Human Interaction and Emerging Technologies (IHIET 2022), Vol. 68, 2022, 357–364
https://doi.org/10.54941/ahfe1002753

Evaluation of a Mobile and Seamless Travel Companionship in Smart Public Transport

Waldemar Titov, Seyedehfatemeh Ayoubi, Carl Friedrich Gerlach, and Thomas Schlegel

Institute of Ubiquitous Mobility Systems (IUMS), Karlsruhe University of Applied Sciences, Moltkestrasse 30, Karlsruhe, Germany

ABSTRACT

In this era of modernization, with the pervasiveness of smart devices, passengers have access to a lot of information when planning their trip by public transport. However, beyond the route information such as the train schedule and the ticket fare provided by the railway agencies, users do not have access to other sources of information. Information like local attractions, nearby places and weather condition. They can use many applications, which are not compatible with each other. The impact of the smartphone apps on the relation of travel companion and trip satisfaction is clear. Current navigation systems lack in several ways to satisfy such demand, namely, accurate information about urban traffic in real-time, possibility to personalize the information used by such systems and the need to have a more dynamic and user-friendly interaction between device and traveler and finally a satisfied companion service. The creation of one application (travel companion), which contains all relevant data needed for optimal planning of a trip can make traveling by public transport more attractive and would result in more satisfaction for passengers. In this paper, we research passenger's requirements and their interaction for the travel companion through a tracking app. Research consists of two evaluation methods based on questionnaires and interviews. Every step of the methodology brings interesting feedback on the design and functionality of the travel companion. The paper is based on results of the SmartMMI project – Model- and Context-based Mobility Information on Smart Public Displays and Mobile Devices in Public Transport.

Keywords: Smart public transport, Travel companionship, Usability evaluation, User satisfaction, User experience questionnaire

INTRODUCTION

This paper accumulates findings retrieved during the research project SmartMMI that was funded by the mFund research initiative of the German Federal Ministry of Transport and Digital Infrastructure. As Keller et al. introduced, the whole SmartMMI system combines a smart public transport data platform, a mobile application and a SmartWindow and enables context-aware passenger information (Keller et al. 2019). Beyond the design of the interactive SmartWindow, they also research the interplay of mobile application and SmartWindow for situational passenger information. To

develop a travel companionship and interactivity, the passenger information system needs to be aware of the passenger's expectations and needs. To do this, we evaluated SmartMMI app through an online survey and interview in which 24 persons participated. We conducted two different questionnaires that were used to evaluate user interface satisfaction (QUIS) and user experience (UEQ), and structured interviews. Through the evaluation process, the result of each study in each evaluation method resulted in practical feedbacks, which is mentioned at the end of this paper. However, how would be the user interaction with such companion technology in case of access to both smart window and mobile app interface? Would they be satisfied with this facility? This matter would be the focus of this research to evaluate the travel companion (TC) during their journey.

RELATED WORK

De Amorim et al. report on a usability study testing of a mobile application for public transport ticketing that applied a check-in/be out scheme, using near field communication, Bluetooth, and GPS (De Amorim et al. 2019). The study was implemented as a field test in the city of Porto, using a prototype of the developed application. In this study, eight users tested the app in real public transport, performing given number of tasks. The users started at a station they chose, and their trip required at least one interchange. The study included a pre-test questionnaire and during performing the tasks, the users were asked to think aloud. All tasks were performed using the mobile application. After the tasks were finished, the authors conducted a structured interview, focusing on the app's usability.

Habermann et al. describes the usability evaluation of a smartphone application that was developed as part of a project concerned with multi-modal transport (Habermann et al. 2015). A platform supporting mobility with several modes of transport was also developed in this project. The core functions of the applications were routing and booking of trips with public transport or other transport modes, such as car sharing. The authors report on the evaluation of an initial prototype for the smartphone application. They evaluated the perceived ease of navigation and interface quality in a questionnaire that was filled out by participants after performing the tasks.

