"Get off your car!" - Studying the User Requirements of In-Vehicle Intermodal Routing Services

Peter Fröhlich[1], Matthias Baldauf[1], Stefan Suette[1], Dietmar Schabus[1], Ulrich Lehner[1]
Marko Jandrisits[2], Alexander Paier[3]

[1]Telecommunications Research Center (FTW)
Donaucity-Str. 1
A-1220 Vienna, Austria
+43 1 5052830-85
{surname}@ftw.at

[2]ASFINAG Maut Service GmbH
Am Europlatz 1
A-1120 Vienna, Austria
+43 50108-12422
marko.jandrisits@asfinag.at

[3]Kapsch TrafficCom AG
Am Europlatz 2
A-1120 Vienna, Austria
+43 50811-2209
alexander.paier@kapsch.net

ABSTRACT
Traffic information from diverse transportation domains is increasingly becoming interlinked and accessible in real-time. Upcoming intermodal transportation services could advise drivers to change to a public transportation means, especially in case of severe congestions on the road. We present a road user study with 52 participants with an in-car intermodal routing prototype that gained first empirical evidence on the user requirements in such scenarios. We found that a considerable number of recommendations for modal shifts to public transit were actually accepted by the drivers. In-car inquiry results highlight that decision-making under such complex time-constrained conditions needs to be supported by a considerable amount of updated, detailed and valid information about time savings, pricing, connections and also the actual route situation ahead. We show that the presentation of such large amounts of information should be feasible without categorical safety losses, even with small-screen devices (such as smartphones). To guide further development, related design experiences with regard to presentation modality, system input, and screen design are shared.

Categories and Subject Descriptors
H.5.1. Information Interfaces and Presentation: Multimedia Information Systems—Artificial, augmented, and virtual realities; H.5.2. Information Interfaces and Presentation: User Interfaces—GUI

Keywords
Intelligent transportation systems, intermodal routing, multimodal transportation, traffic telematics user studies

1. INTRODUCTION
Increased traffic in metropolitan areas has resulted in chronic congestion, causing delays and pollution. As a result, every year nearly 100 billion Euros are wasted, which accounts for 1 percent of the EU's gross domestic product. Urban traffic is responsible for 40% of CO_2 emissions and 70% of emissions of other pollutants arising from road transport [6]. Over the last years, strategies have been proposed to address these urban mobility problems and to reduce CO_2 emissions caused by transportation [7].

To this end, traveler information services are being developed that are capable of processing distributed mobility-related networked traffic data in real-time a nd that can derive context-dependent recommendations to their users. Prominent examples are 'intermodal routing services', which are enabling users to achieve the best possible *combination* of transportation means, by air, car (owned, shared or rental), public transportation, bicycle an on foot ([11],[17],[16]).

The classical use case for such services has been based on pre-trip situations, that is, people can inform themselves via a stationary or mobile web application about the optimal route and combination before starting their journey. On-trip usage scenarios of intermodal routing services, by contrast, have so far rarely been investigated. How can persons who have already started their journey be informed about potential late-breaking problems with their chosen transportation mode, and how should rerouting recommendations be provided? A strong additional challenge in comparison to pre-trip intermodal routing services would be to convince drivers to perform unplanned 'modal shifts' between different transportation means.

Investigating on-trip re-routing recommendations may be especially worthwhile for in-car presentation, because the attractiveness of using a car can deteriorate very quickly depending on the current traffic situation. Simply changing the route to a neighboring street will often not be helpful, as congestion situations often affect wider urban areas. By contrast, given the availability of Park-and-Ride (P+R) stations, which have been established over the last decades at the border of many city centers, switching to a metro or rapid train would provide measurable benefits in case of such large-scale road congestions.

In principle, as drivers are increasingly employing internet-enabled navigation services on a regular basis via in-car assistance systems, personal navigation devices, or smartphones, it should be well feasible to propose them additional options for public transportation in real-time. However, initial research on user responses to intermodal routing services is necessary, in order to attain evidence for *acceptability* of the overall service type to pursue it at a larger scale. To this end, we need to identify the most important *incentives and barriers for accepting a recommended modal shift* from car to public transportation.

Since intermodal routing services have so far rarely been a topic in safety-related human factors research, we primarily need to assure that these do not violate *safety guidelines*, especially those related to cognitive load and driver distraction (compare [12]). To this end, we should also investigate whether *smartphones* are generally suitable for communicating such information, as their smaller screen size and limited audio output could increase distraction from driving task under certain conditions.

