Airbot: Using a Work Flow Model for Proactive Assistance in Public Spaces

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Abstract
We investigate how a task-sensitive personal assistant on smartphones can support users in public space. Therefore, we designed, implemented, and evaluated AIRBOT, a mobile chatbot providing air travelers with proactive information during flight relevant tasks. We tested the application on passengers at a major airport ($N = 101$). The results of our evaluation study suggest, firstly, that AIRBOT's utility is acknowledged by its users and, secondly, that its use affects the perception of passengers' airport service experience, both positively and negatively.

Author Keywords
assistance system, cooperative problem solving, human-computer interaction, mobile information needs

ACM Classification Keywords
H.5.2 [USER INTERFACES]; C.5.3 [COMPUTER SYSTEM IMPLEMENTATION]: Portable devices

Background information
There is general agreement that context is of major importance in all information behavior activities (see e.g. [**?**, **?**]). The variety of contextual factors on which the information needs of users depend is large (see [**?**] for an overview of different notions and parts of context). *Situation* is one of these influencing factors – in particular if the situation is not

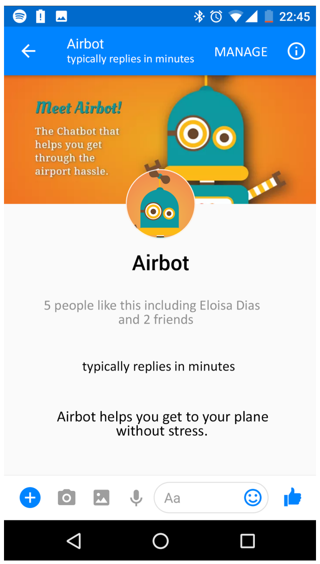

Figure 1: The AIRBOT's main screen.

well-known to users and, at the same time, requires users to adhere to a particular order of sequence of steps within this process. Information needs arising in these situations may result in the discomfort of users. A mobile, proactive information system, which is based on the process model of the particular task, may comfort users by fulfilling their information needs throughout this process. In this poster, we use passenger services at an airport as an example to investigate this problem.

The reasons to choose this scenario were threefold: First, a passenger survey conducted world wide by IATA in 2016 reveals the need for personal information systems at airports [**?**]. Second, recent work suggests that specific user groups may not benefit from signage in public spaces, e.g. small people in crowded or information-overloaded settings like airports (see e.g. [**?**, **?**, **?**]). Thirdly, aircraft ground handling is a good example for a situation a larger number of people is not subjected to on a very regular basis. It is, yet, complex enough to pose several information needs – which is evident, for example, by the large number of information kiosks and terminals that can be found in airport buildings.

Research Questions

Based on this scenario we were interested in two research questions:

- Is a proactive and task-based assistant acknowledged by passengers?
- Does assistance provided by a mobile information system have an effect on satisfaction with passenger services during aircraft ground handling?

We hypothesized that a proactive and task-based mobile assistant is able to induce differences between groups with respect to the satisfaction regarding passenger services (SPAS). Exceptional day-related factors (DSIT) (e.g. time pressure), familiarity with the passenger services at the airport (FPAS) and the the satisfaction with orientation opportunities in a literal and metaphorical sense (SORI) are expected to have a positive relationship with the overall satisfaction (e.g. frequent flyers may have a better understanding of the workflow). Moreover, the day-related factors and the familiarity both have an impact on a passenger's orientation in a literal and metaphorical sense (e.g. frequent flyers know the locations they have to visit during passenger services better).

We followed a three step approach to gain insights into these questions:

Understand the way travelers solve their needs today Semi-structured interviews with airport information agents were conducted to understand the "airport workflow" and the information needs arising therein.

Build a prototype application suitable to fit information needs Due to the widespread use of Facebook's Messenger platform, we decided to base our prototype system called AIRBOT on it (see Fig. **??**). This will enhance the ecological validity of the experimental results, as leveraging Messenger is expected to increase the likeliness of use real-world scenarios.

Assess whether the system fulfills its goal We conducted an in-situ survey-based user study at a major European airport to assess the usefulness of our approach.