The smartphone application that Chowdhury and Giacaman report about was also evaluated in the field (Chowdhury et al. 2015). The application enables the user to plan trips with one or more destinations and supports the user during their trip. The authors performed a study with 21 engineering students that were asked to travel four routes in total, of which the participants should travel one set of two routes using the given application and one set of two routes without the application, using information sources they normally would use during such a task. The study was unsupervised, and the participants were given forms to record at which time they started their trip, how long they waited and how long it took them to board a vehicle, as well as their time of arrival and how long it took them to plan their trips. The participants were also asked to fill out a questionnaire focused on the application's usability, after completing their tasks.

Stopka was dealing with user requirements for mobile application to support door-to-door mobility in public transport (Stopka et al. 2014). Transport operators for coordination of timetables, synchronizing arrival and departure times between the different transportation modes, and the traveler information system, often create these applications (Ezzedine, et al. 2008).

METHODOLOGY

An efficient and inexpensive method to measure user experience from different user group's points of view is thus the usage of validated questionnaires. It has the advantage that the questionnaires split the general notion of user experience into several simple quality criteria, which describe distinct and relatively well-defined aspects of user experience that can be measured independently (Schrepp et al. 2014).

We decided to conduct our own questionnaire and two other literature published ones that we believed could be adapted to evaluate the mobile app more precisely. The questionnaires we used includes as follow:

1. UEQ (User Experience Questionnaire) – The main goal of the UEQ is to allow a fast and immediate measurement of user experience. The UEQ considers aspects of pragmatic and hedonistic quality. The original German version of the UEQ was created 2005 by a data analytical approach to ensure a practical relevance of the constructed scales, which correspond to distinct quality aspects (Schrepp et al. 2014). The results of some studies showed a sufficiently high reliability of the scales (measured by Cronbach's Alpha) (Laugwitz et al. 2008).
2. QUIS (Questionnaire for User Interface Satisfaction) – It was developed by Chin et al. in 1988. A usability-testing instrument has been designed to measure the satisfaction of users about their interaction with the computer interface. QUIS consists of 27 items in five sections. The first section measures the overall satisfaction, and the four others measure user satisfaction regarding screen, terminology and information, learning, and system capabilities aspects. In this paper, we used the short version of QUIS 5.5. (Chin et al. 1988).
3. Our Questionnaire – This is composed of some statements about user's experience with navigation, map visualization, battery consumption, their opinion about ads and level of satisfaction with the app.

Participants

The survey was conducted with 24 persons working with two different interfaces of virtual form of smart window and the mobile app. Respondents comprising undergraduate/ postgraduate students, employees, parents with children, and tourists are involved in the evaluation of the relevant features of the SmartMMI app. Figure 1 shows selected snapshots of the SmartMMI app used in our evaluation.

The ages of the participants ranged from 21 to 36 years. Thirteen participants were students of different majors, 6 participants employed and five tourists. Fifteen participants stated to use public transport regularly, five

