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Walking, Waiting, Interchanging:
A Scenario-Based Analysis of User Requirements in Local Public Transport

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Abstract

This paper describes the results of an acceptance study about requirements for use of public transport. The study focused on user requirements about waiting periods at bus stops, walking distances to the destination and the acceptance of interchange connections from the point of view of different user groups. To gain these findings, a scenario-based analysis of user requirements was carried out. The aim was to determine the framework conditions under which future public mobility concepts could be used. One case of application would be Demand-Responsive Transport concepts like ridepooling.

Introduction

"I like busses that ride quickly and promptly and without interchanges. I also prefer routes without detours and don't want to walk big distances" That sounds like a typical statement of users of public transportation systems. In this paper this presumption about the attitudes of passengers are kept under close scrutiny. Among other things, the question is asked whether the participants prefer direct connections instead of connections where they have to change. Another question concerns the importance of short walking distances to stations. The evaluated study makes a valuable contribution to the research of passenger requirements for flexible and demand-oriented mobility concepts.

The scenario-based analysis of user requirements focused on user requirements about characteristics of local public transport from the point of view of different user groups with methods of stated preference. Two of the main aspects that were included in the online questionnaire referred to passengers' attitude towards walking distances to bus stops, waiting periods and the acceptance of interchange connections. These aspects are presented in this paper.

Study Design

Scenarios: Extracted Usage Situations

To gain findings about users' requirement, a pairwise comparison was made. With this method, the participants are offered two alternatives in order to find out which one is preferred. It is a trade-off decision where the participants are not allowed to choose both options.

In this study, participants were presented scenarios on two topics that can be seen in figures 1 and 2. For the first topic (walking and waiting), the participants were asked to imagine they are standing at a bus stop downtown. The bus ride to their destination would take 10 minutes, not taking the bus and walk instead would take 20 minutes. Three scenarios were presented to the participants for this topic: When taking the bus, the participants had to wait 5 minutes (scenario 1.1), 10 minutes (scenario 1.2), 15 minutes (scenario 1.3) until the bus arrives at the bus stop. The participants were asked to name the option they would prefer in each of the three cases.

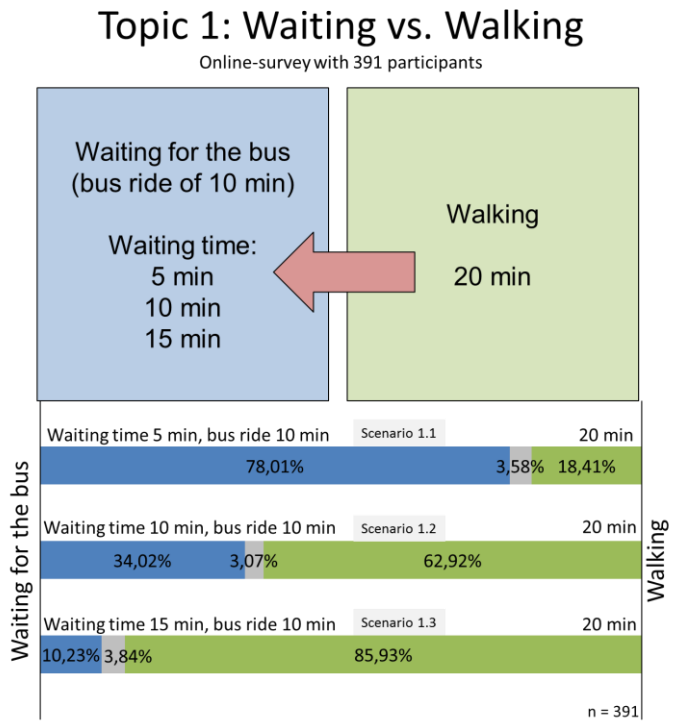

Figure 1: Description and results of the first topic: Walking and waiting (Scenarios 1.1, 1.2 and 1.3) (Source: author)