Due to the lack of previous research on this aspect of intermodal routing services, requirements for the necessary information to be presented to the users should be provided. A central question would be the *information quantity* and *level of detail* that drivers need for their route decision. Furthermore, it is important to understand which *types of information* are most relevant for presentation. It is finally important to recommend as many and detailed as possible *user interface design guidance* for such types of services. Traffic operators and service developers should not underestimate the necessity of proper user interface design, and empirical evaluation studies need to be performed in order to maximize ecological impact.

This paper provides first empirically gathered requirements from the driver perspective for such in-vehicle intermodal routing scenarios. We are focusing on situations where drivers are recommended to leave their car and change to a public transportation means. In the following section, we describe in detail the methodology of a comprehensive road study that we conducted to tackle the research issues brought up above. Section 3 presents the results of this study, and section 4 concludes with generalized recommendations, a critical reflection and an outlook on further work.

2. METHOD

To address the above described research and design questions, we conducted a road study on the motorway with 52 participants and more than 2300 driven kilometers. After a description of the test participants sample, the applied procedure and test route are explained. We then describe the research prototype developed for the study and give an overview of the types of data collected during the trial.

In order to gain as many as possible requirements for intermodal routing services, both regarding the necessary decision-relevant information and practical guidance on user interface design, we ran the study in two iterations. The first iteration was conducted with the first 23 participants using an initial user interface prototype that allowed several options with different detail levels of information. The second iteration was then conducted with another 29 participants, featuring a refined user interface prototype that incorporated feedback from the first iteration and that was designed with the purpose of end-user roll-out.

2.1 Participants

The 52 participating persons had been recruited with the help of the institute's test person database, and they received a gift voucher for a consumer electronics store as an incentive. Given the more critical safety risks of motorway-based user studies, we admitted only participants with a minimum of 4 years driving experience and regular recent highway driving. Furthermore, we did not accept persons older than 65 years. The mean age was 34.8 years (min: 22, max: 60). 22 females and 30 males participated. The larger share of male participants account for the higher share of male highway drivers [4].

We had a balanced distribution of experience with navigation devices: 16 participants stated to have no prior experience with navigation devices, 16 were regular and 20 were sporadic users of navigation devices.

2.2 Procedure and Test Route

The overall procedure consisted of a briefing phase, an accommodation phase and a test phase, in which the participants were driving on the motorway, and a final interview in the institution's laboratory. In the briefing phase, participants were informed about the test procedure and signed consent forms. They were informed that they would be using a future real-time information system capable of providing intermodal route recommendations, based on the current traffic situation. They were then given a walkthrough of the system prototype and about its main functions. Such a short introduction was necessary, as we did not want to bias test results by initial confusions and learning effects caused by a lack of training: the main focus was on understanding the information and presentation requirements in context, rather than immediate intuitiveness.

During the test drives, the participants drove along a pre-defined route, which was a round trip on a highway in the Vienna metropolitan area (see Figure 2). The route length was about 45 km, with an averaged test driving time of 30 minutes. The participants were accompanied by two researchers: an experimenter and an operator. The experimenter managed the test procedure, handed in the materials, provided instructions and coded pre-specified aspects of driving behavior. The operator managed the test instrumentation.

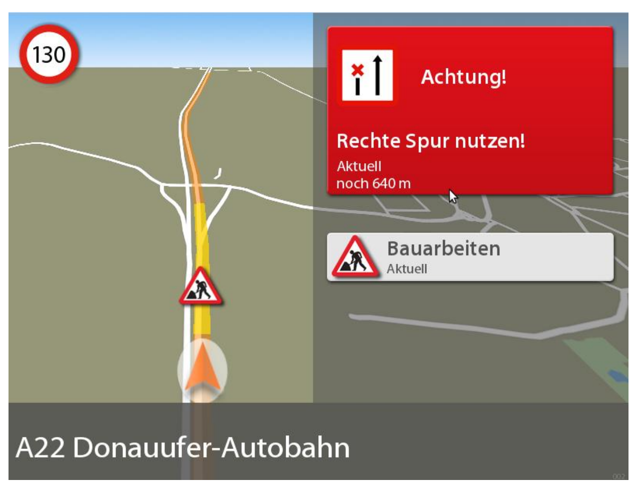

Figure 1: Realtime safety service system (without intermodal traffic recommendation)

