Identification of User Requirements for Mobile Applications to Support Door-to-Door Mobility in Public Transport

Ulrike Stopka

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

Abstract. The mobility service market has changed rapidly in the last decade. Innovative solutions like bike-, car- and ridesharing complete the classic individual car and public transport. The integration of these different transport modes to intermodal mobility solutions can be supported very effectively by the features and services of modern smartphones. The development of augmented mobility apps requires a continuous acquisition and evaluation of the public transport user needs and preferences. The paper describes the influencing factors for these demands and overviews different clustering and investigation approaches from practical projects and scientific studies. Finally the results of an own empirical study at the TU Dresden based on a focus group interview are presented. Appropriate recommendations for action are derived.

Keywords: intermodal mobility, public transport, mobility services, mobile applications, user requirements, preferences, habit, focus group, usability.

1 Motivation

Against the background of declining resources and rising energy prices, demographic changes with dramatic shifts in population density maintaining a well-functioning public transport is of particular public interest in every country. In the area of individual transport, car drivers have become accustomed to use intelligent navigation systems. Without their own activities they are continuously informed about the travel route, expected travel time, detours, accidents and any other possible disturbances on their way. These days the private car is still most convenient for door-to-door transport. Public transport is not yet able to meet these expectations in the same way. That's why it lost some of its attractiveness compared to car traffic. As reaction to this situation the initiative of the German Federal Ministry for Economic Affairs and Energy "Door-to-Door - A mobility initiative for public passenger transport of the future" was launched. The related research projects and activities focus on passenger navigation along his route from the starting point to the final destination. This includes pre-trip planning, on-trip information and dynamic guidance. The specific combination of innovative information, navigation and routing services with modern communication platforms like social media and mobile devices makes intermodal

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travelling for passengers more flexible, convenient and secure. Granting ubiquitous access to all kinds of data mobile services will essentially support seamless mobility in correspondence to today's way of life.

Recent developments in mobile communication and internet computing have paved the way for a wide variety of mobile applications. Many transport companies and associations, car manufacturers and other providers of mobility services offer a significant number of apps on the market supporting effectively a particular mode of transport. But these are more or less stand-alone solutions (see Fig. 1)

The reason therefore can be seen in the complexity of coordination different transport companies' databases and in the demanding processes to build compatible interfaces and structures for data exchange. Furthermore transport companies and data owners have often only a limited willingness to share their real-time traffic data with other providers.

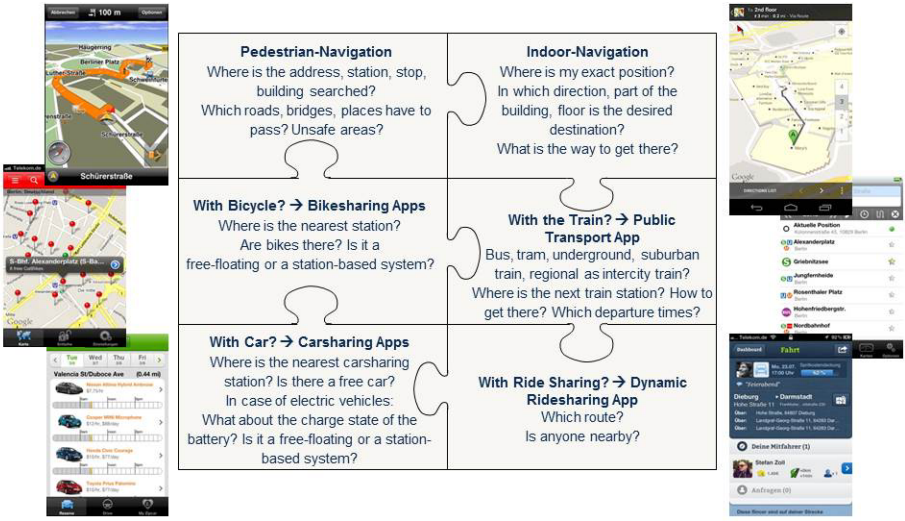

Fig. 1. Mobile applications as stand-alone solutions

Today the intermodal real-time information and travel guidance services are not yet fully taken into account. The complex door-to-door mobility covers:

