Proof-of-concept studies with humanoid robots for smart building services

Nasim Beheshtian
Tampere University
(email: nasim.beheshtian@tuni.fi)
Kalle Kähkönen
Tampere University
(email: kalle.e.kahkonen@tuni.fi)
Kirsikka Kaipainen
Tampere University
(email: kirsikka.kaipainen@tuni.fi)
Aino Ahtinen
Tampere University
(email: aino.ahtinen@tuni.fi)

Abstract

Humanoid robots are gaining growing interest and their technologies are developing all the time and reaching next levels of performance. Presently there are already some commercial solutions available that can be used as platforms for proof of concept studied for understanding further the actual possibilities and limits of those solutions. The research behind this paper is focusing on this kind of trials and testing where potential solutions for new kind of building facility services are first portrayed, and, after that the humanoid robot solution is programmed and tested in live environment. Examples of possible such applications are welcome center receptionist, guide for finding people and places, instructor for using special devices and entertainer. This paper provides a synthesis of results of two studies where humanoid robot Pepper was programmed and tested for enhancing social experience of visitors in built properties. The gained research results provide basis for understanding the human - social robot interaction regarding smart building services. The results are used for designing the next stage experiments with humanoid robots for building facility services.

Keywords: social robots, smart building services, user studies, user experience, visitor experience

1. Introduction

In customer service context, customers' experience of social presence and interaction is an important factor determining their satisfaction with the service (van Doorn et al., 2017). Social robots have potential to complement existing service channels, as they are designed to communicate and interact with people by following the social norms associated with the specific role that they have been given (Bartneck & Forlizzi, 2004). In the design of social robots, interaction modalities such as speech, gaze,

gestures and posture can be utilized to mediate a socially interactive experience (Fong, Nourbakhsh and Dautenhahn, 2003). The research reported in this paper addresses novel robotized services that can be positioned within the context of smart buildings. According to a well-established definition, the services of smart buildings include functions that are able to recognise and react to users' and occupants' needs in terms of comfort, health, indoor air quality, safety as well as operational requirements (BPIE, 2017). New digital technologies can be sources for unforeseen concepts and applications for such services (Crooks et al, 2017). Digital technologies, such as sensors, AI and robotics may enable more personalized experience of smart buildings for the users of the buildings. Norberg-Schulz (1980) state that *the character of a space* is an essential part of how people experience the place. Even spaces similar to each other can differ a lot based on the elements (e.g. light, materials, form and structure) that define the spaces. Thus, usage of different elements affects the experience of the space. Concerning the experiences evoked by smart buildings via the use of social robotics we could talk about design of *ambiences.* Ahtinen et al. (2015) define the ambience as follows: *"a multisensory atmosphere and character of space, which is created by the means of ambient technologies, real world objects and spatial design to evoke particular user experiences".*

This paper investigates the possibilities of social robots to enhance the user experience in smart buildings. Social robots have possibilities to enrich visitor's experience of space to become e.g. more personal, more social, or more relaxing. We report *the findings of two studies with a humanoid robot Pepper*: the first study was conducted at university lobby area and the second study at a seminar event. The studies suggest potential experiences that robotic services can mediate for visitors and customers. We also discuss *the possibilities of social robots to enable specific ambiences on smart buildings*.

2. Related Work

2.1 Social robots and their applications

Development of social robots has entered a new era where the aim is for people to interact with robots in their daily environments (Shiomi et al., 2006). Social robots are now being used in many industries such as education, retail, and healthcare with various customer service roles simply because they can perform easy and repetitive tasks in a satisfactory manner (Pieterson et al., 2017). In public places where a robot is working in a customer service role, robots which possess a display screen have been suggested to have an advantage because they allow multi-modal interaction (Mubin et al., 2018).