Table 1: Parameters for the multimodal routing situations

Routing recommendation	Distance to destination	Available public transportation opportunity	Saved time	Costs (parking and public transportation)
1	21 km	Rapid train, then metro	20 min	€10.20
2	9,1 km	Metro, then further metro line	30 min	€23.60
3	6.5 km	Metro line	45min	€23.60€

The first part of the route was dedicated to the accomodation phase that enabled participants to get familiar with using a real-time driver information system on the motorway. Within this accommodation phase, the prototype featured a split screen showing on the left a map of the route ahead, on the right messages containing safety information and driving instructions (see Figure 1). Furthermore, the system provided spoken instructions that were introduced by a non-speech notification sound. This experimental prototype for the accommodation phase had been adopted from previous related road studies (compare [8] for a more detailed description).

The second part of the route led back into the city center, and this was the test phase in which the intermodal service was evaluated. To model a somewhat realistic scenario for context-aware in-car public transport recommendations, drivers were asked to imagine that they had entered the destination "Karlsplatz", which is a main square in the city center, and that the system would be providing appropriate route instructions.

At a pre-specified point, the driver information system recommended a new route in form of a P+R opportunity and rapid public transit, due to a severe traffic congestion on the roads towards the destination in the city center (which is not unrealistic during rush hour times in the investigated area). Participants could then obtain further information (see a description further below) and then could either keep with the previous route or select the new route with the public transportation opportunity. They were also asked to provide some immediate comments regarding their experience with the system.

Figure 2: Illustration of the route for the test phase, including the routing recommendations and the route destination

After this test route point, the participants continued driving for about 5 kilometers on the test route. This procedure was repeated at two pre-specified sections further ahead on the test route. With this setup, we aimed to simulate normal driving and avoid the pure succession of unusual critical situations: the driver could "fall back" into a typical driving habit, and would again after a while be confronted with the next intermodal route recommendation. Furthermore, this experimental setup should help the driver to reserve sufficient mental resources for such unusual decision situations.

The parameters selected for the three multimodal routing scenarios were motivated by providing real-life background information and recommendations. Furthermore, the scenario was selected to model a case in which a change to public transportation may actually be useful for a driver (see Table 1). Naturally, as drivers were approaching the city center during their drive, the distance towards the destination decreased for each of the three multimodal routing decision points. The information on the public transport connections and prices were based on the actual timetables. The proposed saved time increased in the three decision points, assuming an aggravation of the congestion, and also to get an indication on the incentives motivating a modal shift. We specified the costs according to the current transportation prices and the parking fees at the tested P+R locations.

2.3 Initial User Interface Prototype

The initial user interface prototype mainly aimed at gathering feedback about the overall conceptual design and acceptance of the service prototype and to identify an appropriate level of information detail. Within our conceptual user interface design, we took some apriori decisions based on best-practice experience (see Figure 3). In order to minimize visual demand, we restricted screen design to short keywords, a map for spatial guidance and soft buttons for user input. Verbal and quantitative information was complementarily provided via spoken language.

When a notification about a novel opportunity for public transportation was presented to the driver, a non-speech notification sound was played and the following basic spoken information was provided: "Park and Ride opportunity Korneuburg. Rapid transit. Saved time: 20 minutes. Daily costs: 10 EUR." Simultaneously to the notification sound, a green bar at the bottom of the screen appeared, containing a common P+R logo, the question "Use P+R?", and three buttons (see Figure 3, top). The left button ("Yes") enabled the driver to agree to the proposed option of using the P+R opportunity.

Figure 3: Initial prototype: The upper part shows the first screen provided to the users (small screen version), and the lower part shows the detail screen that appears when pushing the "Detail" button (large screen version).

A "No"-button was not included in this first iteration for screen space saving reasons – not choosing the P+R option was indirectly achieved by not pressing the "Yes" button until passing another predefined trigger point where the green bar disappeared.

To find out how much information the driver would need for a decision, we offered two related buttons: The "Info" button replayed the audio notification mentioned above, and the "Detail" button presented more explanatory information. This included a map providing a comparison of the two alternative routes (see Figure 3, bottom) and further details via auditory information: "*You will reach Park and Ride Korneuburg in 5 minutes. Free places are available. 2 minutes footway to the train station Korneuburg. S6 to Praterstern, change to U1 to Karlsplatz*" (see [5] for a demo video).

