"Konnichiwa, Mr. Robot": a direct observation of hotel visitors' attitudes and anxiety regarding service robots

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Abstract

Purpose – This study investigates human behavior, specifically attitude and anxiety, toward humanoid service robots in a hotel business environment.

Design/methodology/approach – The researcher adopted direct observations and interviews to complete the study. Visitors of Henn-na Hotel were observed and their spatial distance from the robots, along with verbal and non-verbal behavior, was recorded. The researcher then invited the observed hotel guests to participate in a short interview.

Findings – Most visitors showed a positive attitude towards the robot. More than half of the visitors offered compliments when they first saw the robot receptionists although they hesitated and maintained a distance from them. Hotel guests were also disappointed with the low human–robot interaction (HRI). As the role of robots in hotels currently remains at the presentation level, a comprehensive assessment of their interactive ability is lacking.

Research limitations/implications – This study contributes to the HRI theory by confirming that people may treat robots as human strangers when they first see them. When a robot's face is more realistic, people expect it to behave like an actual human being. However, as the sample size of this study was small and all visitors were Asian, the researcher cannot generalize the results to the wider population.

Practical implications – Current robot receptionist has limited interaction ability. Hotel practitioners could learn about hotel guests' behavior and expectation towards android robots to enhance satisfaction and reduce disappointment.

Originality/value – Prior robot research has used questionnaires to investigate perceptions and usage intention, but this study collected on-site data and directly observed people's attitude toward robot staff in an actual business environment.

Keywords Robot appearance, Human–robot interaction, Robot hotel, Negative attitude, Anxiety, Behavior observation

Paper type Research paper

1. Introduction

Business organizations expect robots to improve operational effectiveness and efficiency, reduce cost and release the pressure of hiring experienced staff members. Robots were first designed to carry out repetitive, boring, and stressful tasks at high speed and high precision (Engelberger, 2012). Huang and Rust (2018) predicted that robots will replace not only mechanical jobs but will also be equipped with analytical, intuitive and empathetic skills. By combining sensors and artificial intelligence (AI), machines can act according to the current state without human intervention. This evolution has catalyzed hotels to implement

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self-service technologies for hotel guests to complete check-in and check-out procedures. Hotels can also use robots to replace humans when handling these processes (Ivanov *et al.*, 2017). Therefore, robot designs mimic a human appearance and movement to increase their acceptance.

Human-like robots can be categorized into two main types: humanoid and android robots. Humanoid robots have the shape of a human body with a head, two arms and two legs, while android robots resemble humans not only in appearance but also in behavior (Mara and Appel, 2015). A well-known example of an android robot is C-3PO in the movie *Star Wars* in 1977. Android robots can interact through speech, have the intelligence to provide recommendations, express personality and attitude while also walking like human beings. Their behavior forms an image in people's minds of what a robot should look like and how it should interact with humans. However, 40 years after *Star Wars*, the behavior of current robots remains far behind that of C-3PO. The most recent robots can dance and jump like human beings. They have also been equipped with AI and machine learning abilities to learn while interacting with humans through speech recognition systems. Here, robot designers expect that the robot will respond like a human being, but their personality is still at the introductory stage (Zlotowski *et al.*, 2015). Furthermore, their appearance is not aesthetically similar to that of humans (Broadbent, 2017).

Today, the hospitality industry perceives robots as a new labor force. In this respect, they will provide round-the-clock service to visitors without needing a break. However, the implementation of service robots may change the customer service experience (Pinillos *et al.*, 2016). Therefore, hotels attempt to implement different robots to provide automated services to hotel guests. For example, Yotel automated its luggage storage system with Yobot (Yotel, 2012). Aloft Hotels and InterContinental Hotels (IHG) have attempted to surprise their hotel guests with robot butlers to deliver amenities to in-house guests (Aloft Hotels, 2014; IHG Corporation, 2015). In addition, Hilton Worldwide collaborated with IBM to introduce the first robot concierge – Connie, in their lobby, who provides hotel and local information to hotel guests through speech communication (Hilton Worldwide, 2016). However, these service robots do not resemble or behave like humans. For instance, Connie can verbally communicate with hotel guests, but its appearance is not human.

Another disadvantage is that the mobility of these robots is limited. They were stationed at the counter or moved slowly to a destination on wheels. Henn-na Hotel in Japan was the first hotel with human-like robots at the reception counter. However, unlike Connie, these robots did not have any interactive intelligence. Therefore, although service robots provide personal service to hotel guests, it is crucial to understand the guests' perception and acceptance of the services these robots offer. Research has focused on robots' mechanical development, functionality, machine learning with AI integration and human–robot interaction (HRI) interfaces. Nevertheless, hotel robots need to operate in an environment originally built for human beings (Heerink *et al.*, 2010). Therefore, it is important to ensure that people have a positive attitude towards service robots when perceiving and experiencing the same service level as that offered by human staff.