- pedestrian navigation from the front door to the nearest public transport stop,
- use of rental bike to reach the next stop,
- the purchase of electronic tickets,
- information about the planned change of transport means or due to disturbances, delays or accidents,
- offering alternative routes based on real-time data,
- sending messages including authorization codes to get access to carsharing or bikesharing services
- indoor navigation to the destination point in buildings (see Fig. 2).

That means door-to-door apps should offer intermodal information, navigation and guidance, access, online disposition and booking services including the possibility of electronic payment/ticket for users who want to switch between train, tram and bus as well as bike- or carsharing.

Fig. 2. Door-to-door mobility supported by mobile apps

In this context it should also be considered to what extent Crowdsourcing and Social Sensing can be used to improve the quality of intermodal apps and accompanying services as a win-win-situation for both – for transport users as well as transport companies and service providers. At least the level of personalization, up-to-dateness and accuracy of travel information and recommendations is the most important competitive advantage.

Nevertheless: in the recent past first mobile apps for public transport with intermodal approaches have been developed and piloted in Germany such as "Smart-Way" [1] (in Dresden), "Cairo" [2] as a situation-aware mobile traffic information system (in Berlin), "moovel" [3], "von AnachB" [4], "DB-Navigator" [5] and other solutions.

2 User Requirements for Mobile "Door-to-Door" Applications

2.1 Influencing Factors

The requirements for seamless dynamic mobility applications are affected by a number of different factors shown in Fig. 3.

In terms of demographics, age plays an important role because of the openness to new ideas, i.e. both for new forms of mobility as well as new technologies, skills in handling smartphones, Internet, mobile services and their features are strongly age-dependent.

demography	preferences	route	context of journey
age	technology	purpose of journey	system knowledge (network of transport routes, stations, ticketing)
income	intermodality and multimodality	social circumstances (travel alone, in company, in a group)	local knowledge
captive riders choice riders	means of transport	pressure of time	awareness of the route
restrictions	convenience	freqency of use	spatial aspects of the journey
	willingness to run	kind of ticket and ticket purchase	
	barriers to public transport use	price sensitivity	
	willigness to dynamic rescheduling		

Fig. 3. Factors influencing the user requirements for mobile door-to-door applications [6]

Furthermore, there is a big difference between captive and choice riders. Captive riders must use public transport services were as choice riders have access to own vehicles.

Regarding preferences

- the degree of enthusiasm for technology,
- willingness to change transport means during one trip from A to B (intermodal use)
- willingness to use different transport means during a given time (week, month) (multimodal use),
- the preference for own car or bike,
- the comfort,
- the willingness to accept longer walks or
- to change spontaneously routes

affect the demands on mobile apps intensively.

The combination of these numerous individual factors leads to complex scenarios of user requirements (see Fig. 4). Thereby a trade-off always exists between the simplicity and clarity of use and the degree of complexity.