To gain device-specific insights of intermodal route recommendations, we had a 'large screen' setup, which consisted of a 12" touch-enabled screen representing a built-in driver information system, and a 'small screen' setup, which was represented by an *HTC Desire* smartphone with a display diagonal of 3.7". Both screens were fed by a laptop computer running our custom user interface prototyping toolkit [1]. This software toolkit allows for the easy creation of user interfaces for advanced (interactive) in-car applications based on a series of dedicated in-car HMI widgets, and it features a high-quality text-to-speech engine.

While the large 12" touch screen was connected to the laptop via the VGA adapter (and USB as well for communicating touch events), we wrote a video streaming module to provide the USB-connected smartphone with visualizations by the same rendering engine. Touches on the smartphone display were also forwarded to the laptop computer where the corresponding mouse actions are triggered. This approach allowed us to supply and test arbitrary end devices with one prototyping toolkit executed on a laptop computer while conveying the impression of fully functional mobile applications for the test driver. For both two screen sizes the same conceptual design was applied (see Figure 3). The refined prototype was updated based on feedback as a result of the first iteration evaluation, and thus it will be presented as part of the results in section 3.6.2.

2.4 Data Collection

For data collection, we considered several measures:

- *Route choice:* We tracked whether drivers accepted the new proposed route (by pushing the respective button) and thereby indicated overall preparedness to change to public transportation means in the given situation.
- *Information choice:* We counted the number of button presses, especially for "Info" and "Detail", in order to attain an indication on the amount of information necessary for driver decisions.
- *Usage problems:* Observed problems with using the interface were noted, such as when important task-relevant information has been overlooked or when problems with button selections occurred.
- *Driving behavior:* During the three critical situations in which the intermodal recommendation was provided, the experimenter identified "unsafe driving behaviors", such as sudden braking or distance keeping, on a 7-point rating scale.
- *In-car inquiry:* Users were asked after each of the three intermodal routing situations which choice they have made and why, which parts of the presentation had supported them most and which were most annoying to them.
- *Final inquiry:* After the test drive, participants were asked about several aspects related to in-car intermodal routing services, such as the relevant factors that would make them "spontaneously" change from car to public, the types of information that were relevant for their decision, and missing information.

3. RESULTS

During the user study, each of the 52 participants experienced 3 situations where intermodal routing was provided. Out of these 156 intermodal routing situations, 2 could not be analyzed due to technical problems, resulting in a sum of 154 analyzed situations. The results description first elaborates on general acceptance of intermodal routing recommendations and provides the obtained results for information and presentation. Then, improvement possibilities based on the first and second prototype iteration are presented. Statistical analysis was based on nonparametric tests (Wilcoxon, Friedman, and Mann-Whitney, respectively).

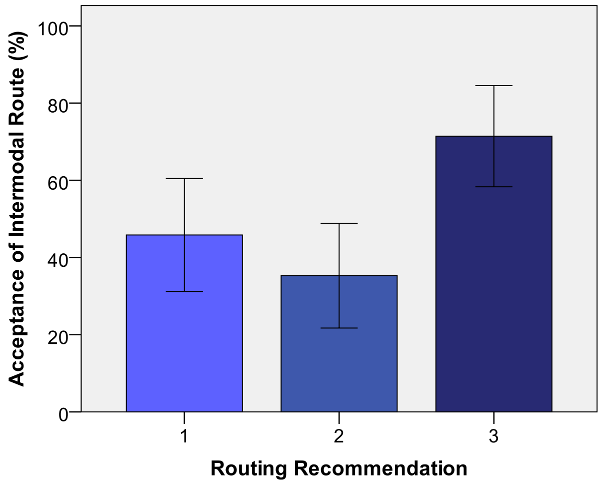

Figure 4: Acceptance ratio for the three given intermodal route recommendations

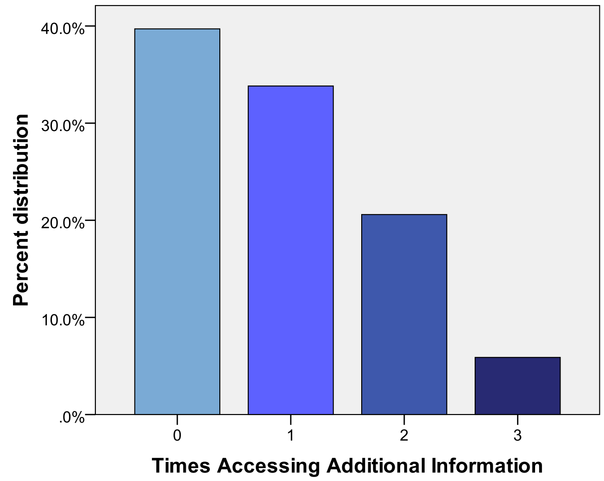

Figure 5: Percent distribution of the frequency of accessing additional information in intermodal routing situations