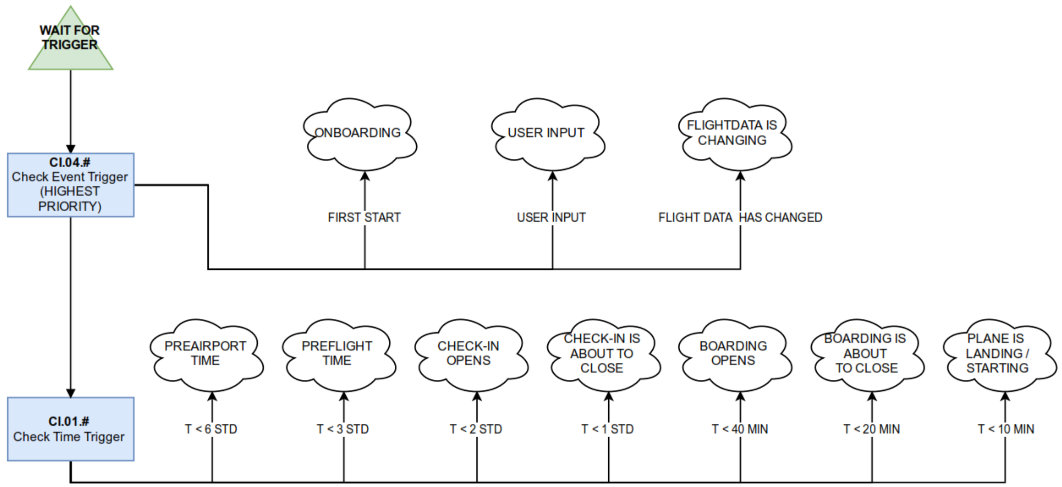

Figure 2: The protoype's Workflow model for passengers from the point in time they arrive at the airport until boarding.

Groundwork

Interview Results
A systematic review of eight interviews with information kiosk staff members at the airport revealed, among others, two important information needs:

Wayfinding Questions most often deal with virtually all locations passengers need to visit, i.e. check-in counters, gates, restrooms, security checks, but may also refer to hotels in the nearby city center.

Procedure The most frequent category of questions is concerned with aspects prior to boarding. Misunderstandings are frequent in these conversation due to the assumptions passengers have (e.g. passengers tend to ignore the fact that different carriers share flight numbers, resulting in being misled by information personnel).

The interviews were, moreover, used to create a workflow model (see Fig. **??**), encompassing the prototype steps and points in-time resulting in a successful boarding.

Prototype Application
Based on these insights we implemented a mobile assistant for airport passengers called AIRBOT. The assistant relies on the aforementioned model, implemented as a finite state machine to track a passenger's activities and the state of the task to be completed (see Fig. **??**). The state is advanced not only by observing a passenger to perform an activity, but also by checking timeouts for activities that are indispensable for finishing the task (see again Fig. **??**). AIRBOT is connected to the airport's real time information and flight management system and therefore able to process live flight data. On this basis, AIRBOT can proactively send reminders and notifications to passengers (see Fig. **??** for exemplary conversations AIRBOT is able to initiate).

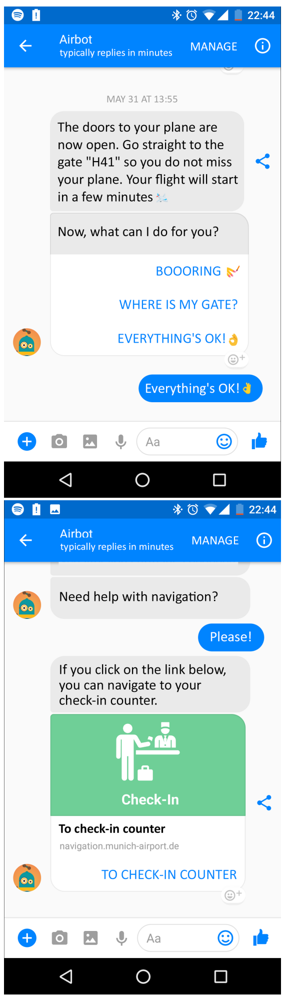

Figure 4: The screenshots of AIRBOT above visualize generic conversations AIRBOT is able to make.

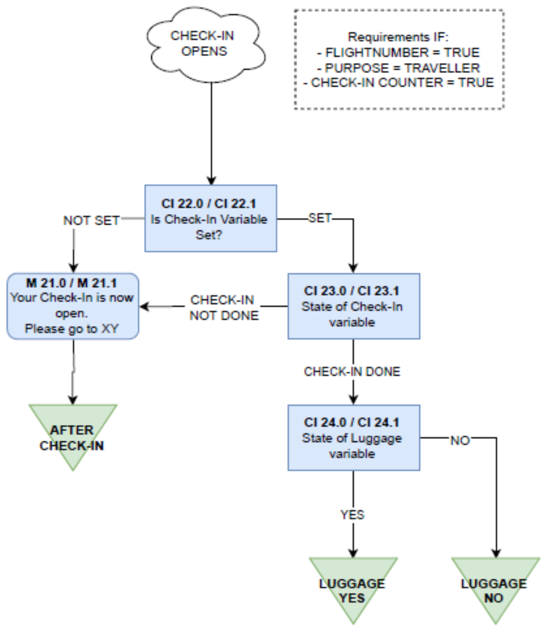

Figure 3: The dialog rules once the check-in has opened.