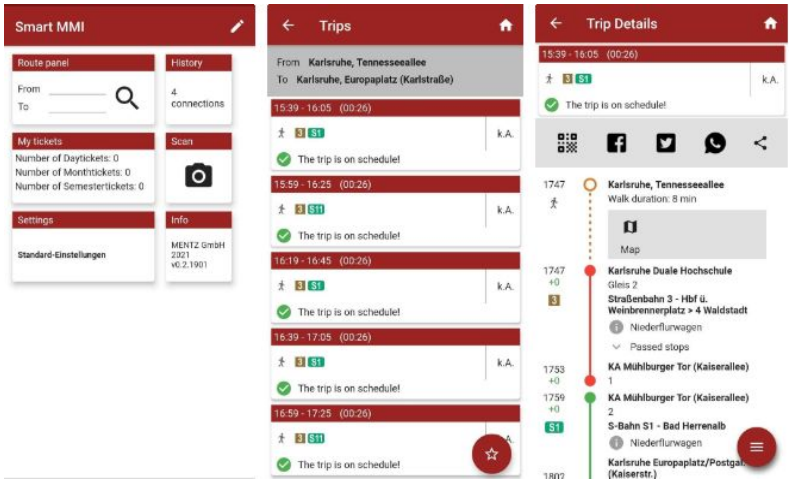

Figure 1: Screenshots of the SmartMMI app interface during intermodal Journey. Left: start page. Middle: choosing from recommended trips. Right: trip details of an individual track.

persons stated one to three times a month and four other participants use public transport less frequently than once a month. All subjects stated to have a high technical affinity, were familiar with the operating technology, and could participate in the study without extensive technical introduction.

Study Procedure

The questionnaire was answered online through the generated URLs list that sent to the participants via e-mail individually. The questionnaire was divided into two parts. After a few general questions, the first study design section contained about the attractiveness, perspicuity, efficiency, dependability, simulation, and novelty based on standard UEQ method. The second part asked questions about the user interface satisfaction and technical aspects such as the navigation, map visualization, learning of the app and app capabilities.

The results give a good insight into the varying preferences of different passengers. At the end, we held an online interview as well to collect information on the following:

- What information is important for passengers during a train journey?
- Which information should be displayed on the SmartMMI app, specifically?
- What are the needs experienced by the users in connection with the app?
- What factors are relevant for each interaction point and how could they influence the passenger acceptance and use of the app?

With this approach, we expected that users bring up new ideas for information that could be considered for further development.

Table 1. The mean and variance of UEQ scales and coefficient of Alpha per item.

UEQ Scale	Mean	Std. Dev.	Cronbach's Alpha
Attractiveness	1.51	1.07	0.86
Perspicuity	1.80	1.14	0.79
Efficiency	1.57	070	0.51
Dependability	1.15	0.76	0.58
Stimulation	1.18	1.46	0.86
Novelty	0.43	2.19	0.82

Conducted Analyses

The evaluation approaches for mobile app were analyzed according to the characteristics defined in the section above. Thus, the overall results for each research question and attributed extracted from the evaluation approaches are discussed in subsequent sections. Carrying out the whole survey took around 13 minutes averagely per person. When working with the SmartWindow and then moving to the app, participants spent on average 65 seconds on completing the task and 203 seconds for questionnaire during the remote online meeting.

UEQ Analysis

Several studies have shown a sufficient reliability (measured by Cronbach's Alpha) and construct validity of the scales (Laugwitz et al. 2008). Inter-item correlation alpha values varied by only 0.05. The items are scaled from −3 to +3. Thus, −3 represents the most negative answer, 0 a neutral answer, and +3 the most positive answer. The mean ratings varied between 0.427 and 1.082, while standard deviations ranged from 0.836 to 1.479. Thus, it is no surprise that the mean value is above the neutral value (i.e., 0) of the 7-point Likert scale.

A close inspection of the mean ratings in Table 1 reveals that the ratings of items within each travel need factor align close to one another, although novelty items are negatively skewed toward the higher end of the 7-point agreement scale. The UEQ scales distribution of responses are displayed in Figure 2. The average rating of the entire sample is above or close to the mean and the largest mean difference was found in novelty features of the app. From quality aspects point of view, hedonistic quality items (simulation and originality) assess the lowest mean, among others.

With the availability of a benchmark, it is relatively easy to decide if a new product has sufficient user experience to be successful in the market. A comparison of the results for the different scales with the results of the products in the benchmark allows then conclusions about the relative strengths and weaknesses of the product.

Figure 2 shows that SmartMMI app scores high compared to the products in the benchmark which this can indicate that users generally found the product's user experience (UX) satisfactory except the Novelty and Simulation, which are indicated again as the weakness of the app by participants.