3.1 Acceptance of Route Recommendations

In the analyzed 154 decision situations, the new route with public transportation was selected about as often as it was rejected (74 / 48.1% vs. 75 / 48.7%), while a small minority was undecided (5 / 3.2%). When asked about the most important reasons for *accepting* the proposed new intermodal route, the large time saving was the most important mentioned reason (31 times explicitly mentioned, i.e. in 42% of the observed test situations with route acceptance). Also individual attitudes had an impact in some decision situations, such as a general personal preference for public transportation (10 / 13.5%) and ecological awareness (6 / 8%)). Another frequent comment in the tested decision situations was that they were curious about such a new routing service and that they wanted to try it out (8 / 10.8%).

By far the most often mentioned reason for *rejecting* an intermodal route suggestion were costs (32 / 42.7%). The concrete difference between the amounts (ranging in our case between €10 and €23) appeared to have a small, but not very decisive impact on the participants' decisions: it rather appeared that having to pay more than just a few Euro were a significant barrier for spontaneous use of P+R. A further mentioned reason for rejection of the recommendations was a general personal reluctance of using public transportation, or certain types thereof other than the metro (9 mentionings / 12%).

Also, practical concerns were mentioned as reasons (6 / 8%), such as the need of carrying someting, that the car can be used for combined drives within the city, or problems with picking up the car at the P+R garage. A further important reported reason for rejection of the recommendations was that relevant details of the presentation were missed or not completely understood (7 / 9.3%). In the rest of the observed driving situations, answers were unspecific.

Interestingly, the acceptance frequency of the intermodal route recommendations was differing significantly between the three decision points, $X^2=13.62$, $p<0.001$. Especially at the last decision point, which was closest to the city center and which had the most time saving advantage, participants accepted the route change in 71% of the cases, which was significantly more often than at the first decision point (46%, $Z=-2.547$, $p<0.5$) and the second decision point (35%, $Z=-3.607$, $p<0.001$).

3.2 Information Requirements

As noted before, we were interested in finding out the amounts and qualities of information necessary to take decisions in the context of intermodal routing. Figure 5 shows that in more than half of the routing decisions, participants accessed additional information by pushing the "Detail" button up to 3 times. On average, the "Detail" button was pressed 0.93 times to get more information (SD=0.92) at the tested decision points.

Similarly to the above reported factors for accepting intermodal routing recommendations, the information that was mentioned most necessary were the expected time savings, info about the public transport connections including the footway distance, and a clear definition of P+R and transportation costs including available space and hourly rates, which they partly missed in the prototype. Further information not to be forgotten is an indication of the causes of the changed route information, such as distance to the accident or length of the traffic jam.

3.3 Driving behavior

The experimenter coded the driver's behavior with regard to occurrences of unsafe driving events. However, only very few critical driving situations occurred, resulting in a very high mean score of 6.78 (SD=0.53). The button presses necessary for accessing more information did not appear to be problematic while driving, but in some cases the small screen had to be touched several times, which caused some irritations (observed 7 times, that is, 5% of the 154 investigated route decision points).

3.4 Presentation Modality

Our data appears to confirm also for this use case that audio is a highly recommendable modality for information presentation. Basically, in 75% of the test situations, test participants primarily relied on the auditory presentation, about 20% on a combination of audio and visual presentation, and only 5% purely on visual presentation. Typical related comments by users who had prioritized the presented audio information were: "I could concentrate better on the road", "All necessary information, such as saved time, was covered by the spoken messages", "I didn't need to read the screen", and "the spoken voice is pleasant and well comprehensible".

Users who valued the combination of the auditory and visual presentation gave comments such as "the map showing the route recommendations is good, also shows me where about to change trains", "audio provides the necessary information about time and costs, and the map shows me where to go", "the auditory notification provides the primary information, and the visual presentation enables me to confirm if necessary", and "the visual presentation helps with iconic presentation such as the P+R logo".

