Interactive Public Displays for Paperless Mobility Stations

Cindy Mayas(✉), Tobias Steinert, and Heidi Krömker

Technische Universität Ilmenau, Postfach 10 05 65, 98684 Ilmenau, Germany
{cindy.mayas,tobias.steinert,heidi.kroemker}@tu-ilmenau.de

Abstract. A current development in public transport is the transition of paper-based mobility information into public displays at mobility stations. Mobility providers and users can benefit equally from this progress. This paper describes the evaluation of eight interactive public displays at a completely paperless test station in Stuttgart, Germany. The evaluation is based on analytical and empirical methods and covers data of the first year of operation.

Keywords: Public displays · Usability · Mobility information
Public transport

1 Introduction

The future of mobility is characterized by digitalization and flexibilization [1]. Firstly, the transfer of information within mobility providers and between mobility providers and travelers is mostly based on digital communication. Secondly, more public, shared, and individual mobility modalities are offered, for instance on-call busses, car and bike sharing, or taxi offerings, and enable more individual and flexible routing of travelers. Within these developments, stations are the hubs of mobility and mobility information and have to face new challenges:

- Increasing amount of information about departures and arrivals,
- Increasing amount of information about terms of use, and
- Increasing demands on actuality of information about delays and disturbances.

Today, the majority of information (about timetables, network plans, terms of use, construction zones and so on) is provided on paper, which has to be changed manually in case of modifications, at German stations. Thus, the introduction of paperless mobility information systems at stations does not only support the mentioned challenges, but also enables more efficient organization structures for mobility providers. The public mobility provider of Stuttgart introduced interactive displays [2] at one test station, in order to replace completely paper-based mobility information. This paper presents the user-oriented evaluation of the first year of use of eight interactive displays at the test station.

M. Kurosu (Ed.): HCI 2018, LNCS 10902, pp. 542–551, 2018.
https://doi.org/10.1007/978-3-319-91244-8_42

2 Objective and Test Subject

The interactive displays comprise the same collective information as the hardcopies at the same place before. The interactive application is controlled via a 46'' touchscreen (see Fig. 1) and includes the following information:

- Timetable,
- Route map,
- Ticket information,
- Station map, and
- Information on disturbances and deviations from timetable.

Fig. 1. Example of an interactive public display at the paperless test station [3]

Some supportive functions, as zooming and searching, are implemented next to the navigation functions, which were tested in an usability study according to the established criteria of usability und user experience of DIN EN ISO 9241-110 [4, 5]. The results of the usability study were included in the subsequent final development of the interactive public displays. Therefore, the field evaluation focuses on the following three aspects of use, next to the detection of further usability issues:

- Extent of use,
- Context of use, and
- Degree of acceptance.

3 Method

3.1 Overview

According to these objectives, a method mix (see Fig. 2) is applied, considering data on different levels. In a first step, system logfiles are analyzed from six months in order to find out general information about the extent of use. In a second step, an online survey is conducted in order to reveal the different aspects of acceptance and some factors of the context of use. Finally, users of the interactive displays are observed and interviewed in the field in order to gather specific data about the context of use and the usability.

Fig. 2. Evaluation methods

3.2 Logfile Analysis

The logfile analysis includes data from eight interactive public displays from October 2016 to March 2017. The data of the first month after the introduction of the new technology at the station was neglected due to many aimless uses for exploration or for fun. Therefore, the data from October 2016 was excluded from the analysis and the evaluation is based on the datasets from November 2016 to March 2017. In addition, data sets of three to four days per device are missing for technical reasons. After this data cleansing a total of 252 948 user interactions were analyzed on 151 days.

3.3 Passenger Inquiry

Questionnaire. The passenger inquiry was conducted with a standardized online questionnaire. The questionnaire includes questions about the previous uses of the interactive public display, the acceptance, further opinions about the displays, and personal information. The acceptance was analyzed according to the dimensions for the acceptance of media technologies by Quiring [6]:

- Relative Advantage - the degree to which an innovation is considered better than its predecessor technology,
- Compatibility - the degree to which an innovation is considered consistent with existing experiences, values and needs,
- Conceivableness of Complexity - the degree of difficulty to understand and use the technology,
- Observability - the degree of noticeability of the benefits of the technology.