Equipped with the described functionality, AIRBOT assists passengers by providing task relevant information at the right time. Passengers are no longer required to know the correct workflow and the different locations where they have to perform specific workflow activities (e.g. check-in, passport control, or boarding).

Method

Survey

The survey to evaluate the personal assistant was designed to be applicable to both the treatment group participants (AIRBOT users) as well as to the control group participants (non-AIRBOT users) and had two parts. The first part was presented to all users. It comprised questions (see Table **??**) suitable to measure the four latent variables either directly (FPAS and SPAS) or using several items (SORI and DSIT). Whereas control group passengers only had to answer questions concerning these four factors, AIRBOT users were asked to answer additional questions in the second part. These questions assessed the users' experience with AIRBOT. All questions but `o_ari` were measured on a 5-point Likert-like scale. The comprehensibility of wording of questions was cross-validated by two think-aloud protocols (see [**?**, p. 63]), the second of which took place at the airport itself.

Procedure

Treatment group participants were acquired in the public areas of the airport. They were required to have an active Facebook account and to have the Facebook Messenger App installed on their own mobile phone, which they were asked to use in the experiment. The experimenter explained the kind of assistance AIRBOT was able to give and asked the participants to remember to answer the final survey right before take-off or just after landing at their destination. In contrast to the treatment group, the control group participants were acquired at their gate. They were asked to answer the survey using a tablet device provided by the experimenter. None of the participants was compensated for taking part in the study.

Participants

$N = 101$ passengers participated, all of whom were recruited on site at Munich Airport, Germany, between May 24th, 2017 and May 28th, 2017. Treatment ($N = 51$) and control group ($N = 50$) were equally sized. A Log-Likelihood test revealed that the groups did not differ in terms of frequency of visits to the airport ($G = 4.52$,

LV	Description	MV	Phrasing
Satisfaction Pass. Services [SPAS]	The degree of perceived satisfaction a passenger has with respect to all passenger services during aircraft ground handling.	s_pas	To what extent did you get along with passenger services?
Familiarity Pass. Services [FPAS]	The degree as to which a person is familiar with the process of passenger services during aircraft ground handling.	f_pas	To what extent are you familiar with passenger services?
Current Situation [DSIT]	The degree as to which passengers feel comfortable with walking distance, waiting time and time pressure.	d_wti	My idle time during passenger services was too long.
		d_tip	To what extent did you feel pressed for time during passenger services?
		d_dis	The distance I had to travel during passenger services was too long.
Satisfaction Orientation Opportunities [SORI]	The degree as to which passengers feel oriented in literal as well as a figurative sense, i.e. they know "what they need to do next" etc.	o_ari	How many times did you have to ask for directions and/or information during passenger services?
		o_sig	To what extent were signs giving directions or identifying locations helpful?
		o_iwa	To what extent were you satisfied with those information systems located in the waiting area?
		o_ori	To what extent was it easy for you to orient yourself at the airport?

Table 1: A description of latent (LV) and measured (MV) variables used in this study. Please note: All questions were translated from German to English.

$df = 3, p = 0.21$) nor with respect to the reasons for their travels ($G = 3.026$, $df = 2, p = 0.22$). Regarding age (see table **??**), however, treatment and control group differ significantly in terms of counts ($G = 10.768$, $df = 2$, $p = 0.005$***) with a slightly increased number of younger people in the treatment group. Although rendered significant, the age distribution is likely to increase ecological validity of the results, as the general user group of Facebook is known to be young [**?**].

	$a < 30$	$30 \leq a < 40$	$a > 39$
T	33	15	3
C	24	11	15

Table 2: The counts of age groups for participants in the treatment and control group.

Results

How do AIRBOT *users assess the proactive assistant?*
The majority of users (see Fig. **??**) found the AIRBOT experience to be fun and helpful and is willing to use the chatbot system again. Users acknowledged the kind of information as adequate and number of messages AIRBOT provides as reasonable. They also liked the tone of voice these are written in and a majority of users indicated that they are willing to reuse AIRBOT.

Differences between groups
Further data analysis comprised several steps. We estimated the relationships between the latent variables using PLS Path Modeling (see e.g. [**?**]), thereby checking the validity of the ad-hoc survey. In contrast to several disjunct regression analyses PLS Path Modeling has the unique ca-

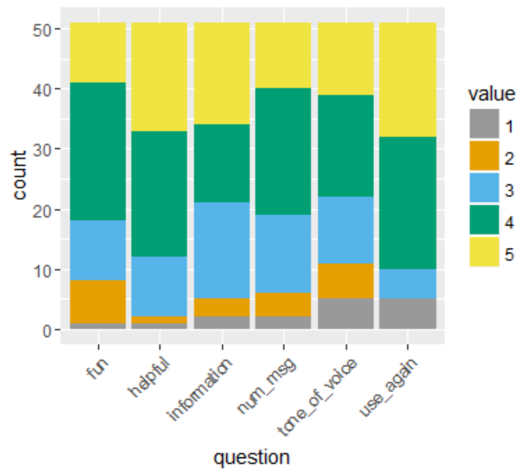

Figure 5: Ratings of questions regarding the user friendliness of AIRBOT with 1 meaning the lowest level of agreement and 5 the highest

pability to take all dependencies between the four involved latent variables into account. The figures obtained indicated a proper model fit. As a consequence, we use the obtained latent variable scores for all subsequent analyses.