3.5 Screen Size

Two different screen sizes were compared, a large screen representing built-in driver information systems, and a small screen to account for the increasing number of smartphones finding their way into the car. We did not find statistically significant differences neither regarding the driving safety, nor the acceptance of the routing recommendations. It seems that due to the available auditory information, participants did not have to look onto the screen too often and long, only for confirmation purposes, and thus no safety problems could occur.

We observed that button selections were more difficult on the small screen, necessitating several tries for successful selection. This was not only caused by form factor and virtual button sizes (see next section), but also sometimes by the temporary touchscreen sensitivity problems due to the streaming between the operator's PC and the smartphone.

3.6 User Interface Design Aspects

3.6.1 *Feedback to initial prototype*

In the initial user interface prototype, a few usability problems were observed. An obvious usability limitation was that in the research prototype only a "Yes" option for accepting the route change was available, but not a "No" option for keeping with the standard route (in case the user did not select the proposed route, the system automatically stayed at the standard route and the multimodal routing recommendation disappeared when passing a predefined trigger point).

This lead to problems during usage in a few cases (6% of the 69 route decision points investigated in iteration 1), and 5 users qualified this as an issue in the final interview (22% of the 23 users of iteration 1). As mentioned earlier, the explicit "No" button had been omitted for screen space saving reasons, in order to be able to have more options for offering several levels of information details. Furthermore, the button size, especially for route selection, was sometimes experienced as too small, especially with the smart phone version.

3.6.2 *Refined UI design*

Figure 6 shows the graphically refined design, where the "Yes" and "No" options were grouped and placed more prominently with a larger button size and color differentiations. Furthermore, on the first screen, additional information was now accessible only with *one* "Info" button, leading to the second screen with the route map. On that second screen, more detailed spoken information could be accessed via the "More" button.

3.6.3 *Feedback to refined prototype*

We assessed the potential improvements of the refined designs in comparison to the initial prototype by counting the number of situations with usage problems. The ratio of situations with observed usability problems compared to the overall number of test situations was rather low (16% and 12%), no significant

Figure 6: fined intermodal driver information prototype (iteration 2): On top the redesigned first screen is shown (small screen version), and the bottom figure shows the detail screen that appears when pushing the "Info" button (large screen version).

difference was found between the two prototype versions. However, as Figure 7 illustrates, we found that on average significantly fewer participants *mentioned* issues with the refined than with the initial prototype (87% vs 37%, $Z=-3.54$, $p<0.001$). .

Naturally, the second testing iteration provided further insights that could feed into the design of intermodal routing services. Most notably, some users complained that they needed to press two buttons ("Info" and "More") in order to get to the desired detailed information. Improvements should go into the direction that users can quickly get access to detailed information, in order to help them back up their decisions. Another mentioned improvement opportunity was a different and specific notification sound for intermodal routing services.

4. CONCLUSIONS

In this section, we summarize the main findings and then conclude with some critical reflections on the applied methodological approach and indications for further research.

4.1 Main Findings

As the most general result, it appears that intermodal routing services in the car bear considerable potential. The acceptance of recommendations for changing to public transit was accepted in 50% of the test situations, which is more than could be expected given the necessity to leave the own car at such short notice.

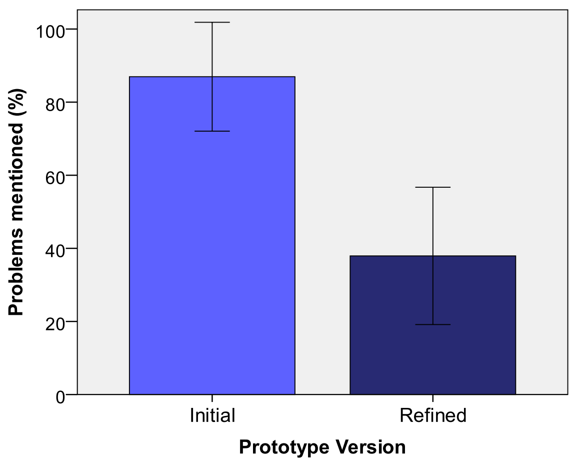

Figure 7: Percentage of participants mentioning problems after having used the experimental vs. the refined prototype

It appears that very strong time savings need to be achievable in order to motivate drivers for such a modal shift, thus this service will probably have its strongest impact in severe wide-area traffic congestions. Further factors for accepting intermodal routing recommendations are the availability of convenient public transportation and not too far distances (our participants appeared to feel less prepared to change into a normal train than into the metro already in the inner city. Of course, much already appears to be predetermined by the overall personal attitude of road users towards public transportation use. However, our study sample only comprised 3 (6%) participants who would not use public transportation by principle, which can be regarded consistent to representative surveys in the investigated region [3].