Previous research has investigated visitors' perceptions of, and attitudes towards, robots in a business context (Iwasaki *et al.*, 2018; Niemelä *et al.*, 2017; Yamazaki *et al.*, 2008) and in hotels (Ivanov *et al.*, 2018). However, these studies were either laboratory experiments or one-off projects, while none of them investigated human attitudes towards robots in a natural hotel environment. Therefore, this study attempts to shed light on hotel visitors' perceptions of, and attitudes toward, aesthetically human-like service robots while also highlighting future development trends. Thus, the objectives of this study are as follows:

(1) To observe and analyze interactions between visitors and robot staff in a natural hotel environment.

(2) To identify attitude and anxiety levels of the hotel visitors towards robot staff.

(3) To understand hotel guests' expectations of, and experience with, hotel robots.

2. Literature review

2.1 Human–robot interaction (HRI)

Given the increasing number of service robots adopted by business entities and for personal use, the demand for HRI studies has increased (Murphy *et al.*, 2019). HRI has focused principally on the two areas of operational interaction and social interaction. Modern service engineering thus needs to consider both the technical and human sides of service (Freund and Spohrer, 2013). The degree to which visitors like a service robot influences their judgment toward the robot (Bartneck *et al.*, 2009). Therefore, positive first impressions often lead to a positive evaluation of, and trust in, the robot (Calvo-Barajas *et al.*, 2020). Humans may tend to have an emotional attachment to a robot. Therefore, they will treat the robot as a companion after interacting with it over a short period (Weiss *et al.*, 2009).

Prior research illustrated that people mindlessly apply social rules to computers and technology (Nass and Moon, 2000; Weiss *et al.*, 2009). When interacting with computers and robots, people tend to apply stereotypical social categories, such as gender and ethnicity, along with in-set and out-set status (Nass and Moon, 2000; Nijssen *et al.*, 2021). Anxiety and negative attitudes may exist when humans interact with strangers from another culture. Rosanda and Istenič's (2021) study revealed similar findings when humans interact with a robot. Moreover, humans may apply social behaviors, such as politeness, in their interactions with computers and robots (Eyssel and Kuchenbrandt, 2012; Rehm and Krogsager, 2013). The presence of a robot can also increase human honesty (Hoffman *et al.*, 2015).

Studies on human reaction and spatial distance from a robot indicated that humans, especially adults, distance themselves from the robot during the first encounter (He *et al.*, 2020; Shi *et al.*, 2011; Walters *et al.*, 2005). Alternatively, hotel guests co-create positive experiences and additional values when interacting with a robot during their stay (Murphy *et al.*, 2016). von der Pütten *et al.* (2018) examined visitors' non-verbal behavior toward the android robot "Geminoid HI-1." They placed this robot, disguised as a customer, in a café. Their findings indicated that the robot's eye contact influenced human interactions. However, the robot in this experiment was not a working employee; therefore, it is impossible to deduce how people might interact with robots in a business context.

Several studies were conducted in shopping malls and museums to observe visitors' reactions towards robotic staff (Iwasaki *et al.*, 2018; Niemelä *et al.*, 2017; Yamazaki *et al.*, 2008). Unfortunately, none of these robots looked aesthetically like a human. Furthermore, the robots were only set up once for the experiment instead of being daily working robots. To the best of the author's knowledge, this study is the first study that attempted to examine the HRI of a human-like robot in a natural hotel environment.

2.2 Robot appearance and human attitude towards hotel service robots

Robots have been developed for decades, and they are categorized into three main areas: industrial robots, professional service robots and personal service robots (Murphy *et al.*, 2016). The most usual form is a machine-like industrial robot. They replace humans by carrying out repetitive and monotonous work at high speed (Engelberger, 2012). AI and machine learning capabilities are incorporated into robot development. Therefore, service robots, like Connie at Hilton Hotel, can verbally socialize with hotel guests and provide recommendations to their inquiries.

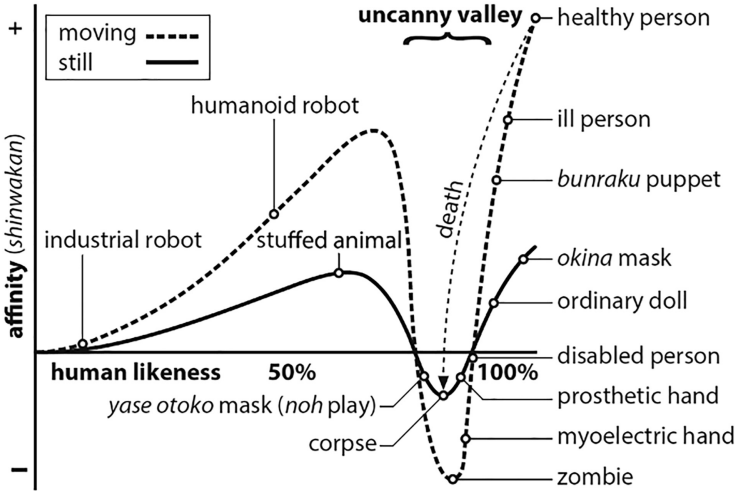
The main concern of hotel managers regarding service robots is the perceived hotel service quality and how the robot co-creates experiences with hotel guests during their stay (Ivanov *et al.*, 2020). Anthropomorphism refers to "the tendency to imbue the real or imagined behavior of non-human agents with human-like characteristics, motivations, intentions or emotions" (Epley *et al.*, 2007, p. 864). This idea enhances the emotional attachment of humans to objects and animals, concurrently with reducing avoidance (Kiesler and Goetz, 2002; Li *et al.*, 2010). Humanoid robots tend to be perceived as more intelligent than mechanoid robots, and the taller robots are also perceived as more human-like than shorter ones (Li *et al.*, 2010). In general, a robot with a human appearance is more likely to induce positive perceptions and attitudes because visitors feel that they are interacting with human staff (Shin and Jeong, 2020). However, androids are not 100% aesthetically human-like and their non-human behavior could make visitors uncomfortable.