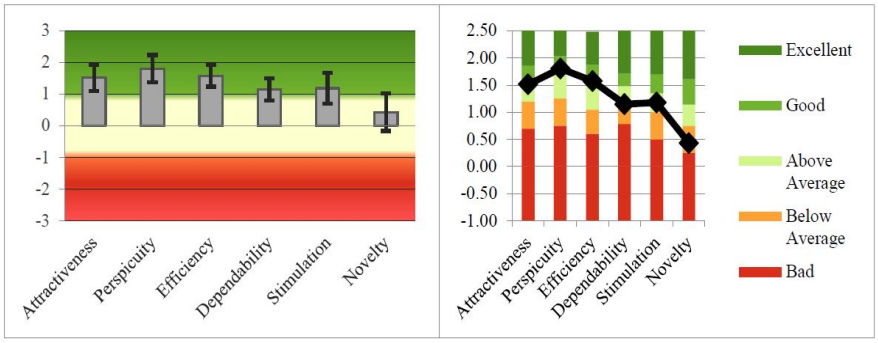

Figure 2: Left: The distribution of UEQ scales answers; Right: Benchmark graph from UEQ Analysis.

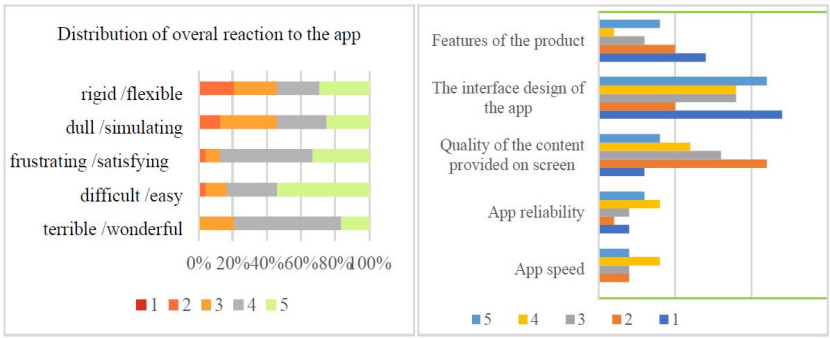

Figure 3: Left: Distribution of overall reaction to the app; Right: Capabilities Comparison of SmartMMI app.

QUIS and Our Added Questions Analysis

Summary data for each question in the short version of QUIS 5.5 are categorized bellow. Each of the six general satisfaction questions, and 22 specific questions are listed by question number.

- overall reaction to the app (shown in figure 3 left)
- app screen: All participants agreed on easiness of reading characters in the app and just 20% of them found the organization of the information confusing.
- terminology and app information: participants stated that the understanding of contents was consistent but there was no availability of error messages and progress of the task during navigating.
- learning: They were mostly satisfied with the interaction with the app and showed that it was very easy to learn features.
- App capabilities (shown in figure 3 right).

RESULTS AND DISCUSSION

We implemented two different questionnaires and interviews to analyze the satisfaction, usability, interaction, design, and companionship of

functionalities of the SmartMMI app profoundly. Some caveats need to be pointed out about the interpretation of these data. First, due to the COVID-19 pandemic, it was limited to invite participants on site and give them more impression to reach results that are more reliable. It is also possible that the results could have been somewhat different if we had been able to collect data from more participants using the questionnaire and the obstacle was that the app was available only for android users. Keeping all those caveats in mind, it is interesting to note that the SmartMMI app was one of the simplest applications among other tracking apps which its main role is assisting the passengers through the journey while using SmartWindow complimentary. Additionally, it was concluded that the app was successful in applying travel companion during the passenger's journey. These were the main result of our evaluation that counts as an exclusive feature among other independent complex applications in the market.

