Social Robots: Development and Evaluation of a Human-Centered Application Scenario

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Abstract. This study aimed to develop and evaluate an application scenario for the use of a social robot, following a human-centered design approach. The social robot, which assisted the reception desk staff of a hotel by answering simple, repetitive and time-consuming questions (e.g. parking information, directions), was perceived predominantly positive by employees and guests of the hotel. However, the results suggested that to effectively reduce the employees' workload and to provide a reliable source of information for the guest, the robot had to work on a high level of autonomy and technological stability. Additionally, the use of a social robot may estrange guests and employees alike, as they prefer human interaction or are fearful of job loss, respectively. An early inclusion of the employees in the design process has shown to reduce fears and increase acceptance towards the social robot and its integration into the workforce.

Keywords: Human-centered design · Social robot · NAO · Hotel · Human-robot interaction

1 Introduction

Social robots are being introduced in various fields such as healthcare, education and public spaces as artificial companions and helpers [1]. Social robots can express and perceive emotions and conduct sophisticated dialogues with human interaction partners [2]. While research interest has increased in recent years [3] and several studies investigated the use of social robots in hotels [4–6], the focus has been limited mainly to technical aspects. Further studies in the real-world context of hotels are widely seen as a prerequisite in order to gain in-depth knowledge about the productive use of a robot in a hotel [4]. Various works show that a user-centered design of human-robotics interaction covering user needs in the service area remain a challenge [5–8]. This refers to the development of suitable application contexts and use cases, and to the technical restrictions that render applications difficult to implement beyond entertainment functionalities [7, 8]. In a case study in Switzerland, several social robot deployments

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were investigated; the study showed that the robots are valuable in attracting attention, but do not generate any meaningful benefit or reduce the effort for the staff in terms of support [7]. Another example of limited deployment is the Henn na robot hotel in Japan, which gained a lot of media attention after it recently had to cut more than half of their robot workforce and replace them by returning to traditional human-provided services [9]. The robots in the Henn na hotel could neither reduce the workload for their human counterparts nor reduce costs. Another recent study with 393 respondents in five different hotels warned of possible resistance by employees when introducing a robot into the workforce [10].

On this basis, a case study was conducted in a Swiss hotel which aimed to answer three research questions applying a human-centered design (HCD) [11] approach:

- Which area of the hotel offers a high potential for the use of a social robot?
- Which application scenario with a social robot offers an added value for employees and guests in the hotel?
- Can early involvement of staff in the human-centered design process reduce concerns about social robots from an employee perspective?

2 Methodology

2.1 Context of Use Analysis

In the initial context of use analysis five semi-structured interviews [12] were conducted with management and entry-level employees. The focus was laid on identifying use cases of social robot employment, and chances and risks regarding the use in the hotel. The employees were asked about their attitude towards robots and their willingness to work with a robot. In the interviews the reception was identified as a suitable location for the application of a social robot. Subsequently, four observations [12] were carried out by using a standardized observation sheet. Particular attention was paid to employee work processes, which could potentially be standardized and carried out by a social robot to support the staff.

2.2 Specification of User Requirements and Development of Application Scenario

With the help of the data obtained in the context of use analysis, nine user requirements were specified bottom-up. An application scenario was developed, in which a social robot would support the employees by answering simple and repetitive questions (e.g. directions, parking information) asked by guests of the hotel. In addition, the robot would be able to perform a number of entertainment tasks (e.g. telling jokes). The programming of the robot NAO (version 6) by SoftBank Robotics was a continuous process that took place iteratively over several phases of the human-centered design process. Speech, movement, gestures and visual expressions were developed with the software Choreographe provided by SoftBank Robotics.