Mori (1970) proposed the "uncanny valley effect," which illustrates that people would have an unpleasant impression of a robot if its appearance were not perfectly realistic. According to Mori (1970), after humans die,

> . . . we are unable to move; the body goes cold, and the face becomes pale. Therefore, our death can be regarded as a movement from the second peak (moving) to the bottom of the uncanny valley (still), as indicated by the arrow's path in Figure 2 *[Note from the author: see Figure 1]*. We might be glad that this arrow leads down into the still valley of the corpse and not the valley animated by the living dead. I think this descent explains the secret lying deep beneath the uncanny valley (Mori *et al.*, 2012, p. 100).

Therefore, the unnerving strangeness of humanoid robots may stem from abnormal facial features (Seyama and Nagayama, 2007). In addition, imperfect human-like robots may create an uncomfortable environment because they remind people of death (MacDorman and Ishiguro, 2006).

In the social context of HRI, researchers have studied head, eye and body orientation as indicators of the level of engagement (Srinivasan and Murphy, 2011). A robot's eyes appear to be particularly important when judging whether a face is alive or not (Looser and Wheatley, 2010) while also affecting visitors' robot interaction intentions (Iwasaki *et al.*, 2018; MacDorman and Ishiguro, 2006). A human-like robot creates a stronger sense of social



Source(s): based on image by Mori *et al.* (2012)

Figure 1.
The uncanny valley with the presence of movement

presence, typically perceived as more enjoyable by visitors (Heerink *et al.*, 2010). To add to this, a robot with emotional facial expressions could enhance the first impression regarding trustworthiness (Calvo-Barajas *et al.*, 2020).

To measure people's behavior and emotion towards robots, Nomura *et al.* (2008) proposed the *Negative Attitudes toward Robots Scale* (NARS) and Robot Anxiety Scale (RAS). These instruments evaluate the negative perceptions of robot interaction. The measurements included (a) the physical interaction and emotional interactions with robots, (b) anxiety towards communication capability and (c) anxiety about robot behavioral characteristics.

A robot hotel receptionist is the first contact point when guests arrive. Therefore, the appearance of a robot will directly affect guests' first impressions of the hotel and their stay experience (Walters *et al.*, 2009). However, prior studies illustrated that hotel guests prefer caricatured robot staff to human-like robots (Shin and Jeong, 2020; Yu, 2020). Tung and Au (2018) explored user experiences of robot staff in various hotels by using secondary data from four online review sites. Yu (2020) examined the comments from YouTube videos, and the results indicated that hotel guests showed negative perceptions of human-like robots. However, the findings of these two studies could not reflect the customer's on-site behavior. However, the results did reveal that members of the younger generation, especially the males, supported the introduction of service robots in hotels (Ivanov *et al.*, 2018).

To improve a robot's capabilities, some academics have recorded and analyzed the interaction of and behavior towards robots by hotel guests (Pinillos *et al.*, 2016). Choi *et al.* (2020) interviewed hoteliers and guests, finding that they perceived human staff service quality more highly than robot staff service quality. Visitors also expressed that the caricatured robot was the most preferred morphology, but they still preferred to be served by humans (Shin and Jeong, 2020). However, these two studies only examined the perception or usage intention, and the participants might not have had prior robot interaction experience.

Much of the literature on HRI mentioned above was quantitative and conducted in a controlled environment. This study adopted direct on-site observations to understand people's attitudes and reactions towards service robots. The research obtained visitors' responses towards humanoid robot service staff in a natural business environment. The data were categorized based on Nomura *et al.'s* (2008) psychological scales, NARS and RAS, for HRI evaluation. Thereafter, analysis of the results combined spatial distance between people and robots and the elapsed time of interactions with the robots. These data enabled the researchers to examine hotel visitors' robot interaction attitudes and the anxiety levels regarding robot staff.

3. Methodology

3.1 Background of Henn-na Hotel

In July 2015, the Henn-na Hotel opened in Huis Ten Bosch, a theme park in Sasebo, Nagasaki Prefecture, Japan. This facility was the world's first robot hotel, with no human staff visible on the premises. Recently, this hotel chain expanded, and by 2021, it had 17 hotels in operation. Furthermore, two are scheduled to open in 2022 in Seoul, South Korea, and New York, USA (Henn-na Hotel, 2021). This hotel chain only provides accommodation services, while vending machines offer microwavable food.

