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USER ACCEPTANCE OF SOCIAL ROBOTS: A SOCIAL RESPONSE PERSPECTIVE

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Research in Progress

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Abstract

Anthropomorphism of social robots has been argued to be an important factor that determines individuals' usage of social robots. Little research on social robots has explained how the anthropomorphic design of social robots affects users' social responses to social robots and how social responses further affect user acceptance of social robots. Drawing on the social response theory, we propose a conceptual model to examine user acceptance of social robots. Specifically, three anthropomorphic features (appearance, voice, and response) are proposed to trigger users' social responses (perceived social presence and perceived humanness) to social robots, which lead to individuals' intention to accept social robots. The proposed research model will be empirically tested with data collected among hotel customers via an online experiment. The current study aims to contribute to the social robot acceptance literature from the social response perspective.

Keywords: Anthropomorphism, social robot, social response theory, social cue, user acceptance.

1 Introduction

Social robots have been increasingly used in various service contexts due to the potential benefits of their applications, such as in healthcare, transportation, and hospitality services, and as personal assistants, reception assistants, and waiters (Saari et al., 2022). At present, social robots have also been employed to be able to eliminate the physical contact between consumers and service employees during the COVID-19 pandemic, which is important for eliminating infections (Seyitoğlu & Ivanov, 2021). Prior literature stated that social robots could provide services to consumers efficiently and effectively and also reduce the workload of employees (Yang et al., 2020). When it comes to deploying social robots in their businesses to provide customer support, organizations would also want to know what elements can influence the acceptance of social robots. Thus, there is a need to investigate individual users' acceptance of social robots.

Generally, social robots are defined as autonomous agents that can act socially based on their role during interactions in complex and dynamic social environments (Duffy, 2003; Welch et al., 2010). The advancements in the design of social robots facilitate interactions with humans following the human-human interactions and adaptation to environmental and social cues (Sarrica et al., 2019). According to Schuetz and Venkatesh (2020), social robots have cognitive capability, which makes social robots different from traditional information systems (IS) (Schuetz & Venkatesh, 2020).

As prior research suggests, the perceived humanness of robots influences user acceptance of robots (Premathilake et al., 2021; Schuetz & Venkatesh, 2020). The anthropomorphism of robots reflects the

perceived humanness of robots (Ho & MacDorman, 2017) and can be defined as the capacity to which robots are perceived as human-like to individual users (Moran et al., 2015). According to Tondu (2012), users engage with a robot more when the anthropomorphism of the robot rises. Moreover, user perceptions of robots deviate from the other IS due to the human-like cognitive capabilities embedded in social robots (Schuetz & Venkatesh, 2020). Therefore, it is necessary to consider the roles of anthropomorphic features embedded in social robots when examining individuals' intention to accept social robots.

Prior studies have also attempted to explain the effect of anthropomorphic features on individuals' perceptions as well as their intentions to accept social robots. For instance, Gnewuch et al. (2018) found that the delays in dynamic response related to thinking and typing can increase user perceptions of humanness and the social presence of conversation agents (CAs) since delays give the "thinking" aspect in a conversation similar to human-human interaction. Schuetzler et al. (2014) also argued that the interaction responses from CAs lead to user perceptions of the engagement with and the humanness of the CAs. Highly anthropomorphized facial images of CAs have been found to increase users' social responses to CAs, such as social judgment, social influence, competence, homophily, and trustworthiness of CAs (Gong, 2008). Premathilake et al. (2021) argued that the appearance, voice, and response of social robots are important anthropomorphic features of social robots, and these features can influence individual users' perceptions of the functions of social robots, such as the utilitarian, hedonic, and social functions of social robots, which can further predict their intentions to accept social robots. Premathilake et al. (2021) have further considered the different anthropomorphic featuer of social robots in their study, they investigated the impact of anthropomorphic features on user perpetions mainly from the view of technology functions and have ignored the unique feature of social robots as human-like. Few studies have attempted to follow the theories in human-human-interaction to examine how anthropomorphic features of social robots can work as social cues to trigger users' perception and behaviour regarding social robots.