Participants. A total of 219 persons took part in the survey. 57 persons cancelled the survey after few questions. The data shows that the majority of these participants either have never visited the test station or have never used the interactive public display and

were therefore not interested in finishing the questionnaire. A total of 162 completed questionnaires remained for the analysis.

Due to the self-selection process of the participants through an online acquisition, the sample of the survey is not representative for all travelers. Especially, male travelers in the ages between 18 and 34 years are over-represented with a total share of 38% of the participants. In contrast, women and persons in the age over 65 years are underrepresented in the survey (see Table 1). This mismatch will be compensated in the final user field observation and interviews.

Table 1. Participants of the passenger inquiry (n = 162)

Gender	Percentage	Age	Percentage	Public transport usage [6]	Percentage
Male	70%	<18 years	9%	Power user	60%
Female	26%	18–34 years	49%	Commuter	8%
Not specified	4%	35–49 years	22%	Daily user	11%
		50–65 years	11%	Occasional user	17%
		>65 years	5%	Not specified	4%
		Not specified	4%		

46 participants did not receive further questions about the use of the interactive display, because they either haven't visited the test station before or haven't used the interactive public display at their visits of the paperless station.

3.4 User Field Observation and Interview

Observation. The observation of the users in the real context at the test station was conducted at three days. For this purpose, a weekday with average intensity of use (Thursday) and two days with above-average intensity of use were selected (Friday and Saturday) in several weeks in August 2017. The observations were conducted each day at different times of day. Overall, 55 use session of the interactive public displays could be observed. The aim was to cover the under-represented group of occasional passengers, female passengers and passengers, who are especially older than 65 years. The observation was documented in a semi-standardized observation protocol.

Post-observation-Interview. Due to the fact, that travelers often use the interactive public display shortly before or even while the expected train enters, only 25 persons could be interviewed directly after the observed use. 30 people entered a streetcar immediately after use or left the station on direct route. The interview covered questions about the actual information need, the context of the travel and the assessment of usability criteria.

Participants. Table 2 shows that the share of participants of the user observation are well suited to compensate for the under-representativeness of some groups in the user survey. The observation includes 30 observed female persons and 32 observed persons, who were older than 50 years, respectively 65 years. In addition, 75% of the users were

on their way for errands or leisure activities and covers mainly the group of daily and occasional users. In that way, the data of the observation and interview complements the data of the passenger inquiry.

Table 2. Participants of the user field observation ([1]n = 55; [2]n = 25)

Gender[1]	Percentage	Age[1]	Percentage	Public transport usage[2] [6]	Percentage
Male	40%	<18 years	4%	Power user	20%
Female	55%	18–34 years	24%	Commuter	5%
Group	5%	35–49 years	14%	Daily user	30%
		50–65 years	25%	Occasional user	45%
		>65 years	33%		

Half of the interviewees had never used the interactive public display before. The results of this group are therefore a good indicator of the intuitive usability of displays. One quarter of the interviewees have already used displays in a few cases (one up to five times). Another quarter of interviewees uses the displays regularly.

4 Results

4.1 Extend of Use

Dwell time. The dwell time of a user session was analyzed as the time from the first interaction (click) of the user up to the moment he or she leaves the interactive display. The time before the first click, while the user is standing in front of the display without interaction, was neglected because the first click is required in order to activate the display from the standby mode and the majority of users activates the display immediately. The median dwell time of all 57984 users session of the logfile analysis takes 18 s with 3 interaction clicks. The dwell time of the majority of users is even much shorter. Figure 3 shows, that 32.6% of the users remains less than 10 s at the interactive display. Most of them aim to check the planned departure time of the next streetcar and tap two times at the most.

The dwell times were computed in the following way:

$$t_{kn} - t_{k1} + 5\,s = \text{dwell time}$$

t_{kn} = time of the last click of a session
t_{k1} = time of the first click of a session
5 s = median time of all differences between two clicks as estimated dwell time after the last click.