In these properties, robots perform all hotel frontline services, which means that visitors do not see any human staff members. More specifically, these hotels are equipped with humanoid receptionists, robot concierges, mechanical robots for handling luggage storage, and robot butlers for carrying luggage and escorting guests to their rooms. The in-room robot provides room ambiance control, responds to inquiries and interacts with guests through speech. The robot receptionists have sensors that will play a pre-recorded welcome message when guests approach the reception counter. However, they do not have a voice recognition system and cannot respond to guests' verbal requests.

The research conducted the observations in this study in May 2018 at Henn-na Hotel Hamamatsucho, which opened on April 27, 2018. This is the second Henn-na Hotel to have opened in Shinagawa, Tokyo, located in the central business district (CBD). This area is not a popular location for tourists, as there are no attractions nearby. Nevertheless, it is home to ten embassies. This hotel is smaller than the first hotel in Nagasaki, with two android robot receptionists and one concierge robot. However, luggage storage and robot butler service are not available.

3.2 Behavioral observation and the observation settings

This study adopted direct behavioral observation, which refers to:

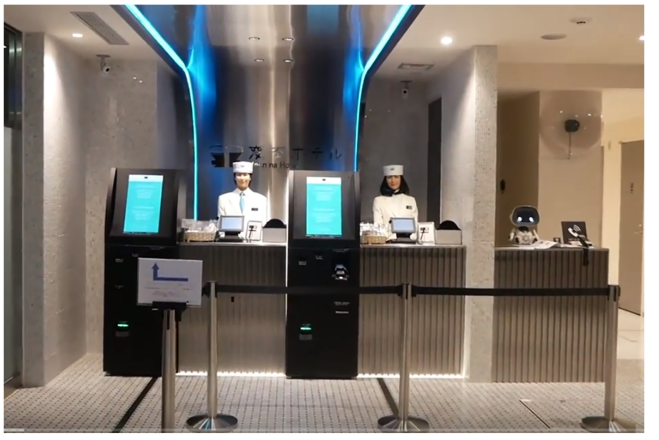
> a researcher seeing and/or hearing, and then systematically recording, the behaviors of an individual or set of individuals within a particular social context of interest, such as the classroom, the playground, the peer set, the home, the clinic, or the workplace (Heyman *et al.*, 2014, p. 345).

Behavioral observation includes three aspects: non-verbal behavior, linguistic behavior and spatial relationships (Cooper and Schindler, 2013). According to Brunt *et al.* (2017), non-verbal behavior documents body movements, facial expressions, hand signals and head movements. Linguistic behavior documents human utterances during a conversation, presentation or interaction. Finally, spatial behavior attempts to structure space around individuals, including the proximity of people or objects.

The researcher checked into the hotel on May 17, 2018, and stayed for two nights. The researcher sat at the hotel lobby on both evenings, from 18:30 to 19:30, observing everyone who entered the hotel and how they interacted with the lobby robots. Observations did not involve researcher interaction with visitors, meaning that there was no communication with those entering the lobby. This ensured that the researcher could observe individual reactions in a natural setting (Shaughnessy *et al.*, 2008).

The hotel's official check-in time starts at 15.00, while the nearby office workers finish their day after 18:00. Therefore, the researcher chose the evening because she could then observe both hotel guests and visitors. In addition, since the hotel was new and had been open for less than one month, the researcher assumed that those who entered the hotel were first-time visitors. Therefore, their reactions should reflect their first impressions of the robot.

Plate 1 illustrates the layout of the reception counter. Two robot receptionists faced the hotel entrance, and there was a tablet on the counter. There were two self-service kiosks in



Source(s): Photo credit: the author

Plate 1.
Reception counter of Henn-na Hotel Hamamatsucho

front of the counter for scanning passports and issuing room keys. One table-top robot concierge was placed on the right-hand side of the reception counter, and it played a welcome message when people entered the hotel lobby. When people approach the reception counter, the robot receptionists play voice messages to guide the visitors through the check-in process.

Figure 2 illustrates the hotel lobby's floor plan, indicating where observations took place. The green line indicates the walking path to the reception counter for check-in. The observer sat on the bench facing the glass wall, with the hotel entrance on the observer's left-hand side and the reception counter on the right-hand side. This location allowed the observer to view visitor behavior and facial expressions immediately when they entered the hotel. The size of the lobby was small; therefore, the observer could observe visitors' body movements and facial expressions. However, the language barrier and the visitors' soft voices meant that the researcher could not document visitors' conversations on the worksheet.

3.3 Sampling and data collection tools

This study adopted the purposive sampling method. Here, the researcher noted the behavior of all visitors who entered the hotel on a worksheet. The researcher excluded visitors who took the elevator back to their rooms without stopping in the hotel lobby from the observations. The researcher documented on the worksheet all the included visitors' verbal, facial and behavioral actions. The design of the worksheet was adopted and simplified from the NARS and RAS measurement items developed by Nomura *et al.* (2008). Table 1 shows the information recorded on the worksheet.

If those observed were the arriving hotel guests, the researcher approached them after they checked in and invited them to participate in a short interview lasting from five to ten minutes. The three interview questions were:

(1) For what did you book into this robot hotel?