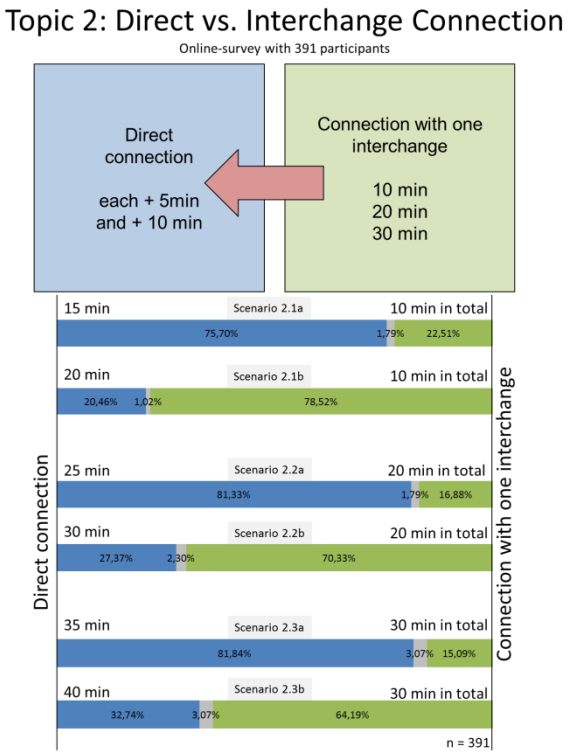

Figure 2: Description and results of the second topic: Interchanges (Scenarios 2.1a/b, 2.2a/b and 2.3a/b) (Source: author)

The second topic referred to interchanges. The participants again were asked to imagine they are standing at a bus stop downtown. There are two bus connections to choose from: One is a direct connection, at the other connection they had to interchange to another bus. Six scenarios were presented to the participants for this topic: 15/20 minutes direct vs. 10 minutes with one interchange (scenario 2.1a+b); 25/30 minutes direct vs. 20 minutes with one interchange (scenario 2.2a+b) and 35/40 minutes direct vs. 30 minutes with one interchange (scenario 2.3a+b). The specification of the time in each case refers to the total travel time, i.e. for interchange connections from boarding the first bus to leaving the second bus (including interchange time). The participants were asked to indicate the option they would prefer in each of the three cases.

Personas: Requirements of different user groups

Passengers have different requirements for public transport systems. In order to consider the needs of different user groups, the development of personas can be useful. In the project IP-KOM ÖV (2011) personas were developed. These are based on the recording of demands and characteristics of different passenger types with regard to their public transport use. For the study that is presented in this paper six of the personas with different characteristics, needs and requirements for public transport were used: Power users, ad hoc users, commuters, occasional users, everyday users and tourists. At the beginning of the questionnaire six statements of passengers were presented to the participants (see table 1). The task was to find themselves in one of the statements in order to enable the allocation of answers to typical personas during the evaluation.

Table 1: Statements in questionnaire and equivalent personas (Source: author)

Statement in questionnaire	Equivalent persona - based on IP-KOM ÖV (2011)
I'm using bus or train to work / school / university every day. Also in my free time I often use public transport for shopping or to come to events. I don't own a car because I can get everywhere by public transport or bicycle.	Power user
I only use public transport in exceptional cases, for example if I can't get through in winter or my car is in the repair shop or I'm spending my holidays in another place.	Ad hoc user
I travel to work / school / university with public transport every day and know my connections exactly. Punctuality is my first priority. If there are any problems, I would like to be informed timely.	Commuter
As I am physically disabled in my mobility, I need barrier-free stops and short interchange routes with sufficient transfer time. I occasionally use public transport for activities like small shopping trips.	Occasional user
I need public transport to do all my daily tasks (shopping, visiting the doctor, taking children to training). I must always be able to cope well with the often varying everyday life.	Everyday user
For excursions and activities with the whole family or holidays I like to use public transport because you can get from A to B in foreign cities so quickly and easily.	Tourist

Study Participants

A total of 391 fully completed questionnaires were submitted in the online survey. As figure 3 shows, about 45 percent of the participants are up to 30 years old. In terms of gender distribution, the participants were almost balanced. About one quarter of the participants live in small towns with up to 10,000 inhabitants. This is the class with the largest share. Only about one in a hundred of the participants lives in the biggest size class of over 1 Mio. inhabitants. Among the medium-sized and large cities, the distribution is reasonably balanced.