This very efficient use might be supported by the developed 2-click-navigation and the station-based information concept, which should enable travelers to fulfill the basical information needs as fast as possible. The short dwell times of the users are very important for the success of the interactive public displays instead of paper-based information.

While static, large paper-based information is available for more than one user at the same time, the interactive public displays provides information for only one user at the same time. Therefore, some more frequented waiting points are equipped with two interactive public displays, in order to guarantee each traveler the possibility to get the required passenger information by the interactive displays.

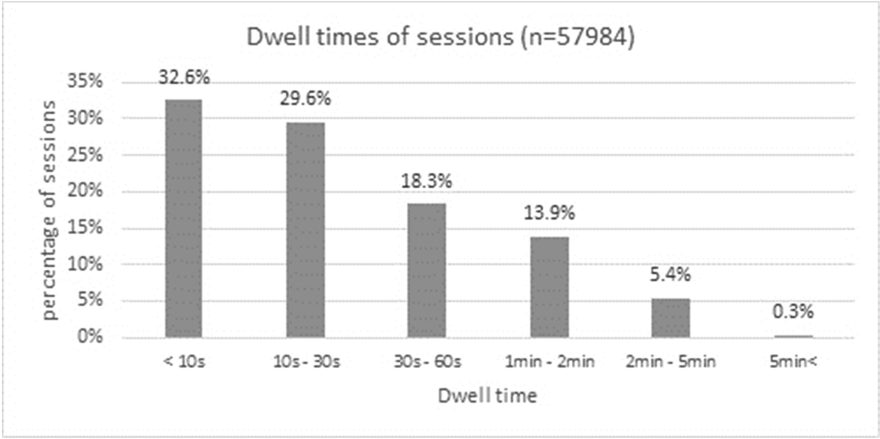

Fig. 3. Dwell times of use sessions

Clicks. The analysis of the overall amount of clicks of all interactive public displays shows, that displays in waiting areas are used more than three times more than displays in passage areas. Figure 4 displays the mean amount of overall clicks of the five interactive displays in waiting areas of streetcars and of the three interactive displays in passage areas at the entrance of the station.

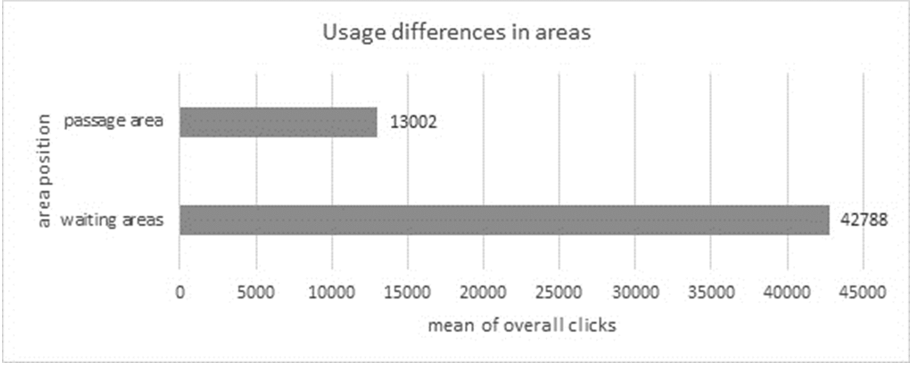

Fig. 4. Differences in the use between passage and waiting areas

The displays in the entrance area are especially important for tourists or occasional users, in order to orientate at the station and find the correct waiting point. In contrast,

the majority of the passengers, for instance commuters and further daily users, already knows their waiting point and can orientate at the station without further information.

4.2 Context of Use

Next to the context of the travel, the travelers' information needs as the basic motivation of use are most relevant for the content decisions. The results of the data from the inquiry and the post-observation-interview indicate a similar share of information needs, see Fig. 5. The predominant information need is the information about the next departure time of the required streetcar or bus. Although the real-time departures of the next arriving vehicles are displayed separately on dynamic displays, most users check the timetables for their travel plan. Therefore, the route of a line as well as information about disturbances are the next important information needs. All the other available information, for instance about tickets or station maps, are specialized information, which are required for several user group, for instance tourists or occasional users.