(2) What were your expectations of these robots before check-in?

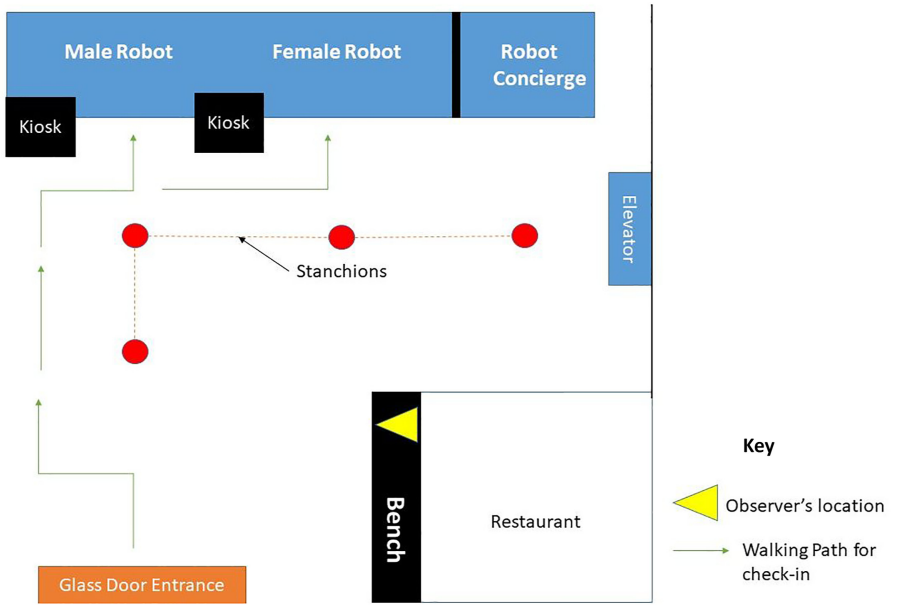


Figure 2.
Hotel lobby layout and the observation location

Items	Data recorded
Set ID	Unique ID number
Visitor type	Visitor/hotel guest
Arrival time	Time of the visitors enter the hotel
Number of persons in the set	Total number of people in that group
Observed demographic characteristics	The demographic based on the experience and judgment of the researcher (Gender, age and ethnicity)
Spatial distance	The distance between the robot and the visitors; have multiple records if the visitors stop moving. It is a relative location (e.g. stop at the entrance; stop at stanchion etc.)
Non-verbal Behavior	Facial expressions (smile; annoyed; laugh etc.) Body movement (waving hands; taking photos etc.)
Verbal Behavior	Audible verbal compliments about the robot
Interaction among the set towards the robots	Audible conversation/vocabulary within the set about the robot
Departure time	Time of the visitors leave the lobby

Table 1.
Observation worksheet

(3) What has been your overall experience with these robots?

Out of the four groups of arriving hotel guests, two groups agreed to participate in the short interview after checking in.

4. Findings

4.1 Demographics of the visitors

During the 2 one-hour observations in the hotel lobby, the researcher observed 24 individuals in 11 sets of hotel guests and visitors. Four sets were hotel guests, and seven sets were walk-in visitors. In-house hotel guests who directly headed to the elevator without interacting with the robots were excluded. Among these 24 visitors, 11 were female and 13 were male. Furthermore, 16 were Japanese, while the remaining 8 came from other Asian countries. The researcher approached two sets of hotel guests and invited them to participate in an in-depth interview. This interview allowed them to share their hotel decision criteria, along with their robot interaction experience in the lobby, with the researcher. One – H2 – was a businessman from Thailand, and the second – H4 – comprised a mother and son from Hong Kong. Table 2 lists the researcher's observation and judgment of visitors' demographic characteristics.

4.2 Background information of the interviewee sets

H2 and H4 accepted the 10-min interview and shared their hotel selection criteria, expectations and experience with the robots. H2 was a business traveler from Thailand who came to Tokyo to meet clients in the Hamamatsucho area. He chose the hotel because he had seen YouTube videos about it. Therefore, he commented, "*. . . it's worth a try to stay.*" The conversation with H2 was in English.

H4 was a mother and son from Hong Kong. They traveled to Tokyo every month for medical purposes, and both spoke basic Japanese. However, the researcher interviewed them in Cantonese. They chose the hotel because it is next to the airport express line and close to the subway and train station. Having been to Tokyo more than 15 times, they wanted to gain more local experience. Therefore, the travel distance to tourist attractions was not their concern. They learned about Henn-na Hotel when it first opened and made