Second, we measured AIRBOT's potential influence on the the latent variables by means of logistic regression: The results (see Table **??**) indicated that using AIRBOT in particular influenced how passengers perceive day-related situational factors and to what degree they were satisfied with the orientation opportunities provided by the airport.

These results were, finally, further investigated using pairwise Mann-Whitney-U-Tests due to non-normality of the data ($|excess| < 4$ and $|skewness| \approx 0$). For all tests a significance level of $\alpha = .05$ was used, which was corrected according to Bonferroni. We found a highly significant difference in the ratings regarding DSIT for AIRBOT users and non-AIRBOT users ($\tilde{x}_{bot} = 2.43$, $\tilde{x}_{control} = 4.43$, $Z = -7.38$, $p < 7.8e^{-14}$, $r = .74$) with 5 meaning the highest level of agreement or extent and 1 meaning the lowest. This result suggests that using AIRBOT has an impact on perceived waiting time, walking distance and time pressure: When passengers use AIRBOT, they feel less time pressure and experience waiting times and walking distances as shorter than non-AIRBOT users. Moreover, we found a significant difference regarding the satisfaction with orientation opportunities provided at the airport for AIRBOT users and non-AIRBOT users ($\tilde{x}_{bot} = 4.0$, $\tilde{x}_{control} = 4.25$, $Z = -3.38$, $p < .01$, $r = .34$) with 5 indicating the highest level of extent and 1 the lowest: Passengers using AIRBOT are less satisfied with signage and other orientation opportunities (including their feeling of "knowing their current position in the process") provided by the airport.

	Df	Dev. Resid.	Df	Resid. Dev.	p-value
NULL			100	140.006	
SPAS	1	1.794	99	138.212	.181
SORI	1	11.549	98	126.663	.0007***
DSIT	1	67.835	97	58.828	$< 2.2 * 10^{-16}$***
FPAS	1	0.454	96	58.374	.500

Table 3: The difference between the null deviance and the residual deviances for the predictors. Significance values are based on χ^2-tests. Figures provide evidence that SORI and DSIT are important factors.

Discussion

We found, first, that participants were particularly satisfied with the utility of AIRBOT's personalized assistance. More specifically, we found empirical evidence that personalized information companions like AIRBOT lead to enhanced user experience of passenger ground handling: AIRBOT users had a feeling of decreased walking distances, less waiting times and less time pressure during passenger services. These findings are in line with both work stressing the benefit of personalized information content in general [**?**] and findings underlining the need for personalized information at airports [**?**]. Our results suggest, furthermore, that personalized information systems can have a negative effect on the way non-personalized information is perceived. AIRBOT users were less satisfied with non-personalized orientation information offered by the airport. These results relate to general work that indicates that smartphone usage has an effect on the way users walk and where they look at [**?**] and has an effect on the user's awareness of surroundings [**?**].

Future Work

We plan to expand our insights in using a mobile information companion like AIRBOT in public space by providing additional data. In particular, we will update AIRBOT and implement additional functionalities to recommend activities to spend time at the airport and to (at least) partially process natural language user input. In a new field study we will analyze passenger information behavior using AIRBOT more extensively by collecting qualitative data to further understand the reasons for the dissatisfaction with non-personalized information.

From our point of view, these results offer the opportunity to stimulate discussions about other settings that could benefit from such proactive assistance systems. In particular we are interested in the opportunities but also challenges the approach will have to cope with as it is applied to new settings such as public transport or grocery shopping in supermarkets.

Conclusion

Proactive and task-based mobile apps can be used to enhance users' experience in public spaces. Given our system design, we conclude that in the first place it is not the variety of features or informations an app may provide that makes acting in public spaces easier for users, but the fact that the app can assist users in handling tasks at the right point in time or within the required time frame. System design benefits highly, if it is based on the the steps we took: before implementation even starts the workflow of tasks framing the scenario of assistance for users must be analyzed in depth from a user-centered perspective, e.g. by conducting (semi-structured) interviews or by collecting naturalistic (log) data. In a second step, the functionality can be specified in a way that integrates the app smoothly into the user's workflow. Designed in this way, proactive and personalized mobile chatbots can be used to enhance users' experience in public spaces – particularly, as this poster showed, the way air travelers perceive waiting time, covered walking distances and time pressure during aircraft ground handling.

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