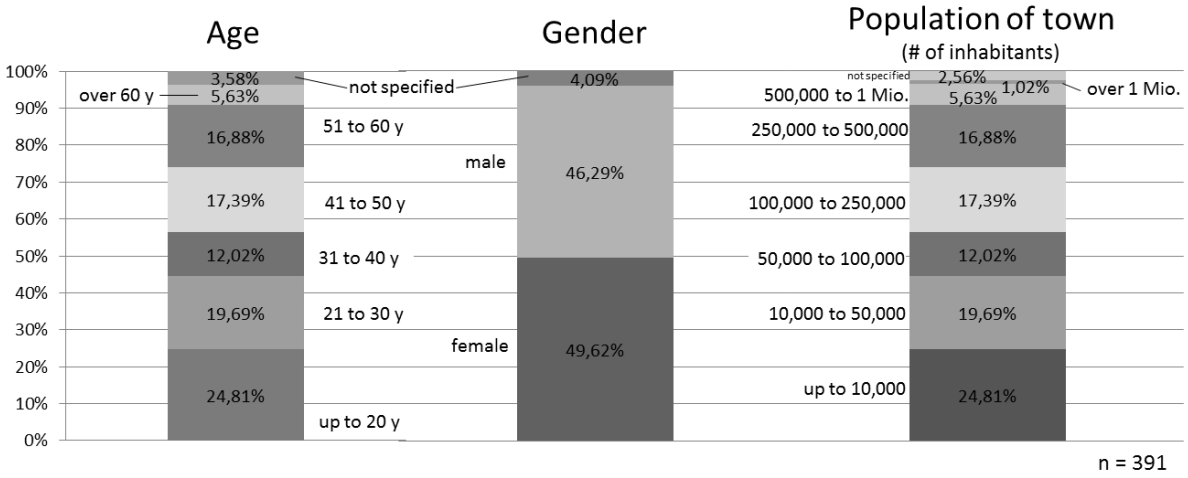

Figure 3: Participants' age, gender and population of place of residence (Source: author)

Participants were asked to find themselves in the descriptions in statements of typical users of public transportation, as shown in table 1. Figure 4 shows the results of this task. The top three personas with whom the participants could identify most strongly are the ad-hoc user, the

commuter and the power-user. In the further course of the description of the results, the answers of the individual user groups are evaluated separately.

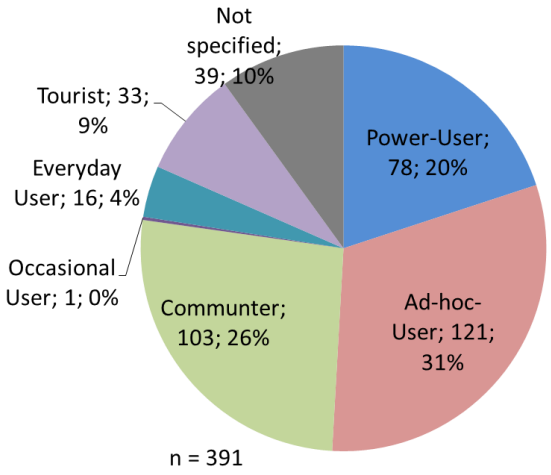

Figure 4: Distribution of Personas among the participants (Source: author)

Results of the Study

Walking Distances and Waiting Periods

Short waiting periods are important for passengers. An evaluation of booking processes of the transportation network company Uberpool revealed that customers in general reject the transport offer when the waiting time (Estimated time of arrival) is about 15 minutes (Myhrvold 2015). So that is the critical amount of time that decides whether a person will use a provided service or better will search for alternatives. Already from a predicted waiting time of four minutes, the probability of use decreases significantly. Short waiting periods are important for passengers. Even at high frequencies of service – i.e. at 5-minutes intervals – passengers do not arrive randomly at the station of metro lines but capture the right moment right before departure time (Luethi, Weidmann & Nash 2005). This phenomenon can be observed especially during the morning peak when most commuters know the schedule. Consequently during the peak passengers are more timetable-dependent and have strong claims on punctuality and short waiting periods (Paulley et al. 2006). Taking these cited study results into consideration, one of the main subjects of the study which is presented in this paper is the passenger's acceptance of waiting times until the ride begins.