Our results furthermore indicate that a good information basis is crucial for drivers to take the required complex routing decisions under time pressure. It is absolutely necessary to provide information about time savings and costs, as these are the key parameters for decision. However, also an easy and transparent indication of how to get to the next train station and further transit connections are necessary. This need for substantial background information is of course a strong challenge for the in-car HMI, because its primary requirement should be to minimize cognitive load and distraction. As in other in-car usage contexts ([13][14],[8],[19]), we could confirm the suitability of the auditory modality for information presentation.

Also it appears that the visual presentation on the screen should not simply double the auditory presentation, but focus of the visual presentation on spatial instructions via suitable map representations. We found that users appreciated the possibility of comparing the alternative intermodal route with the standard car route. Further research might investigate ways to even show two intermodal route alternatives, as the availability of multiple selections have been found to increase credibility in such decision situations [18].

Furthermore, drivers should be enabled to quickly access further detailed instructions, in order to back up their decisions. It is important to thoroughly test the success rate of hitting such buttons, as insufficient button sizes or limited touchscreen sensitivity may be a source of distraction and annoyance. To account for such problems, buttons for in-car applications should be even larger and the system should be more tolerant than suggested by guidelines for traditional mobile applications. However, generally the experimenter's logging of driving behavior did also not support fundamental safety concerns, even when users provided inputs via the button presses.

Our data does not support the possible concern that small screen devices, such as the increasing number of smartphones, may not be capable of adequately presenting recommendations for intermodal route shifts. This finding extends the scope of a recent research study on unimodal real-time in-car routing services, which as well did not observe differences between large and small screen setups, as long as sufficient audio information was provided [9].

4.2 Critical Reflections and Further Work

As in any other empirical research study, caution is indicated when generalizing the obtained findings. In this particular study, the following limitations especially need to be highlighted, and follow-up research studies should aim at compensating these. The overall study setup was that of a small-scale semi-naturalistic road study: participants were trying out an experience prototype with fictitious traffic data in three pre-structured situations, and they were accompanied by researchers to assure the capture of a multitude of usage data. We think that obtaining first structured insights on selected aspects and scenarios of intermodal routing services was suitable, as so far virtually no background data was available that could be used to motivate and guide prototype design.

Having said this, this setup of course does neither allow for conclusions on long-term adoption of intermodal routing services nor does it cover the wealth of usage situations that could arise in real life. In particular, we cannot generalize beyond the investigated use case of recommending modal shifts from the car to public transport. Also less extreme congestion situations may have resulted in different, probably less favorable behaviors and comments with regard to the recommended route changes. Follow-up activities should include field-operational tests, in which a functional version of the prototype is tested over a longer period under real-life conditions and with real-time traffic data.

Within this first study on in-vehicle intermodal routing, not all potentially relevant use cases and user interface design opportunities could be investigated in a systematic way - a full-factorial experimental design would have resulted in a combinatory explosion which would by far have overstrained reasonable test time and budget constraints.

For example, based on recommendations in previous literature, we presented most information via spoken language and only the most fundamental and the spatially encoded information visually. While our data implies that this approach was very supportive for drivers, we cannot finally claim that an exclusive display on the screen in audio-off situations would have been dramatically worse. In order to back up our intuitively sound findings on modality allocation, replication studies should be conducted applying a full factorial design (with visual-only, audio-only, and combined presentation alternatives).

To resolve possible problems with touch input, future research on intermodal routing systems should certainly investigate opportunities for integration of speech commands. Automotive UI research has repeatedly demonstrated the suitability of multimodal dialog systems for various purposes (compare [19]), and especially in this investigated scenario recognition accuracy should be satisfactory, as not many speech commands would need to be discriminated.

The bottom line is that in-car intermodal routing services are a promising application area worth further investigating. In the context of in-car intermodal navigation systems that ask people to leave their car earlier than planned, persuasive design ([15][10]) is absolutely necessary. Related research efforts should be extended in order to provide practitioners with concrete guidelines and illustrations on the design of in-vehicle intermodal routing services.

5. ACKNOWLEDGMENTS

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