a healthier and more sustainable life in cities (Chlond, 2013; Dacko and Spalteholz, 2014). It is based on the assumption that combining different transport modes can help cut private vehicle use and thus enable cities to cope better with problems like traffic congestion, lack of parking space and emissions (Dacko and Spalteholz, 2014; Gebhardt et al., 2017). Against this background, the EU Commission defines intermodality as an "essential component of the European Union's Common Transport Policy for sustainable mobility" (EC, 1997) and many public authorities promote intermodality as a key part of their urban mobility strategy (Hall, 2016; VDV, 2013). It should be noted, however, that intermodality often seems to be used as a buzzword in this discussion. In many cases it is unclear or not stated explicitly which aspects of intermodality are regarded as being sustainable. It appears that a broad shift from car to public transport is an even more important factor for a sustainable urban transport system. However, the central role of public transport in intermodal combinations suggests that a shift from car to intermodal combinations could make a crucial contribution to achieving the positive effects anticipated with regard to sustainability.

On a micro-level (individual), intermodality is discussed as being efficient in terms of personal wishes and the optimization of these parameters (Gebhardt et al., 2017). Initially, however, changing from one means of transport to another is associated with waiting time, orientation, and distances to be covered, and hence it is inconvenient and a potential disturbance on a trip (Preisendörfer and Diekmann, 2000). A routinized and optimized changeover process requires good knowledge of the situation and a high degree of willingness to behave flexibly (Knie, 2013). Unlike the topic of multimodality (Buehler and Hamre, 2015, 2016; Krygsman and Dijst, 2001; Molin et al., 2016; Nobis, 2007; Scheiner et al., 2016), there have only been a few studies on the intermodal travel behavior of people (Jarass and Oostendorp, 2017). Most of the existing studies refer to long-distance traffic (Ubbels and Palmer, 2013; Van der Hoeven et al., 2013) or focus on a certain combination or specific regions. For example, Ahrens et al. (2010a), Kager et al. (2016), Olafsson et al. (2016), and Martens (2004) discuss using the combination of bike and public transport (with examples from the Netherlands, Denmark, Germany and UK), whereas Olaru et al. (2014) analyze the combination of public transport with a private car (for Perth, Australia). The studies referred to all agree on the fact that public transport is advantageous when covering longer trip distances, whereas using a bike is more competitive for shorter trip distances. Combining the two transport modes in a single trip sequence has strong synergy effects (Kager et al., 2016). For example, Kager et al. (2016) have shown how the combination of bike and public transport can be regarded as a separate travel option that can compete with other travel modes in respect of speed, flexibility, trip length, and adaptability to individual needs and local circumstances at the points of origin and destination. Martens (2004) points out, for example, that there is a lack of data on bike-and-ride-trips, as travel surveys focus mostly on the main mode of transport used and do not account adequately for access and egress modes.

Only very few reports deal with intermodality in everyday mobility (e.g. Dacko and Spalteholz, 2014; Köhler and Heinrichs, 2014). In particular, there has been little investigation into the benefits of intermodality for individuals. Calculations show (Gebhardt et al., 2017) that being intermodal is often the most resource-economical option (in respect of time, price, personal energy consumption) for getting from A to B. However, empirical studies focusing on the user's perspective, e.g. studies delivering information about the reasons and preferences for using intermodal combinations, are necessary to ascertain whether intermodality can be understood as a strategy for meeting people's complex and dynamic everyday arrangements and for covering distances within the city in a time-efficient way. Intermodal travel behavior and its implications for mobility offers and urban planning can only be adequately understood by examining the background and logic of intermodal travel behavior from the user's perspective.

In order to address this knowledge gap, this article aims to explore intermodality on an individual level by presenting empirical results from a survey on intermodal travel behavior in Berlin. Being a large city, Berlin offers a wide range of different mobility services, including a dense public transport network. As the capital of Germany, Berlin has been experiencing strong population growth for several years. Within the last five years, the population increased by almost 7% to 3.55 million inhabitants in 2016 (Amt für Statistik Berlin-Brandenburg, 2017a, 2017b). The rising number of people in the city is reflected in the increasing volume of traffic and passengers. In 2016, over 1.48 billion passengers were carried by regular transport services, a rise of over 10% in comparison to 2011 (Amt für Statistik Berlin-Brandenburg, 2012, 2017c). The majority of passenger transport is provided by the public transport operators BVG and S-Bahn Berlin. Berlin has a dense and well utilized public transport network with 16 urban railway lines (S-Bahn Berlin, 2017), 10 subway lines, 22 tram lines and 197 bus lines (BVG, 2017). In addition to the rising number of passengers on public transport means, car traffic and traffic congestion in Berlin is also increasing. Commuters spent 40 h a year in traffic jams in 2016, whereas this figure was only 23 h in 2014 (INRIX, 2015, 2017b), and finding a parking space took up 62 h (INRIX, 2017a). To relieve the city center from commuter traffic, a number of park-and-ride facilities are available at many stations, especially in the outer districts of Berlin (SenUVK, 2018). The passenger car fleet in Berlin has grown by more than 5% since 2012 to almost 1.2 million passenger cars in 2017 (KBA, 2017). However, compared to other large cities, the number of passenger cars per 1000 inhabitants is low at 344 (KBA, 2017) which means that alternative mobility options are an essential requirement for unlimited and flexible mobility in Berlin. The number of new mobility options, such as free-floating car sharing, rental bikes or electric scooters, has been growing for several years. They offer alternatives to public transport and privately-owned cars. In addition, the city is easily accessible on foot and by bicycle due to its inner, polycentric urban structure and flat topography (Jarass and Oostendorp, 2017).

Berlin therefore provides good conditions for combining different means of transport to achieve flexible and situation-related everyday intermodal mobility and is an appropriate example for analyzing intermodality in cities. Given the wide range of different transport offers,