Research shows that social robots are capable of evoking various human experiences. A study conducted in Finland explored experiences evoked by a social robot in a customer service point of a medium-sized city (Kaipainen, Ahtinen and Hiltunen, 2018). They used Pepper, a social humanoid robot developed by Softbank Robotics, for guidance and edutainment at the service point for two days. Pepper was designed to guide customers in finding the right service inside the service point, and to inform them about interesting places in the city through a quiz application. The identified experiences were connected to basic human needs of competence, relatedness, stimulation, security and autonomy. Doing a quiz with the robot was able to evoke *competence*-related experiences, such as accomplishment and challenge, and also *relatedness* experiences, such as *fellowship* and *collaboration*. Moreover, the robot was sometimes able to facilitate connection among unfamiliar people, leading

them to socialize and have friendly encounters. The novelty of meeting a humanoid robot and interacting with it had a *stimulating* effect on many, manifesting in experiences of *delight*, *curiosity* and *wonder*, and for some people interaction created a warm emotional response, addressing the *relatedness* need. Majority of experiences were positive, but on rare occasions, negative *security* related experiences were evident through fear and distrust towards the robot's sudden movements and eye gaze which felt unnatural for some people.

Another example of a social robot is SPENCER, a customer service robot which guides transfer passengers at an international airport (Joosse and Evers, 2017). The study evaluated passengers' experiences related to guidance by the robot. Passengers could interact with the robot through instructions on the touchscreen and the boarding card reader, used their boarding card to introduce themselves and followed the robot to reach their gate. Overall, the participants were *excited* and *satisfied* about robot guidance, and *pleased* to see the airport investing in a new form of interactive technology. Additionally, it was discovered that in designing robot platforms for customer service, it is important to consider the speed of the robot's movement and navigation in crowded places. In general, SPENCER was useful for people who were new to the airport and did not know their way around.

Social robots are even used in the context of events nowadays. One example is REEM, a humanoid robot developed by Pal Robotics (Marchionni et al, 2013). REEM is used at events and conferences as a receptionist and entertainer to greet the attendees by providing information and to give presentations and speeches in many languages. REEM has the ability to talk to people in their own language, make jokes, compliment them, and help them to find a place. Moreover, it can shake hands and detect a person's face, and also track and recognize it later. REEM can navigate through a place autonomously, avoid obstacles and find the shortest path possible for people. According to the study, the experience of *curiosity* was evoked in passerby people, and they approached REEM to become more familiar with it.

Social robots can evoke positive experiences for both customers and retailers at the same time. In a shopping mall study with Pepper, researchers stated that the personnel, and customers reported positive experiences (Niemelä, Heikkilä and Lammi, 2017). The novelty factor of Pepper attracted many people to visit the shopping mall, and this generated more sales for the retailers. This result is similar to results of the study by Kaipainen, Ahtinen and Hiltunen (2018) where they mentioned social robots are capable of creating the *curiosity* and *discovery* experiences (finding a new or unknown thing) in humans because of the novelty element that attracts the attention of people to approach the robot. In the study by Niemelä, Heikkilä and Lammi (2017), Pepper was also capable of creating *pleasant*, *fun*, and *joyful* (*humor*) experiences for customers. The robot's capability to give friendly service and guidance in a crowded shopping environment created a *relaxed* experience for the retailers.

2.2 Chance of social robots for the smart built environment

Automated or semi-automated living environments can be understood as new design concepts for smart buildings and their services. That includes also designing the use of social robots. Compared with centralized smart building services the social robots represent different avenue for the development. Social robots can be understood as distributed autonomous solutions that are a new kind of cross-disciplinary design challenge. This is addressed in the following text paragraphs.

Guidelines for designing social robots in public and personal settings have been suggested in prior research. Luria et al. (2016) identified five design goals that should be considered when involving

humanoid robots at smart environments such as smart homes. First, they suggest that robots should be *engaging* and promote the user's sense of *connection with the environment*, e.g. by tangible user interfaces. The second goal is *unobtrusive*, i.e. minimizing the disruptions to users' other activities as much as possible. Third, when robots are designed to create an interface to smart environments, they should be *device-like*, so that the robot would be seen as more than a social agent. Fourth, the robots should be *respectful* in their interactions, and sensitive to social situations. Finally, the authors state that robots need to be *reassuring*, reliable, and trustworthy for people to be able to connect with them. In the context of using social robots in public places, Mubin et al. (2018) mention that it is necessary to follow certain guidelines. Since people might be hesitant towards social robots in public environments, robots should have a *proactive approach* and *initiate the interaction* with even a short greeting such as "hello". Moreover, in public places people tend to move a lot, and thus a robot needs to be able to *sense the location of a human* it aims to initiate a conversation with. A robot also needs to differentiate the person with whom it is going to engage in conversation and direct its face towards them.