2.3 Evaluation of Application Scenario

The developed application scenario and the programmed robot were first evaluated with employees (n = 6) in a workshop, where they had the opportunity to be acquainted with the robot and the scenario, and give feedback. Second, the application scenario was evaluated along six days in the hotel under natural conditions. In order to facilitate the interaction a poster with guiding questions was placed behind the robot. The robot was positioned next to the reception approximately at guest eye level. Throughout the evaluation, two members of the study team were present to help with technical problems and answer staff or guest questions. The guests interacting with the robot were observed and subsequently interviewed [12]. The observation was carried out with a standardized observation sheet and focused on the interaction quality. In the interview, the guests were asked how they experienced the interaction. Additionally, two self-designed questionnaire items on the usage potential of the robot were asked.

During the evaluation, a semi-standardized interview [12] was conducted with the reception employees in a weekly interval. The receptionists were asked about how they perceived the guests' interactions and how they felt about having the robot as a team member.

2.4 Process Evaluation with Employees

In a final process evaluation, a group interview [12] was conducted with three employees of the reception, in which fears and expectations raised at the beginning of the study and possible changes were addressed. Furthermore, the use of a social robot in the hotel context and the employees' involvement in the entire HCD process was reflected. Finally, the receptionists were asked about the robots usage potential at the reception.

3 Results

The context of use analysis showed that the reception is particularly suitable for the use of a social robot in a hotel. The robot can relieve the reception staff by answering repetitive, simple yet time-consuming questions. The reception is also ideal to leave a lasting impression on the guests through the presence of a robot, the application of which is still novel in the hotel industry. The use of a social robot was not only seen as a potential relief for the employees and a possible added economic value, but also as a possibility to entertain and delight the guests. Other areas of the hotel (e.g. restaurant, room cleaning) were excluded from the study because of technical limitations of the robot or lack of interaction possibilities. The interviewees saw risks and uncertainty of jeopardizing the existing highly positive guest-reception relationship, which could lead to guest abandonment; such a relationship should be preserved when introducing the robot. Furthermore, no additional work should be generated for the employees and the data privacy may not be compromised at any time. The most prominent fear in management interviews was the employees' acceptance of the robot. The reception staff emphasized that they see little added value in the use of a social robot and that the risks

listed above outweigh the potential added value. Fear of job loss was also mentioned in isolated cases.

In the development of the resulting application scenario, the emphasis was placed on ensuring that the natural course of interaction between guests and employees remained intact. The employees therefore should direct the guests to the robot if it can answer the questions. An overview about the setting can be seen in Fig. 1.

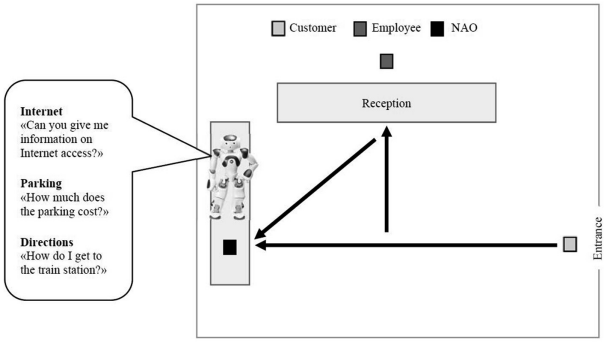

Fig. 1. Layout of reception area with positions of involved actors and guest paths.

In the evaluation of the application scenario and the robot, the employees responded positively. The reluctance and the skepticism towards the use of the robot could be visibly reduced by role-playing and interacting with the robot without restrictions.

During the evaluation of the application scenario in the hotel, a total of 37 people who interacted with the robot were interviewed. These interviews were conducted with 20 men (54%) and 17 women (46%). Of the sample, 27 persons (73%) were on their own and 10 (27%) in a group of two or more. When asked whether they would use the robot again in its current state, seven people (19%) responded "No", six (16%) "More likely No", 10 (27%) "More likely Yes", and 14 (38%) "Yes". When asked if they would use a future improved version of the robot, five people (13%) responded "No," with several people saying that they generally prefer contact with people. One (3%) responded "More likely No," one (3%) "Maybe," seven (19%) "More likely Yes," and 23 (38%) "Yes".