CONCLUSION

Remarkably, mobile apps are growing in daily life and the search for quality of these applications grows in proportion. Despite this evolution, we were able to observe that there are still needs for studies on mobile apps usability evaluation and travel companion technologies. This paper presents the outcomes of results within SmartMMI mobile app, which focuses on the "Analysis of the user experience and interaction in using the TC capabilities". As a first step, the travel companion has been 'deconstructed' into its consumer-oriented capabilities and interaction points, i.e., all those situations in which the travel companion may assist the user in different phases of the travel experience. The main consumer interaction points identified are user identity, preferences, planning, adding tickets, information, disruption, after trip, and on-going communication. For each interaction point, a series of assumptions have been formulated regarding factors (incentives, needs, constraints, barriers) that could (positively or negatively) influence the consumer uptake of the TC approach. To validate these assumptions, questionnaires and interviews were conducted with 24 users from different perspectives to collect further information and to better understand the factors that could influence the uptake and use of the travel companion. The questionnaires and interviews have provided valuable feedback on the design and recommended the functionalities, which the travel companion should have. Nevertheless, more potentials for further improvements and studies can be reached with the public implementation of the project in the city of Karlsruhe through the various feedbacks. Human Systems Integration (HSI) is becoming a critical piece of complex systems to help resolve system designs. This proposal has presented a growing body of knowledge for HSI and new technologies that are being developed to capture critical aspects of HSI. The development of a framework for Human Systems Integration with Systems Modeling Language (SysML) will enable teams to collaborate better by providing a common language and process to distribute models and share information. The Human Systems Integration component in systems engineering will be able to recognize the

human as an integral element of every system by representing behaviors, constraints, states, and goals through-out the entire lifecycle.

ACKNOWLEDGMENT

This work was conducted within the scope of the research project "SmartMMI - model- and context-based mobility information on smart public displays and mobile devices in public transport" and was funded by the German Federal Ministry of Transport and Digital Infrastructure as part of the mFund initiative (Funding ID: 19F2042A). Refer to SmartMMI homepage for more information: https://smartmmi.de/project/. We would like to thank Seyedehfatemeh Ayoubi for her excellent contribution to this project.

REFERENCES

Amorim, D. M. D., Dias, T. G., & Ferreira, M. C. (2018, October). Usability evaluation of a public transport mobile ticketing solution. In International Conference on Human Systems Engineering and Design: Future Trends and Applications (pp. 345–351). Springer, Cham.

Chin, J. P., Diehl, V. A., & Norman, K. L. (1988, May). Development of an instrument measuring user satisfaction of the human-computer interface. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 213–218).

Chowdhury, S., & Giacaman, N. (2015). En-route planning of multi-destination public-transport trips using smartphones. Journal of Public Transportation, 18(4), 3.

Ezzedine, H., Bonte, T., Kolski, C., & Tahon, C. (2008). Integration of traffic management and traveller information systems: basic principles and case study in intermodal transport system management. International Journal of Computers Communications & Control, 3(3), 281–294.

Habermann, A. L., Kasugai, K., & Ziefle, M. (2015, October). Mobile app for public transport: a usability and user experience perspective. In International Internet of Things Summit (pp. 168–174). Springer, Cham.

Keller, C., Titov, W., Sawilla, S., & Schlegel, T. (2019). Evaluation of a smart public display in public transport. Mensch und Computer 2019-Workshopband.

Laugwitz, B., Held, T., & Schrepp, M. (2008, November). Construction and evaluation of a user experience questionnaire. In Symposium of the Austrian HCI and usability engineering group (pp. 63–76). Springer, Berlin, Heidelberg.

Schrepp, M., Hinderks, A., & Thomaschewski, J. (2014, June). Applying the user experience questionnaire (UEQ) in different evaluation scenarios. In International Conference of Design, User Experience, and Usability (pp. 383–392). Springer, Cham.

Stopka, U. (2014, June). Identification of user requirements for mobile applications to support door-to-door mobility in public transport. In International Conference on Human-Computer Interaction (pp. 513–524). Springer, Cham.