It is important for robots to *act socially* to effectively provide information (Fong, Nourbakhsh and Dautenhahn, 2003). The social behavior of robots play major roles in socially interactive robots in different roles. Depending on the robots' purpose, it is important to develop robots which can *improve their social skills*, *bond with people*, and be capable of showing *empathy* and *understanding* towards people. According to Fong, Nourbakhsh and Dautenhahn (2003), for robots to be accepted as natural interaction partners, they need to have more refined social skills, for instance an ability to recognize the social context. Moreover, social robots need to support a wide range of users with various genders, cultures, social backgrounds, ages, etc. The duration of interaction should be extended in order to form a meaningful impact on humans. Currently, humans and robots engage in short interactions, and the robot treats everyone the same, however in order for robots to become part of our lives it is important to develop robots which are able to treat people as distinct individuals (Dautenhahn, 1998).

3. Methodology

The research was conducted through two user studies, one in the context of *university lobby*, and one in the context of *a seminar event*. The studies were mostly qualitative and exploratory in nature, and they were conducted with common user experience research and evaluation methods (Rohrer, 2014).

3.1 Study 1: University

Study design. The aim of the study was to investigate a social robot as a social facilitator of connectedness with university students and staff members. The robot used in our study was Pepper, a social humanoid robot equipped with cameras, microphones, wheels, and touch sensors on its arms and head. Moreover, it has a tablet mounted on its chest that makes it possible for people to interact with it by touch, in addition to displaying text and images. Pepper was selected because it can attract people with its human resemblance, attractiveness in appearance, appropriate size for interaction, its conversation abilities, and multimodal functions (Kaipainen, Ahtinen and Hiltunen, 2018). The study was conducted at a Finnish university campus where Pepper was placed in the public, crowded lobby area. Pepper was presented to people as a performer of various entertainment features, for example dancing, giving hugs, giving high fives, fist bumps, etc. (Figure 1).

Figure 1 University staff interacting with Pepper

Data collection and analysis. Semi-structured *interviews*, *observation*, and *questionnaire* were utilized in this research. Before the interaction began, the participants were asked to fill a form to give their basic information and consent for the user study. There was one question on the form on a scale of 1 (totally uninterested) to 7 (totally interested) to measure the interest level of the participants in social robots. The researchers observed the participants' non-verbal and verbal expressions of feelings and their interaction with Pepper. After the interaction, the participants were interviewed about e.g. their perspectives on social robots, Pepper's entertainment features, social robots as guides and ice breakers, and how they felt about connecting to others by the help of social robots. The data gathered was analyzed through *content analysis* (Elo and Kyngäs, 2008). The notes from the interviews and observations were all transcribed and entered in to an Excel spreadsheet followed by identifying themes. Basic statistical analysis such as mean and standard deviation was used to provide an overview of the results.

Participants. In total 20 participants interacted with Pepper. All participants took initiative themselves to interact with Pepper. The participants included in the study (N=12) were PhD students (6), research assistants (2), and researchers (4). 75% of the participants were male and the most typical age group was 30–35 years. Eleven of them did not have prior experience in interaction with social robots.