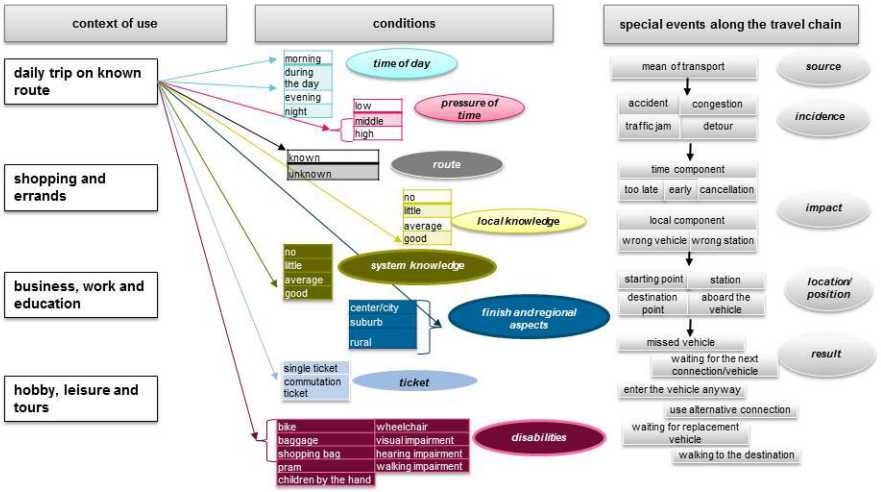

Fig. 4. Complexity of user requirements by various combinations of influencing factors [6]

3 Determination of User Demands on Mobile Apps – Results of Related Works

At the market a variety of studies on user requirements for smartphone-based mobility apps exists [6-12]. They emerged primarily in connection with development, market introduction and systematic evaluation of such apps.

The complexity of user requirements shown in the section above requires a clustering according to certain features and criteria to make them accessible for the development of new intermodal app functionalities and services. In Fig. 5 it can be seen that various projects and studies pursue very different approaches. However, the comparison reveals a certain cluster pattern for user requirements. This is mainly according to "general requirements", "technical performance" and "usability".

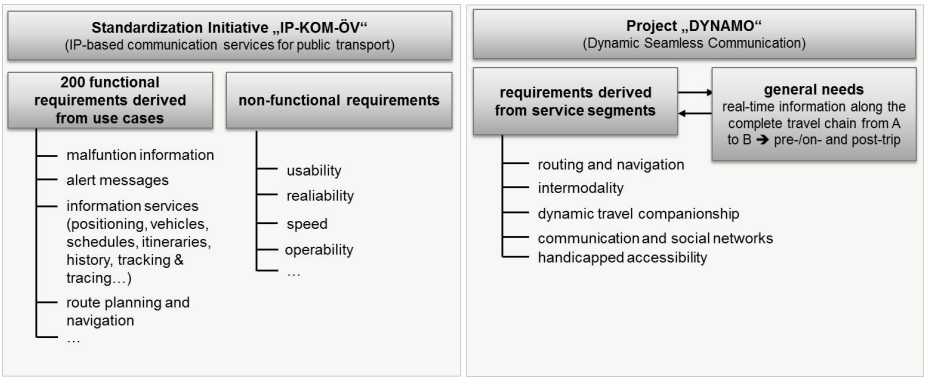

Fig. 5. Classification and clustering approaches for the determination of user demands on mobile apps [6-12]