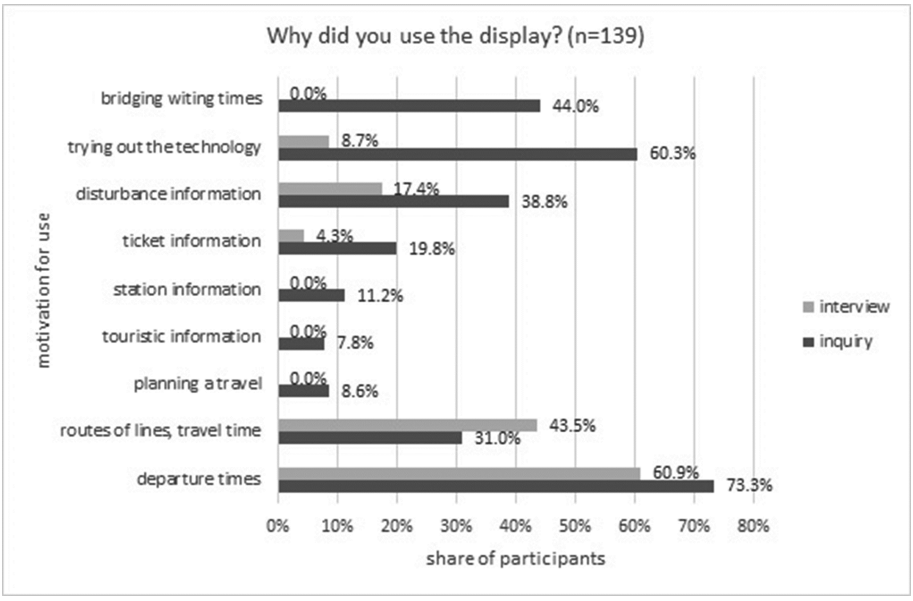

Fig. 5. Motivations for use of the interactive public display

4.3 Degree of Acceptance

The general acceptance of the new information technology at the station is evaluated on a 0 to 4 scale, which corresponds with a very low to a very high fulfillment of the dimensions of technology acceptance, as described in 3.3.

Corresponding to the good usability results of the interactive public display, the compatibility to users' expectations was assessed positively by more than three quarters

of the users. The highest rates for observability (see Fig. 6) can be explained by the receivable benefit of the increased up-to-dateness of information for passengers, which is perceived positively by 83% of the participants of the inquiry. Nevertheless, every third respondent would still prefer the paper-based information instead of interactive public displays, which causes the lowest assessments for the dimensions of the relative advantage.

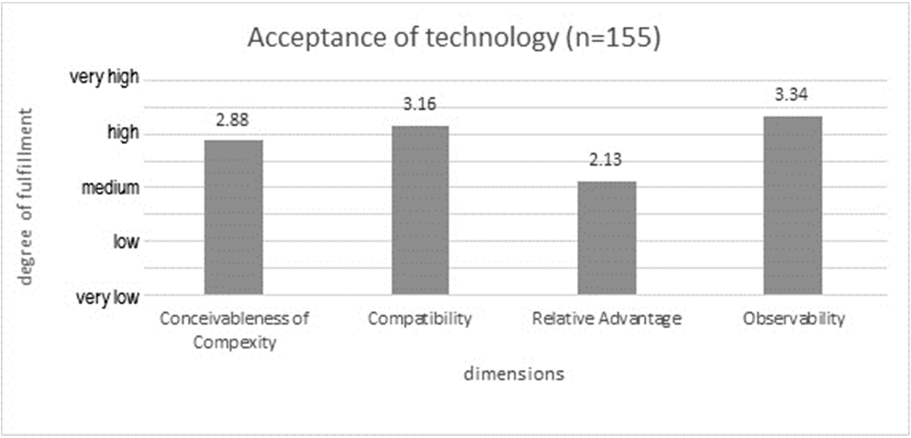

Fig. 6. Assessment of the acceptance of the interactive displays

The conceivableness of the complexity also offers chances for improvement. On the one hand, 69% of participants agree with the statement that the interactive public display facilitates the search of passenger information. On the other hand, 13% of the participants disagree with this statement and 18% are undecided. Thus, nearly every third participant assesses the interactive displays as not up to only partially controllable. This uncertainty should be reduced by certain action, presented in Sect. 5.