The first topic addressed the choice between traveling on a bus including the previous waiting time and reaching the destination by walking. As figure 1 shows, in scenario 1.1 (5 minutes of waiting, bus trip of 10 minutes) more than three quarters of the participants opted for the bus-option and against a walk of 20 minutes. One possible reason for this is the overall shorter time to achieve the destination: 15 minutes in sum for waiting and riding vs. 20 minutes for walking. The answers in scenario 1.3 are the opposite. About 86 percent of the participants preferred a bus ride of ten minutes of 10 minutes after a waiting period of 15 minutes over a walking time of 20 minutes. Overall, the participants opted for the faster option in each case. The participants are therefore time-critical. These two scenarios have shown that the overall shorter time to achieve the destination was more popular in each case. What is particularly interesting is the question of how the answers would turn out if both options would take the same amount of

time. This question was examined in scenario 1.2. When both options would take 20 minutes, still a little under two-thirds would walk the distance and about one third would wait ten minutes for the bus for a bus ride of ten minutes. One explanation is that inactive waiting times may be perceived as unpleasant, e.g. because the feeling of being able to control the situation yourself is higher when you walk. This observation is in line with the findings of other studies: passengers perceive waiting and walking times as more bothersome than longer travel times (in-vehicle-time) (Iseki & Taylor 2009).

The evaluation of the answers of the individual user groups has shown that the power user in the scenarios 1.1 and 1.3 would be slightly more than average willing to wait for the bus (about 84 respectively 13 percent). Only in scenario 1.2 the amount of power user participants who would walk to the destination is significantly higher than the average: Only about 29 percent of the power users would wait for the bus. That is the same amount of commuters who would wait. This is exactly the opposite of the ad hoc user who in scenario 1.2 would be more willing to wait for the bus more than the average. About 45 percent of the power users would wait for the bus. As this evaluation shows, walking in all considered persona groups is popular when waiting for the bus and the bus ride in sum take the same time like walking but the ad hoc user is least willing to walk.

Looking at the responses from different age groups, the proportion of participants who would be waiting for the bus in scenario 1.2 is highest in the oldest age group (over 60 years). As can be seen in figure 5, around 45 percent of this age group would be willing to wait for the bus. In scenarios 1.1 and 1.3 there are no major differences between the answers of individual age groups.