3.2 Study 2: Seminar

Study design. The aim of the study was to explore how a social robot can serve as a social facilitator and how it can contribute to human connectedness at events. By utilizing the *Human Centered Design* approach and initial findings from the university study, we defined our goals based on users' needs and expectations for a seminar event. Next, we implemented a welcoming application on Pepper to create a new and entertaining experience for people who attended the Transdisciplinary Workplace Research (TWR) seminar held at Tampere University of Technology (TUT) in Finland. The application consisted of the seminar schedule, keynote speakers' information, and workshops' locations (Figure 2). Pepper was designated as an icebreaker next to the registration desk to introduce the attendees to the event, greet them, and guide them in the beginning of the event. The welcoming application was presented to the user through both speech and on the tablet in auditory and visual forms and input from the user was in the form of speech. During the seminar breaks, the attendees could interact with the entertainment features similar to the university study.

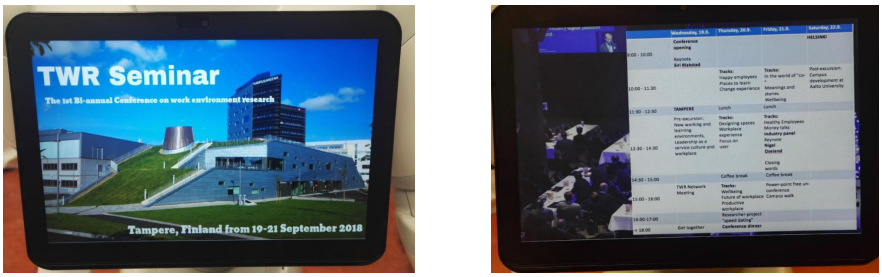

Figure 2: The welcoming application

Data collection and analysis. The data collection methods and the process of the user study was similar to the study 1. Additionally, after the interaction, the participants were asked to complete the *Robot Attitude Scale Survey* (RAS) (Broadbent et al., 2009) to rate their attitudes towards Pepper on an 8-point scale. We used a modified version of RAS consisting of 10 items (unfriendly - friendly; useless - useful; untrustworthy - trustworthy; hard to use - easy to use; unreliable - reliable; dangerous - safe; unhelpful - helpful; boring - interesting; basic - advanced; complicated - simple). The data from the interviews and the observations was analyzed through content analysis. Descriptive statistics such as mean and standard deviation were calculated to provide an overview of the results.

Participants. A total of 31 participants interacted with Pepper in the study. Most of the participants were female (74%) and above 36 years old (45%). The majority were PhD students (41%) and researchers (35%) who had prior seminar attendance experience. Most of the participants (84%) did not have prior interaction experience with a social robots, and the rest mentioned they had seen social robots in other conferences around the world.

4. Results

This section consists of the analysis of the data gathered from the two user studies.

4.1 Study 1: University

Out of the 12 participants, 4 were highly interested in Pepper, 7 participants were interested, and 1 was neutral. We observed that many participants got interested in Pepper when they saw others interacting with it, and this led them to approach Pepper. There were also people who did not take part in the study but just watched Pepper from far and smiled and laughed at its moves and gestures. Of all the participants, the majority had positive mindsets about Pepper's entertainment features and they described interaction as "*fun", "cool", "futuristic", and "amazing"*. Most participants mentioned they enjoyed the entertainment implementations on Pepper, as the following quote reveals: "*[entertainment] was fun and creepy at the same time, like hugging the robot was fun, but creepy because I was hugging a robot, not a human*" (M, 30-35 years).

When participants were asked about networking with others at events, many participants (8) stated they preferred to socialize with familiar people, 2 participants mentioned they prefer to approach people they like to meet, and 2 said they do not socialize at events. When asked about social robots connecting people at events, 7 participants mentioned Pepper can exchange their information or

introduce them to others, and 2 mentioned it can be possible to meet others through entertainment, for example playing games, or dance challenges. The rest of the participants did not have clear opinions on this topic, as one of them mentioned: "*I don't know how, but I am interested to see how Pepper can introduce me to others"*. Participants believed social robots can be used as guides and icebreakers at events by giving the event's introduction and by entertaining people through dance, games, storytelling, and challenges.