The guests felt predominantly positive about the interaction, with occasional negative statements such as "I'm just talking to a robot to see how ridiculous and stupid this is". When asked what they wished for future interactions, aspects of further conversational flexibility, autonomy, and functionality were most frequently mentioned (24 mentions). For example, the guests desired more leeway in the questions that the robot could be asked, as well as the answers it could give. Furthermore, according to various guest statements, the robot should be able to take on more tasks, in both the reception and other areas of the hotel, however specific activities were rarely

mentioned. Almost the same number of requests for improvement were made about the individual language (14 mentions) and speech recognition (13 mentions). According to many guests, it would be advantageous if the robot could speak more languages than just German, the language used in this study. The guests also demanded more proactivity by the robot (6 mentions) when approaching it (e.g. the robot recognizing the guest and greeting the person by name).

From the weekly interviews and the group interview with the reception staff, it can be concluded that the majority of them observed enjoyment and satisfaction among the guests when interacting with the robot. The question of whether the receptionists could imagine the robot as a member of the team at this time did not lead to a conclusive result. On the one hand, the robot was attributed to a certain entertainment value for the receptionists themselves as well as the guests. On the other hand, they only saw limited added value in the answering of routine questions, since difficulties in speech recognition and thus interaction difficulties arose multiple times. Regarding their attitude towards the robot, the reception staff noted that their initially prevailing fears were gradually diminished by active participation in the process and finally completely dissolved. In the beginning, the receptionists were overwhelmed by the idea of a robot in their workplace. This, however, changed when they got to know it during the scenario evaluation. Especially the robots' appearance, which was positively perceived as cute or adorable, was mentioned in this context. In conclusion, all receptionists were of the opinion that they would accept the robot as a team member despite its technical deficiencies, which they regretted, because it did not offer them enough added value in their daily business on top of the other.

4 Discussion and Conclusion

As mentioned in the introduction, previous studies have shown that a challenge is to find an economic benefit of social service robots in a hotel that goes beyond the pure entertainment factor [4]. In this study, the reception area proved to be a suitable area for future use of social robots in hotel operations, since repetitive work processes could be taken over by social robots. This would free employees from monotonous tasks and save time for guests if long waiting times occur at the reception [13]. While employees and guests acknowledged the positive potential of the social robot in this study, it could not be proven that economically relevant effects such as shortened waiting times actually occurred by letting the robot answer recurring guest questions.

Apart from the potential economic benefit, this study also showed by interviewing both employees and guests that the entertainment factor can be a significant reason for the introduction of a robot in the reception area, because compared to other information providers its attractive nature enables a positive interaction [13]. The entertainment factor for guests and employees may also have been so prominent because the robot stood in an exposed position near the reception desk. This was the first point of contact, thereby leaving a lasting impression, which is decisive for a positive customer experience [14]. However, in order to be able to exploit the aforementioned usage potential, the technical restrictions have to be solved.

Robots can nevertheless make us feel uncomfortable, especially if a robot is introduced without involving the human factor [8, 9]. The use of social robots can alienate guests and employees alike, as they prefer human interaction and are afraid of losing their jobs. The results have shown that the early involvement of employees in the design process leads to a reduction of fears and increases acceptance of the social robot and its use. This was achieved by applying the HCD approach. The continuous involvement of the employees led to a more realistic classification of the robot and its capabilities. A further factor for the increased acceptance is the robot's appearance, especially its face, which was assessed positively as cute or sweet. The positive evaluation of the robot as cute is related to theories that say that humans tend to recognize human traits in robots [15]. Whether the appearance of a robot and its way of interacting has an influence on the acceptance by employees must be investigated in more detail in further studies.

This case study shows the value of applying human-centered design in the field of social robots and that the hotel's employees constitute the necessary link between guests and the robot for its successful application in working environments. Only by empowering the employees in the process of the robot's implementation in the hotel can their fears concerning job security be reduced, which, eventually, increases their willingness to support the guest-robot interaction in the hotel, in spite of its technical restrictions. Finally, the acceptance of a robot by employees and guests can be a prerequisite for a successful human-robot interaction that can compensate for its current technical limitations.

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