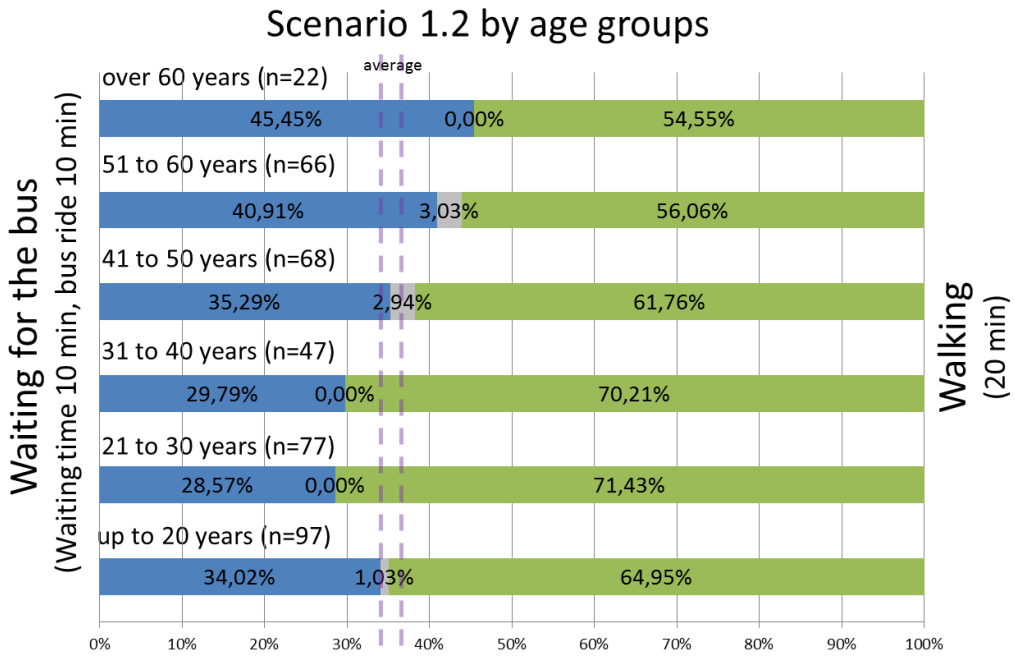

Figure 5: Results of scenario 1.2 by age groups (Source: author)

Interchanges

Key findings from literature research show that good conditions for comfortable interchanges are indispensable for the competitiveness of public transportation systems (Wardman & Hine

2000). It is unsurprising that many studies reveal the reluctance of passengers to interchange (Paulley et al. 2006). Wardman, Hine & Strading (2001) executed a meta study about penalty of interchange. The studies they cite in their paper differ about the time-effective or monetary amount of the penalty, but one perception can be found in every study: Interchange causes negative impact on the passenger's perceived quality of service. Additionally the studies found out that the intensity of the negative impact is influenced by the gender of the passenger, the carried luggage, the all-over travel time or the fact whether a person is time-bound and needs to hurry.

In the presented study the participants had to choose from a direct connection and a connection where they had to interchange to another bus. As figure 2 shows, about three quarter of the participants would choose the direct connection of 15 minutes over an interchange connection of about 10 minutes in total in scenario 2.1a. In the scenario 2.1b, the time for the direct connection increases to 20 minutes. Now the relationship is reversed: Over three quarters would put up with one interchange. The survey therefore showed that a small increase in travel time is acceptable for a generally short travel time, but not a doubling. Similar results were also obtained in the scenario 2.2a/b where the participants opted for a direct connection that takes five minutes longer than the interchange connection, but were not willing to invest ten minutes in a direct connection.

A comparison between scenarios 2.1a/b and 3.1a/b shows that the amount of participants who would choose the interchange connection (30 minutes) is still higher than the amount of participants who would choose the direct connection of 40 minutes –but is less than in the other scenarios. From the results of the survey it can be concluded that a five-minute difference between a direct and an interchange connection generally leads to the choice of the direct connection. Ten minutes difference is more painful for all the time spans requested. For a time saving of five minutes only a few participants accept the uncomfortable interchange, with a time saving of ten minutes but significantly more. Even if the change saves only a quarter of the total travel time (30 instead of 40 minutes), many participants choose the interchange connection. That shows that a short overall travel time is important. The threshold value is between five and ten minutes. If the more convenient direct connection "costs" five minutes, this is acceptable, ten minutes is too expensive.

The evaluation of the answers of the individual user groups shows that for scenarios with a difference of five minutes (2.1a, 2.2a, 2.3a), commuters choose the direct connection more often than average, but for scenarios with a ten-minute difference (2.1b, 2.2b, 2.3b), the proportion of commuters who choose the direct connection is approximately at the average level. This shows that communters are even more time-sensitive than the average decision: An investment of five minutes in a convenient connection is acceptable, but ten minutes is too expensive. In scenarios with a difference of ten minutes (2.1b, 2.2b, 2.3b) ad hoc users choose the direct connection more often than average, which can be interpreted as a greater proportion of ad hoc users who are used to driving by car prefer comfortable connections to fast connections.

The evaluation of the answers of the age groups (figure 6) has shown that in scenario 2.3a as well as in 2.3b the youngest and the oldest age groups were less willing to take the slower direct route than the other age groups.