4.2 Study 2: Seminar

We observed that the majority of the participants took part in the study voluntarily. Some people who did not approach Pepper voluntarily mentioned that they were shy, or they were not sure how to communicate with Pepper. For instance, one person mentioned that "*I'm scared if I do something to break Pepper*" (F, 30-35 years). Additionally, we observed that in many cases the attendees interacted with Pepper in groups. We could observe the *Honeypot effect* (Wouters et al., 2016) as people became curious and approached if they saw others gathered around interacting with the robot. Also, Pepper was the center of attention during seminar breaks, and participants enjoyed interacting in groups, for instance three people started dancing together when Pepper was dancing. Some people preferred to stay close and enjoyed watching others dance, or give hugs to Pepper.

Participants expressed feelings of curiosity and joy while listening to Pepper's welcoming package, and while Pepper was entertaining them. Many seminar attendees were interested in social robots, and commented positively about the presence of Pepper during two days of the seminar. For instance, one person stated: "*Interacting with Pepper was the best part of the day"* (F, 36+ years), and another mentioned that *"Pepper made [the seminar] not boring"* (F, 36+ years). The overall attitude towards Pepper was positive, and according to the RAS attributes it got the highest ratings on Dangerous-Safe (M=6.48; SD=1.36) and Unfriendly-Friendly (M=6.42; SD=1.67). The lowest ratings it got on Useless-Useful (M=5.19; SD=1.83), Complicated-Simple (M=5.19; SD=1.73) and Unreliable-Reliable (M=5.06; SD=1.76).

The study also revealed that many participants enjoyed seeing Pepper as an ice breaker and guide in the beginning of the seminar. The participants showed interest in the idea of Pepper being used as an ice breaker and entertainer at events. They were mainly leaning towards the entertainment and fun factors of Pepper, however, some stated that the entertainment implemented on Pepper was short in duration or lacked variety. Some suggested to implement games, challenges, group dance games, or joke-telling on Pepper to make it more fun and joyful.

When participants were asked about networking with other people at events, the majority mentioned they were interested in connecting with others at events. However, they mostly found the process challenging, and that led them to socialize with familiar people. As one person mentioned, "*It can get really crowded, and it is really hard to meet the right persons"* (F, 36+ years) and another one: *"I always find myself talking to the wrong people, those who have nothing in common with me"*(F, 30-35 years). Most participants did not have clear viewpoints about how social robots could be helpful for connectedness at events, and they suggested the best way would be for Pepper to share their contact information with people who shared similar interests. Some participants suggested Pepper could be a guide and help them find the right person and introduce them. Although participants did not have a clear opinion about social facilitation of Pepper, they were really interested to see such implementation and shared some general high level views, like the following comments reveal: "*The implementation*

should not be childish, it should be implemented in a way that adults get interested in it"(M, 36+ years);*"The interaction has to be fast, and not slow at all"*(F, 25-30 years).

4. Discussion

Similar to previous research (Shi and Choo, 2011) it was explored that the participants' enjoyment and pleasure during interaction has direct impact on their attitude and intention of use on social robots. Similarly, the level of joy, fun, and interest affect people's acceptance of social robots. In our study, we observed that participants were entertained by Pepper, and this motivated them to keep interacting with Pepper and made them curious to look for more applications to use. We noticed that the more enjoyment is experienced by the users, the higher the perception and acceptance towards social robots will be. Pepper's human-likeness made it attractive to many participants; we realized that for some participants the elements of novelty and surprise contributed to attractiveness of Pepper, and for few users this unfamiliarity led to a negative feedback. The attractiveness has influence on enjoyment, and attitude of people towards social robots (Graaf and Allouch, 2013). Similar to Riether et al. (2012) our findings also suggest social robots can be social facilitators, and their presence can result in people gathering around and connect with each other.