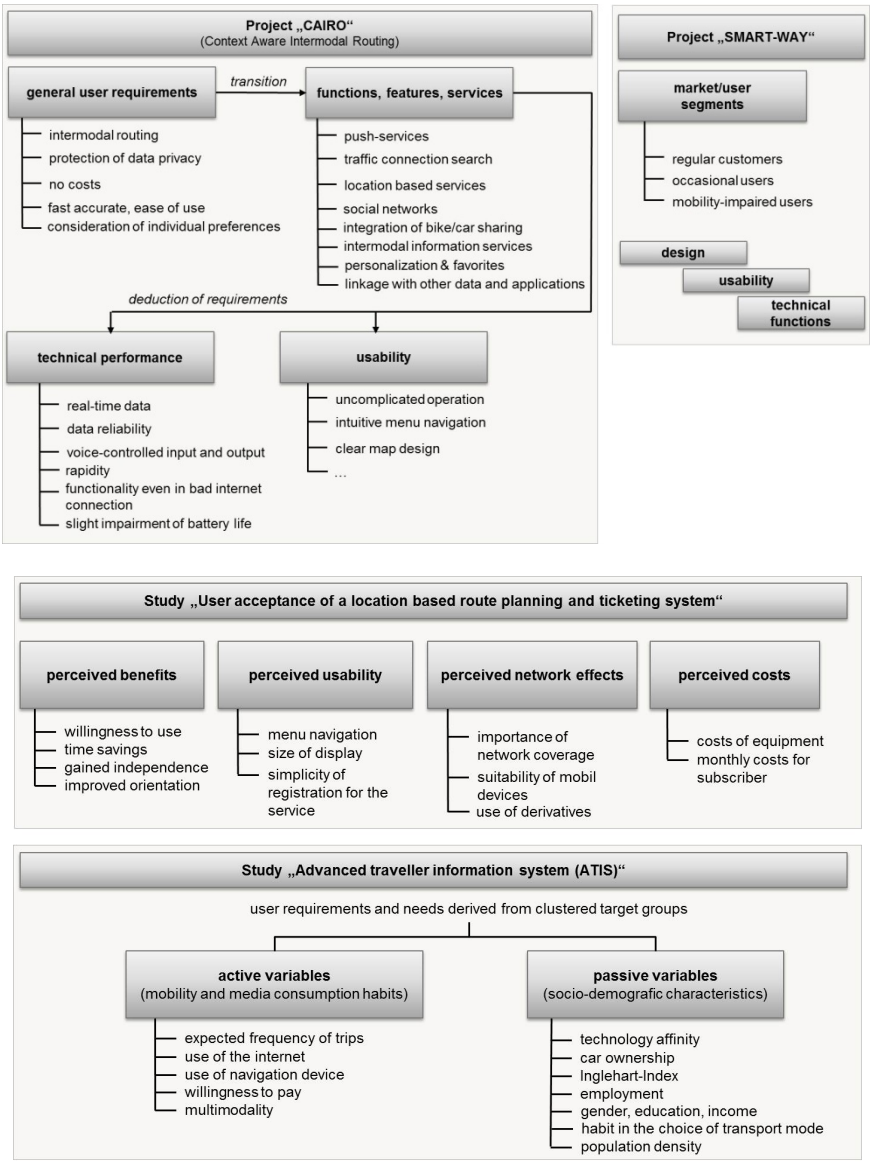

Fig. 5. (*Continued.*)

4 Results of an Empirical Study for the Determination of User Demands on Door-to-Door Mobility Apps at TU Dresden

4.1 Methodology

In preparation for the project work to provide the user and operator requirements for seamless door-to-door services and applications as part of the research project DYNAMO funded by the Federal Ministry for Economic Affairs and Energy a preliminary study at TU Dresden was conducted at the Department of Communication Economics in 2012. The investigation comprised

- a utility analysis (scoring model) of modern mobility applications and online services conducted on the methodological basis of the analytic hierarchy process and
- a focus group interview in order to determine detailed user demands on intermodal mobility apps.

This paper addresses particularly the identification of user requirements based on the focus group method.

A focus group is a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive environment. Moderated group sessions provide the opportunity to gain an insight into the thinking and behavior patterns of the target group. Due to the open and personal character focus groups are able to reveal completely new and unexpected aspects and interrelationships. Through the mutual exchange and confrontation with the perceptions, opinions and ideas of the other panelist focus groups bring more balanced results than individual interviews [13].

The focus group in our study consisted of 8 participants, 6 men and 2 women. The average age of the participants was 28 years, with the youngest participant 19 and the oldest 46 years old. The participants had a high level of education. 50 % held a university degree. Most of the participants were owner of private cars but despite of this all were active subscribers of a carsharing provider (teilAuto). All participants had a very positive attitude toward smartphone usage, a high affinity for technology and first experiences in dealing with navigation apps [14].