Group ID	Arrival Time	Time spent in lobby	No. of people in the group	Status	Demographic characteristics observed
Date observes: May 17, 2018 (Thursday)					
H1	18:35	5 min	2	Hotel guests	Asian tourist couple in around mid-30s
V1	18:50	1.5 min	3	Visitors	Japanese ladies in late 50s–early 60s
V2	19:00	2 min	4	Visitors	Two Japanese businessmen in late 50s, and two Japanese ladies in early 40s
H2	19:22	4 min	1	Hotel guest*	Thai tourist travel for sightseeing
Date observes: May 18, 2018 (Friday)					
H3	18:23	5 min	2	Hotel guests	Two Japanese male in mid-20s
V3	18:30	1.5 min	2	Visitors	Two Japanese males in late-60s
V4	18:32	30 s	4	Visitors	Three Japanese females and one male in mid-20s
V5	18:43	45 s	1	Visitor	Japanese male in mid-40s
V6	18:55	1.5 min	2	Visitors	Mandarin-speaking couple in mid-30s
V7	19:02	1 min	1	Visitor	Japanese businessman in early-50s
H4	19:13	15 min	2	Hotel guests*	Hong Kong tourists (mother and son in mid-40s and early-20s)

Note(s): *Participated in a 10-min short talk at the hotel lobby after check-in

Table 2. Observees' demographic details

reservations on the website when they were aware that it had commenced operations in Hamamatsucho.

4.3 Behavior towards the service robots

The visitor behavioral worksheet documented three areas of behavior, i.e. *attitude towards robots*, *interactions with robots,* and *anxiety level* regarding both *communication with robots* and *robot appearance*.

4.3.1 Attitude towards the robots. During the observation, most visitors showed a positive attitude towards robots. Most smiled when they first saw the robot, with the exception of H2 and H3. H2 traveled alone and did not show any facial expressions or linguistic expressions throughout the check-in process. One H3 male displayed an unpleasant expression when he accompanied his friend when checking in with the female robot.

Female visitors showed more excitement than males when they saw the check-in robots. V1 continually smiled and took pictures of the robot receptionists. Meanwhile, V4 and V6 took selfies with the robots. V2 did not take any photos, but smiled when seeing the robot.

The robot concierge was small and located on the right-hand side of the reception counter. Unfortunately, only V7 was aware of the robot concierge; therefore, the researcher could not evaluate the overall attitude toward this robot. When the researcher pointed it out to H2, H2 did not show any interest in it. Moreover, H2 could not read or speak Japanese; thus, he could not interact with it. His first impression of the robot concierge was positive, and he felt its appearance was more approachable than the robot receptionist. H4 did not show any positive or negative attitude when entering the hotel. The researcher noted and recorded that when they could not retrieve their reservation records after scanning their passports, they looked disappointed and confused.

When the visitors entered the hotel in sets, they stared at the robot, whispered among their companions and sauntered towards the reception counter. V1 just stood at the hotel entrance,

and one of them said "*Subarashii*!" ("Amazing" or "Magnificent" or "Wonderful" in Japanese) to her companions. Another member said, "Robot!" in an excited voice. The two females in V2 said, "*Wow, this is the new robot hotel*!" She spoke in a high pitch at the hotel entrance. After entering the hotel, V2 discussed the kiosk's functions, while V5 and V7 did not have any linguistic expression when they saw the robot. One reason could be that each was traveling alone, so they did not have a companion to talk to.

The younger visitors showed more excitement and had more obvious linguistic behaviors. One of the females in V4 said "*Sugoi*" ("Awesome" or "This is good" in Japanese) when she entered the hotel. Her friends also complimented the robots. Their voices were soft, so the researcher could not hear their conversation. The researcher noted, based on their facial expressions, that their attitude was positive.

The check-in process for H4 was not smooth. The system could not retrieve their reservation when they scanned the passport. After repeated tries, they pressed the "Contact the human staff" button on the tablet for assistance. The human staff came out of the back office one minute later and collected their passports. After five minutes, the human staff came out again and asked them to go through the kiosk check-in process again. They told the researcher that they were disappointed because they did not expect to see a human in a robot hotel. In addition, after H4 collected the room key from the kiosk, she found that the system only produced one key card for them. They could not find any other way to make an additional key from the kiosk or the tablet. "*I do not want to call the human staff again. But it is inconvenient for the two of us to share one key as we will go out separately*". After check-in, they discussed both their disappointment at the system's mediocre performance and also how they needed human assistance.

4.4 Anxiety level towards robots

4.4.1 Spatial distance from the robot. When visitors first entered the hotel, they all hesitated and were unsure of where to stand. After some seconds, they walked slowly towards the reception counter and stared at the robot. Those who came in sets talked to their companions and eventually sauntered to the reception counter. V1 and V2 entered the hotel and stayed two to 3 meters away from the robot. For some seconds, V3 to V7 remained outside and looked at the robots through the glass door. Then, they entered the lobby. V1 also took pictures from a distance.

The three females of V4 approached the reception counter and stood in front of the stanchions (see Figure 2). The only male in this set stood in front of the glass door entrance, waiting for the females to finish their selfies. They showed no intention of interacting with any robot. All visitors stood behind the stanchion, except V7. He ambled along the reception counter, stood in front of every robot, and observed them one by one. He was the only visitor that moved to the robot concierge desk. He stood there and read the instruction card, but did not interact with the robot.

Among the four sets of hotel guests, all of them directly approached the reception counter for check-in after entering the lobby. None of them displayed any intention of further observing or interacting with the robots. H4 faced problems during check-in; therefore, they spent more time in the lobby than the others. The mother sat on a bench, waiting for the human staff. Meanwhile, her son explored the lobby and interacted without hesitation with the robot concierge at the counter.