Based on the previous research and our user studies, we envision that in the future, social robots could be utilized in the design of space ambiences (Ahtinen et al., 2015) in smart buildings. The ambience on the smart space could be flexibly adapted for different situations and user needs by the means of robotics and AI. The social robot could act as "a mediator" of the space experience - it could act as an interactive host of the space who would be in interaction with the visitors and thus enrich the experience of space towards, e.g. more social, personal, playful, inspiring or relaxational, based on the situation. As we have noticed on our own user studies with social robots and the studies conducted by others (e.g. Kaipainen, Ahtinen and Hiltunen, 2018; Marchionni et al, 2013), humanoid robots evoke mainly positive experiences and they have potential on bringing in more social and playful experiences for people. Thus, social robots could be utilized to enrich the experience and ambience of the space, and based on the situation, the experience could be flexibly changed. For example, the future smart building could have many modes and the social robot that would host the space would act accordingly. On the event mode it could be the facilitator of social activities and thus bringing in a proper ambience for making socializing easier. An example of another mode could be for example a relaxational mode to support stress-relieving in the evening time.

Like other studies, our user studies had some limitations. The topic of our research is novel and still in the initial phases, therefore the validity of the results is still limited and require further study. The limited number of participants in our studies indicates involving more people for future studies. The duration of the studies was short, and therefore the results we found may differ from longer studies. Finally, the speech recognition implemented on Pepper was not working properly during some interactions, and the users had to keep repeating their commands for Pepper to understand them.

5. Conclusions

As more devices are becoming smart everyday, our living environments will become smart as well, and robots can become part of this scenario by helping people to perform tasks easier and enrich their

experiences in different ways. Customer service robots are being used in many industries nowadays, and implementing them in smart environments can be the start of a novel future for this industry. By providing more social, pleasurable and entertaining experiences for people, social robots can be accepted and become part of people's lives easier. Based on our research results it looks obvious that people operating in the built environment, e.g. in office buildings, have positive attitude towards humanoid service robots. This attitude can be described with terms such as curiosity and joy. This can provide a useful basis for operational applications.

Acknowledgments

We would like to thank Virpa-D project, and Human-Centered Robotics project to provide the opportunity and resources in conducting this research. Also, we would like to thank Aleksi Hiltunen for all the time and effort he put in to programming Pepper's applications for the user studies.

References

Ahtinen, A., Poutanen, J., Vuolle, M., Väänänen, K., & Peltoniemi, S. (2015, November). Experience-driven design of ambiences for future pop up workspaces. In *European Conference on Ambient Intelligence* (pp. 296-312). Springer, Cham.

Bartneck, C. and Forlizzi, J. (2004). A design-centred framework for social human-robot interaction. In: *Proceedings of RO-MAN 2004, 13th IEEE International Workshop on Robot and Human Interactive Communication*, pp. 591-594. https://doi.org/10.1109/ROMAN.2004.1374827

BPIE (2017) Smart Buildings Decoded, Buildings Performance Institute Europe (BPIE), Belgium.

Broadbent, E., Tamagawa, R., Kerse, N., Knock, B., Patience, A. and MacDonald, B. (2009). Retirement home staff and residents' preferences for healthcare robots. In: *Robot and Human Interactive Communication*. Toyama: The 18th IEEE International Symposium on Robot and Human Interactive Communication, pp.645-650. https://doi.org/10.1109/ROMAN.2009.5326284

Crooks, A., Schechtner, K., Dey, A.K. and Hudson-Smith, A. (2017) Creating Smart Buildings and Cities, PERVASIVE Computing, IEEE CS, April-June 2017, pp. 23-25.

Dautenhahn, K. (1998). The Art of Designing Socially Intelligent Agents: Science, Fiction, and the Human in the Loop. *Applied Artificial Intelligence*, [online] 12(7-8), pp.573-617. Available at: http://doi.org/10.1080/088395198117550

Elo, S. and Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), pp.107-115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Fong, T., Nourbakhsh, I. and Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems*, 42(3-4), pp.143-166. https://doi.org/10.1016/S0921-8890(02)00372-X

Graaf, M.M.A, Allouch, S.B. 2013. Exploring influencing variables for the acceptance of social robots. Robotics and Autonomous Systems 61, 12 (2013), 1476–1486. https://doi.org/10.1016/j.robot.2013.07.007