In the forefront of the focus group interview the participants as well as additional ten subjects had to test and to evaluate various mobility applications in the fields of public transport, carsharing, bikesharing, pedestrian navigation as well as the electronic ticketing with respect to various criteria (see chapter 5). On the basis of these criteria the user requirements for intermodal mobility apps in the following focus group interview were discussed and summarized.

The focus group interview was conducted by a moderator on the basis of a discussion guide including five phases:

1. welcome and introduction,
2. initiatory questions about mobility concepts and the importance of apps,
3. questions to ascertain the fundamental user requirements,

4. questions for the functionality, complexity and personalization of an intermodal mobility app,
5. final questions on the outlook for future developments and derivation of recommendations for action [14].

5 Criteria for User Demands on Intermodal Mobility Apps

Based on literature studies and discussion with experts six criteria for door-to-door mobility apps (see Fig. 6) were identified and used in the app tests and focus group discussion.

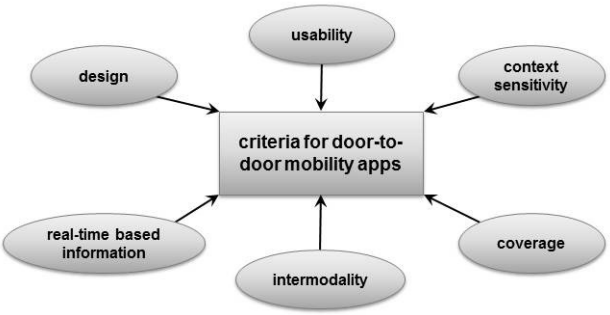

Fig. 6. Criteria for door-do-door-mobility apps [14, p. 90]

The criterion "Usability" comprises the user experience when interacting with the system or getting feedback. It is divided into five sub-categories (see Fig. 7).

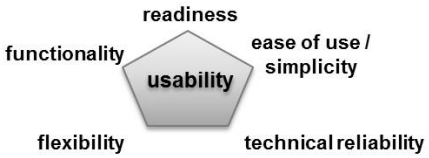

Fig. 7. Different aspects of the criterion “usability”

"Design" means the purely visual aspect of the display and information presentation. "Intermodality" comprises the use of all traditional public transport modes (bus, tram, underground, suburban, regional and intercity rail) and new innovative mobility services (bikesharing, carsharing, carpooling and dynamic ridesharing). "Context awareness" is defined as a filter taking into account the current situation of the user and makes the relevant information just at this moment available to him when it is needed. "Coverage" reflects the range of applications. A distinction is made between regional, national and international offers.

6 Presentation of the Results

The complex representation of the determined user requirements concerning all criteria shown in Fig. 6 is beyond the scope of this paper. Therefore the discussion is dedicated in particular to the user requirements with regard to the criteria "intermodality" and "usability" which are very closely interconnected. In the last consequence, the user requests of mobility apps correspond always to several criteria and can be difficult to be separated from each other. For example, the requirements with respect to intermodal route planning and travel companionship are always linked to the demand for real-time information.

Besides the already known general user requirements with regard to reliability, data security, ease of use, intuitive input and display forms (augmented reality), clear menu structures, simple call up of additional digital information etc. the most important user demands refer to the following aspects:

1. **Multimodal Comparison of all Means of Transport with the Possibility of Intermodal Linkage**

Users want to have a clear comparison of all possible mobility alternatives in order to go from one point A to point B. This includes information for the needed travel time, travel costs, availability of transport links or vehicles and environmental impacts. This comparison should take additionally into account besides the classic private and public transport services the increasing collaborative mobility services based on vehicle sharing. In this context an easy possibility of the transition from public transport to car- or bikesharing offerings is desired. This should be supported by real-time information about the availability of vehicles, their conditions, utility costs and their location including pedestrian navigation to go there.

From the usability point of view this user requirement is met best when the start and destination point of the searched connection can be entered directly on the first screen of an intermodal app (see Fig. 8).