4.4.2 Anxiety in communicating with robots. Among all the visitors, only two attempted to communicate with the robot. One male from V3 stood in front of the stanchions and talked to the male robot receptionist. He said, "*Konnichiwa*" ("Good afternoon") twice, in a loud voice. He looked disappointed when he discovered that the robot had no response to his greetings. V6 asked if the robot could see them. Then they waved to the robot to check. These verbal and

physical reactions demonstrated positive attitudes, and the researcher noticed no anxiety among them about the robots.

All the hotel guests directly approached the reception counter once they entered the hotel. Half of them chose the male android robot, and half chose the female. Except for H3, all guests selected English as the communication channel for the check-in process. H3 retrieved their bookings by voicing their Japanese names to the kiosk, but there was no further communication or verbal interaction with the robot staff.

H1 approached the reception counter and said "*Hello"* to the male robot receptionist. They expressed surprise when the robot did not have any response. While H4 waited for the human staff, the son approached the robot concierge and attempted to talk. First, he tried to talk to the robot in English, but it did not comprehend. Then, he tried to communicate with the robot in Japanese. He stated, "*I found that the robot only understands standard script . . . there is a paper on the desk next to the concierge so that I can read from this paper*". However, the voice recognition system cannot fully understand speech if the speaker has an accent. "*I need to repeat and read out the script slowly, or the robot cannot understand*." He was excited when he successfully communicated with it. He spoke loudly to invite his mother to join in on the interaction with the concierge. H2 and H4 were unaware that the robot concierge plays welcome greetings when they enter the hotel until the researcher informed them of this function.

4.4.3 Anxiety towards robot appearance. Most of those observed did not show any noticeable anxiety when they first saw the robot. V5 observed the robots at the entrance but did not move forward. V7 checked each of them but did not interact with them. The younger visitors took a shorter time to get familiar with the robot. V6 showed hesitation initially, but after 10 s, they waved to the robot. H2 mentioned, "*I have no special feeling about the robot receptionist, they look like a real human from far, but when it speaks, it is a robot no doubt*." He also said that he would like the robot to have speech interaction.

One male in H3 displayed an unpleasant facial expression when he entered the lobby and saw the robot receptionist. He said, "*Kowai*" ("Scary"). His companion laughed and patted his shoulder to comfort him. After check-in, he said "*Kowai*" again, just before they entered the elevator. The mother of H4 also disliked the receptionists because they did not look like real humans. She preferred the dinosaur receptionist in another Henn-na Hotel because it was more fun to interact with. The son liked the appearance of the robot concierge and felt it was much more fun to interact with. "*It is very cute, and it has facial expression when I talk to it . . . the (robot) receptionist is boring*".

4.5 Expectation and satisfaction on service robots

The researcher invited H2 and H4 to share their pre-trip expectations about the service robot. Both H2 and H4 had obtained online information or watched videos about the Henn-na Hotel before making a reservation. As a result, they had a strong impression and believed they could have an exciting robot experience. Therefore, when they realized a new Henn-na hotel would open in Hamamatsucho in the month they traveled, they decided to book this hotel. H2 was excited after he made a reservation. "*I told my colleagues I would stay in the robot hotel, and everyone asked me to take photos and share them on Facebook*."

H4's son also shared his plans with friends before he traveled. After experiencing the hotel robots, he wrote, "*But the robot was not so interactive, so I just took one selfie and put it on Instagram. I am not excited anymore*". The mother also had high expectations of robot interaction, but the interaction was minimal. "*I expected some intelligence and verbal communication (with the robot), but unfortunately no."*

H2 pointed out that he anticipated more interactions with the robot. "*I expected to say 'Check-in' to the robot before I started my check-in process, but it only plays a greeting message*."

He was disappointed that the robot had no voice recognition system and that he had to complete the check-in process via a tablet. H4 shared a similar opinion. The interaction with the robot receptionist was minimal. "*The robot receptionist is just like a recorder and asked me to follow the instructions on the tablet*."

5. Discussion

The observation results in this study illustrate specific behaviors regarding human/robot interactions. First, visitors demonstrated confusion and hesitance when they first saw the robot. They also maintained a distance from the robot receptionists. The reason behind these reactions could be that the robots were facing the main entrance. Therefore, they were staring at the visitors when they entered the hotel. People may treat robots as human strangers and thus generate anxiety and avoidance behavior when first encountering them (Rosanda and Istenič, 2021). Hence, they will keep a distance from the robots (He *et al.*, 2020).

Second, some visitors attempted to interact with the robot through speech. Since the robots did not have a voice recognition system, the visitors displayed disappointment when the robot did not react to their greetings. H2 and H4 had high expectations of robot performance before checking into the hotel. Therefore, both sets clearly showed disappointment when there was limited interaction with the robot receptionists. Such responses indicated that humans generally apply social behaviors when interacting with service robots (Eyssel and Kuchenbrandt, 2012).