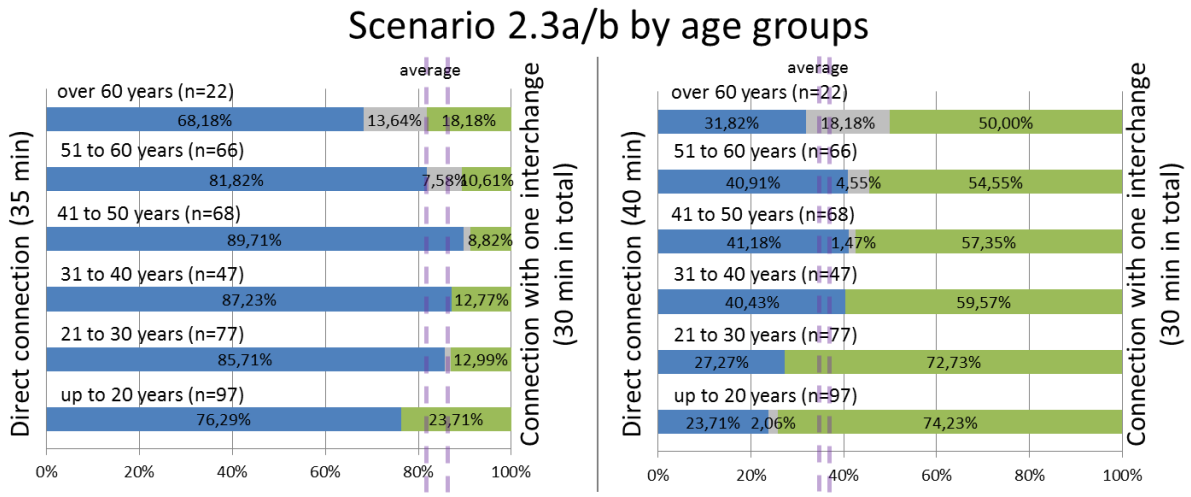

Figure 6: Results of scenario 2.3a/b by age groups (Source: author)

Key Findings of the Presented Study

The study has shown that

- participants are time-sensitive, even interchanging and walking is accepted.
- participants would rather walk a short distance than taking the bus, if both options would take the same time in total.
- the threshold value at which participants would opt for the faster interchanging connection over a more comfortable direct connection is between five and ten minutes.
- in all considered persona groups but the ad hoc user walking is popular when waiting for the bus and the bus ride in sum take the same time like walking.

Derivations of Study Results for Future Public Transport

The presented study revealed that a short travel time is important for passengers using public transport. Passengers also appreciate direct connections, but are prepared to accept interchanges if this significantly reduces the total travel time. The idea is that Demand-responsive Transport (DRT) is more suitable to meet the needs of passengers than line based transport systems.

Demand-Responsive Transportation (DRT), also called Ridepooling concepts, are digital mobility concepts with a high degree of spatial and temporal flexibility, bundling transport requests of different passengers in real-time. Algorithms based matching of travel demand of different users which harmonize in time and space creates individual routes in the sense of a shared mobility. The operation without fixed stops and the high flexibility due to the renunciation of timetables results in a high quality of service for the customer, combining the advantages of both individual and public transportation (Laws 2009).

The presented study has shown that inactive waiting times in particular are perceived as unpleasant. DRTs, which due to their high degree of spontaneity and their short pre-booking times could mean shorter waiting times (Estimated time of arrival), could increase the quality of service from the passenger's point of view. Stopping as close as possible to the starting and

destination point could contribute to reducing the out-of-vehicle-time of the individual travel chain, which adds up to a proportion of 60 percent in scheduled service (Monheim 2010). As, door-to-door service could contribute to increasing the attractiveness of demand-oriented transport even more. A prerequisite for this is that journeys with DRT are realized on an ad hoc basis and that long walking times do not occur due to the fact that the service is independent of the stop. As the study has shown, interchanges are unpopular with passengers. One way that DRT can improve public transport is to provide direct connections between destinations that can only be reached by interchanges with existing line transport.

In summary, the presented study gives an impression of the passenger requirements for public transport. In particular, this has created the basis for increasing the quality of service for passengers in future mobility concepts.

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