Fig. 8. Appropriate presentation at the main page of an intermodal app [14, p. 134]

The starting point is determined directly via GPS. The user can enter time preferences and preferred modes of transport. With these initial data a comparison of all available options can be displayed after the query of connection. In dependence on the selected option the user will be presented all the further steps or alternatives due to the hierarchical system structure. This might be the reservation of a carsharing vehicle, the activation of a rental bike, the possibility of ticket purchase for public transport or the accumulation of points of interest for pedestrians.

2. Link-up Carsharing with Dynamic Ridesharing for the Optimal Matching between a Driver and Passenger

For instance the Carpooling platform “flinc” provides a link to vehicles of the carsharing system “DriveNow”. Users can activate the “flinc” service in their app profile or use the login via the screen in the rental vehicle. By activating the navigation the ride is offered automatically on the “flinc” platform and the driver can select whether he wants to pick up an inquiring person or not (see Fig. 9). But nevertheless the focus group interview showed the existence of numerous use barriers for sharing services.

Fig. 9. Combination of carsharing and dynamic ridesharing [15]

3. Possibilities of Personalization and Efficient Administration of Favorites Include

- options for entering user settings such as "a lot of baggage," "strange city", "here I am familiar", "maximal walk distance", "required transfer time", "average speed", "attractive, fastest, cheapest route" etc.
- efficient linkage of personal defined favorite start and destination points (see Fig. 10)
- import of calendar and address data of favorites from other apps

Fig. 10. Screenshot of the shuttle app “Pendel Panda” [16]

4. **Automatic Consideration of User Context Such as**
- weather conditions, points of interest nearby,
- purpose of travel and deduction of related route recommendations, e.g. as automatic selection of public transport, carsharing or taxi for business trips or deactivating trouble messages for the travel to or from work on weekends,
- storage of all cross-platform settings in the cloud

5. **Integration of Booking and Payment Functions in Intermodal Apps** allowing a "booking through process" via all modes of transport for a selected connection and a detailed cost information for each transport mode (public transport, car-/bike-/ridesharing) [17].
6. **Offering of e-tickets with Discounts for Intermodal Mobility Behavior**, e.g. for bikesharing, carsharing, railway tickets or taxi trips in combination with "pay-as-you-go" or "pay-as-you-use" tariffs [17]
7. **Providing Reliable Real-Time Information in any Case of Trouble and Disturbance**

   Users want more information and insights into the nature and causes of disturbances like the expected duration and the general options for action. In this context it is interesting to know users do not expect "precasted" alternatives. They need rather absolutely reliable forecast information when the journey can be continued or when a replacement vehicle is ready for use etc. They want to make decisions based on their own experiences and knowledge. This means user prefer reliable real-time based information giving them the freedom of choice.

   Furthermore users don't want a link between their public transport use profile and social network services like Facebook. Instead they are looking for direct, quick and helpful communication with the transport company.

7 Conclusions and Outlook

User demands on mobility apps are growing. 10 years ago it was enough to be informed about schedules and departure times of public transport services. Nowadays the customer wants to know if he can park the carsharing vehicle at the station, if a rental bike is available at the destination station and how long the complete journey does it take. This information should be delivered immediately and reliably with a few keystrokes [17]. Therefore the goal of "door-to-door" apps is to support seamless "mobility on demand" solutions for the customer. Public transport should become as comfortable as car trips in terms of navigation, travelling routines and flexibility. In this context smartphones indeed facilitate the ride with public transport [17]. The integrated use of travel planning, reservation and booking, real-time information, navigation and travel accompanying as well as the access to different means of transport including billing can be controlled by the customer's personal device. But the growing variety of functions and user requirements is in some way contrary to the need for easier operation and faster information retrieval. This trade-off should be considered in future development processes of app-features and services more intensively than today. It requires a continuous acquisition and evaluation of public transport user requirements

and preferences. These issues will be investigated by the further research in the Dynamo-project "Dynamic seamless mobility" in the next two years.

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