Nevertheless, Duffy (2003) stated that meaningful social interaction between humans and robots includes a good anthropomorphic deployment quality. High anthropomorphic qualities lead to people having overly optimistic expectations about a robot's abilities, resulting in a feeling of disappointment (Wirtz *et al.*, 2018). Furthermore, an artificial service agent that closely resembles a human could be perceived as less warm (van Doorn *et al.*, 2017). In this study, the service robots' had limited language ability and, thus, the visitors' perceptions of verbal interaction with robotic staff remained unsatisfactory.

Finally, from the observations, the visitors did not feel uncomfortable with the current robot appearance. However, the "uncanny valley effect" might have some validity for H3 and H4 because of the robot receptionists' imperfect, unrealistic human appearance (Seyama and Nagayama, 2007). Furthermore, given the robot receptionists' limited communication ability, the researcher cannot be sure if the visitors' anxiety responses would change if the robots could verbally interact with them. Therefore, it could be concluded that these hotel guests preferred caricature robots as service staff (Shin and Jeong, 2020; Yu, 2020).

6. Theoretical and practical implications

6.1 Theoretical contributions

This research contributes to previous literature in the following ways. First, this study investigated people's actual behaviors and attitudes towards service robots in a natural business environment, which stands in contrast to examining perceptions of a robot or robot usage intention (Çakar and Aykol, 2021; Choi *et al.*, 2020; Yang *et al.*, 2021). Thus, this study is more direct and relevant to the hospitality industry. Second, this study contributed to the HRI theory by confirming that people may initially treat a robot as a human stranger (Rosanda and Istenič, 2021). However, when a robot's face is more realistic, people expect it to behave like a human (Broadbent, 2017). Finally, this study adopted direct observation as a data collection method in its research methodology. The advantage of this technique is that researchers can capture the actual phenomena rather than rely on reconstructed or contrived versions of them (Tombs and McColl-Kennedy, 2010). Hence, there is no memory error or bias (Heyman *et al.*, 2014).

6.2 Practical contributions

The results of this study make significant contributions to the hospitality industry, specifically since social and service robots are becoming more common. They can be beneficial by providing companionship, increasing communication and reducing costs, especially in labor-intensive sectors, like hotels (Ivanov and Webster, 2019). Hence, the visitors' attitudes towards robotic staff in this study offer insightful considerations for future robot adoptions. Except for hotel guests who conducted the check-in process at reception counters, most visitors stayed at least 1 m away from these counters. They either stood in front of the stanchion or next to the entrance to observe the robots. This behavior implies that people are still nervous about interacting with robots (Walters *et al.*, 2005, 2009). Therefore, the suppliers of robots should either caricaturize them or aesthetically improve the appearance of humanoid ones.

Voice activation and speech interaction with a robot can also be challenging because hotel guests travel from different countries and have different accents. It is currently not easy to have an affordable voice recognition system that can interpret various accents. However, with the increasing amounts of speech data and the rapid development of AI learning abilities, the voice recognition system will soon be affordable and powerful enough to understand a range of accents (Buhalis and Moldavska, 2021; Chi *et al.*, 2020).

7. Limitations and future research

This study has the following limitations. First, the sample size of this study was small. There were only 24 visitors, and only 3 of them agreed to be interviewed by the researcher. Second, most visitors were Japanese, and all visitors were Asian. Therefore, the results cannot be generalized to all visitors. Third, unlike the first hotel in Nagasaki, this hotel did not have a mechanical robot for luggage storage, and no butler for luggage delivery and escort service. The in-room control system was also unavailable. Therefore, hotel guests could only use the bedside panel or the hand phone to control the in-room ambiance. As a result, the overall interaction of visitors and guests with robots was limited to the robot receptionist and concierge. Moreover, the fact that only two visitors were aware of the robot concierge's location of at the corner of the reception counter meant that this study could not compare the people's attitude towards a human-like robot and a caricature robot.

Finally, the observation method (direct observation without interaction or intervention) also has limitations. First, researchers cannot make causal statements about the situations; therefore, the observed behavior can only be described instead of being explained. Second, since only one observer conducted the on-site observation, no inter-rater reliability can be evaluated. Third, the data collected from the observation relies on the memory and writing skills of the observer. Because of the limitations of the observer's attention, memory and cognition, not all the reactions of each visitor observed were transcribed correctly. Finally, the perceived behaviors observed were subjective, as other observers may have drawn different conclusions from the observations.

Most research on HRI has been laboratory-based, where the controlled environment cannot reflect a natural business environment. Human reactions in the laboratory are different from those in a natural business environment because their needs and desire for immediate service could alter their behavior. To address this limitation, future HRI research in the service industry should be conducted in a natural business environment to enable researchers to understand visitors' actual behavior during a service experience. It is especially important when robots need to serve multiple people and work in a busy environment.

Furthermore, future hotel service robot research should also include a consumer behavior model to examine the effect of robots on the cognitive and emotional reactions of visitors and

guests within the hospitality industry. In addition, people's behaviors, such as body movement, could be affected by the customer's cultural background (Kenner, 1993; Low, 2003). Therefore, future studies should include cultural factors that could affect people's behavior towards robots.

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