Joosse, M, Evers, V. “A guide robot at the airport: First impressions”. In Proceedings of the Companion of the 2017 ACM/IEEE International Conference on Human-Robot Interaction (HRI’17). ACM, New York, NY, USA, 149–150. https://doi.org/10.1145/3029798.3038389

Kaipainen, K., Ahtinen, A. and Hiltunen, A. (2018). Nice surprise, more present than a machine. In: *Mindtrek'18*. Tampere: International Academic Mindtrek Conference, pp.163-171. https://doi.org/10.1145/3275116.3275137

Luria, M., Hoffman, G., Megidish, B., Zuckerman, O. and Park, S. (2016). Designing Vyo, a robotic Smart Home assistant: Bridging the gap between device and social agent. *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*. https://doi.org/10.1109/roman.2016.7745234

Marchionni L., Pages J., Adell J., Capriles J.R., Tomé H. (2013) REEM Service Robot: How May I Help You?. In: Ferrández Vicente J.M., Álvarez Sánchez J.R., de la Paz López F., Toledo Moreo F.J. (eds) Natural and Artificial Models in Computation and Biology. IWINAC 2013. Lecture Notes in Computer Science, vol 7930. Springer, Berlin, Heidelberg

Mubin, O., Ahmad, M.I., Kaur, S., Shi, W. and Khan, A. 2018. Social robots in public spaces: A meta-review. In: *International Conference on Social Robotics (ICSR 2018)*, pp. 213-220. https://doi.org/10.1007/978-3-030-05204-1_21

Niemelä, M., Heikkilä, P. and Lammi, H. (2017). A Social Service Robot in a Shopping Mall: Expectations of the Management, Retailers and Consumers. In: *Proceedings of the Companion of the 2017 ACM/IEEE International Conference on Human-Robot Interaction*. Vienna: HRI '17, pp.227-228. https://doi.org/10.1145/3029798.3038301

Norberg-Schulz, C.: Genius Loci -- Towards a Phenomenology of Architecture. Rizzoli International Publications, New York (1980)

Pieterson, W., Ebbers,W., Madsen, Ch. 2017. New channels, new possibilities: A typology and classification of social robots and their role in multi-channel public service delivery. In Proceedings of International Conference on Electronic Government (EGOV2017). Springer, Cham, 47–59. https://doi.org/10.1007/978-3-319-64677-0_5

Riether, N., Hegel, F., Wrede, B. and Horstmann, G."Social facilitation with social robots?," *2012 7th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Boston, MA, 2012, pp. 41-47. Https://doi: 10.1145/2157689.2157697

Rohrer, C. 2014. *When to Use Which User-Experience Research Methods*. Nielsen Norman Group. https://www.nngroup.com/articles/which-ux-research-methods/

Shin, D., Choo, H. 2011, "Modeling the acceptance of socially interactive robotics: Social presence in human-robot interaction", *Interaction Studies*, vol. 12, no. 3, pp. https://doi.org/10.1075/is.12.3.04shi

Shiomi, M., Kanda, T., Ishiguro, H. and Hagita, N. 2006. Interactive humanoid robots for a science museum. In: *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction*. pp.305-312.https://doi.org/10.1145/1121241.1121293

Softbankrobotics.com. (2018). *Pepper the humanoid robot | Softbank Robotics*. https://www.softbankrobotics.com/emea/en/pepper?q=emea/en/pepper

Van Doorn, J., Mende, M., Noble, S.M., Hulland, J., Ostrom, A.L., Grewal, D. and Petersen, J.A. 2017. Domo Arigato Mr. Roboto: Emergence of automated social presence in organizational frontlines and customers' service experiences. *Journal of Service Research*, vol. 20, no. 1, pp. 43-58. https://doi.org/10.1177%2F1094670516679272

Wouters, N., Downs, J., Harrop, M., Cox, T., Oliveira, E., Webber, S., Vetere, F. and Moere, A. (2016). Uncovering the Honeypot Effect: How Audiences Engage with Public Interactive Systems. In: *Designing Interactive Systems*. Brisbane. pp.5-16. https://doi.org/10.1145/2901790.2901796