5 Recommendations

The results reveal the following general fields of action for interactive public displays:

- Communicate the benefits of the interactive public displays: Especially the user groups, which are more critical towards the interactive public displays, should be sensitized by focusing the communication on aspects that increase the value for the passengers. Especially, the aspects of information variety, actuality, and accessibility should be addressed in communication.
- Use interactivity to increase information quality: Some static content, such as a tariff zone plan, is not self-explanatory. Capacities in the utilization of public displays could be used for the communication of more detailed and assisting information. Further improvements of information quality could be achieved through detailed disturbance information or real-time information.

- Ensure short dwelling times: An intuitive navigation concept, which makes the main content available with two clicks at the maximum, guarantees a fast satisfaction of the travelers' information needs and the vacancy of the interactive public display for further travelers. A clear collective information concept, which focuses on the most important collective information needs, such as timetables, route of lines, travel times and disturbance information prevents long-term uses by single users delving into detailed individual information.
- Integrate the interactive public displays in the overall passenger information concept: Interactive public displays are a concept to replace static paper-based information by more dynamic information. The public displays are not suitable to completely replace individual and personal information via personal devices, such as smart phones. The public displays add the existing broad information service, including dynamic real-time-departure displays, passenger information applications for personal devices, service staff and so on.

6 Discussion

The selected method mix for the study design provides advantages and disadvantages. The major advantage is the positive cost-benefit ratio. The combination of the three methods logfile analysis, passenger questionnaire and field observation enables a fast overview of the key criteria extend and content of use as well as the acceptance. The study design is easy to repeat, in order to gather comparison data in other test stations or other cities, for other concepts of interactive public displays, and at a later point of time. These comparison of data is planned for subsequent studies and might reveal additional insights in effects of environmental factors on the use of the interactive public displays.

The disadvantage of the shown application of the methods is the varying representativity of the participants. Although the study covers data about all user groups and especially all representative courses of interactions with the interactive public display, it would be desirable to reach representative data according to the average of the population in each method. To reach this aim it is recommended to support the self-selective online questionnaire by a paper-based questionnaire and personal interviews, which are conducted based on defined selection criteria in the field. In addition, the presented three-day-observation should be extended to a seven-day-observation covering an artificial week over two or three months.

In summary, the study revealed very positive results regarding the degree of acceptance and matching the information needs of the travelers. Nevertheless, the field interviews and the acceptance data detected also some reluctance of the use of the interactive displays, especially of elder travelers and first-time users. Therefore, a regular sensitization for the benefits of paperless mobility information at stations and the continuous optimization of the information quality and usability is required.

References

1. Schade, W., Krail, M., Kühn, A.: New mobility concepts: myth or emerging reality? In: Transport Research Arena (TRA) 5th Conference: Transport Solutions from Research to Deployment, Paris (2014)
2. Hörold, S., Mayas, C., Krömker, H.: Interactive displays in public transport – challenges and expectations. Proced. Manuf. **3**, 2808–2815 (2015). https://doi.org/10.1016/j.promfg.2015.07.932
3. Pictures by ST-VITRINEN Trautmann GmbH & Co. KG
4. DIN EN ISO 9241-210:2010: Ergonomics of human-system interaction – part 210: human-centered design for interactive systems (2010)
5. VDV-Report 7036: User Interface Design für die elektronische Aushanginformation. VDV, Cologne (2014)
6. Quiring, O.: Methodische Aspekte der Akzeptanzforschung bei interaktiven Medientechnologien. Elektronische Publikationen der Universität München. Kommunikations- und Medienforschung. Münchener Beiträge zur Kommunikationswissen-schaft Nr. 6, Dezember (2006). https://epub.ub.uni-muenchen.de/1348/1/mbk_6.pdf. Accessed 19 Apr 2018