According to social response theory, humans apply social rules and expectations to anything that displays human-like traits or behavior while responding mindlessly to rudimentary social cues (Nass et al., 1994; Nass & Moon, 2000). Social response theory provides an appropriate theoretical basis to examine the effect of various social cues embedded in human-like technology design on individuals' perceptions of the technology, such as social robots with human-like features (Gnewuch et al., 2018; Liu et al., 2018).

Thus, this study applies the social response theory to investigate how the anthropomorphic features of social robots as social cues will trigger users' social responses to social robots among individual users, which in turn determine their intention to use social robots. Following the study of Premathilake et al. (2021), we set the response, voice, and appearance of social robots (anthropomorphic features) as the variables reflecting social cues (visual, auditory, and verbal cues), and perceived humanness and perceived social presence as the social responses, which determine individuals' intention to accept social robots. Empirical data will be collected via an experiment among hotel customers to test the proposed research model. This study aims to provide explanations for users' intention to accept social robots from the social response view.

The remainder of the paper proceeds as follows. First, a literature review on social robot acceptance, anthropomorphism, and social response theory is presented. Then, we discuss the research model and the relevant hypotheses, followed by an explanation of the planned research method. In the end, the expected contributions of the current study are highlighted, and the limitations of the study are discussed.

2 Literature Review

2.1 Research on Social Robot Acceptance

Social robots as an innovative technology have attracted the attention of scholars. Some theories related to technology acceptance have been applied in the literature to explain user acceptance of social robots.

For instance, Technology Acceptance Model (TAM) (Davis, 1989) has been applied to understand the acceptance of social robots by including additional social elements such as social presence and perceived sociability (Heerink et al., 2010). Wirtz et al. (2018) applied TAM to elaborate the acceptance of service robots in the service context by including the constructs related to functional, social, emotional, and relational elements in TAM. Likewise, in the research on a zoomorphic robot called i-Cat, Heerink et al. (2008) highlighted the importance of social presence and the nature of interactions in explaining user acceptance of robots among elderly users from the view of IS functions. Some studies have applied theories based on value to investigate social robot acceptance. Meyer et al. (2020) discussed the personal value of using social robots by examining how social robots' human-like appearance and behaviors trigger users' social cognitions about social robots, which lead to the perceived personal value encountered with social robots. Further, the attribution of human-like characteristics to robots also drives user acceptance of robots (Meyer et al., 2020). Fulfillment of personal values positively affects user intentions to accept robots (Čaić et al., 2019). Park et al. (2021) examined user acceptance of social robots in different service settings and found that the perceived usefulness of robots, privacy concerns, and user trust towards artificial intelligence (AI) affect user acceptance of robots regardless of the service settings. Security, emotions, human-oriented perception, embodiment, and mutual experience during interactions between humans and robots have also been found to be important antecedents of user acceptance of social robots (Zheng et al., 2021).

Prior literature also found that the value of using social robots might deviate from user expectations and requirements, which can hinder the use of social robots among users (Pino et al., 2015). Some factors related to individual users have also been argued to affect user acceptance of social robots (Diederich et al., 2020; Klamer & Allouch, 2010). For instance, user interest in robotics and technology enthusiasm has been found to affect their acceptance of robots (Diederich et al., 2020; Klamer & Allouch, 2010).

Acceptance of social robots tends to differ from the acceptance of other IS due to the human-like cognitive capabilities of social robots, which might make social robots not only technology embedded with hedonic and utilitarian functions but also human-like functions. The anthropomorphic features embedded in social robots, such as the cognitive capability in interactions and even physical appearance, might influence social robot acceptance among individuals from the view of human-oriented perception (Klamer & Allouch, 2010; Premathilake et al., 2021). The traditional technology acceptance models, such as TAM, unified theory of acceptance and use of technology, task technology fit, might not fully explain the acceptance of social robots due to the lack of human-like features and human-oriented perceptions in these theories.

2.2 Anthropomorphism

Anthropomorphism has been observed in various forms in different disciplines, such as human-computer interaction, engineering, IS, and psychology. The application of cognitive or emotional states in anthropomorphism is expected to rationalize an entity's behavior in a specific social environment (Duffy, 2003). Emotionality, desire, warmth, and openness are examples of human-like traits or characteristics (Salem et al., 2013). However, as Fan et al. (2016) stated, regardless of the fact that such traits can be found in objects, nonhuman agents with such traits are generally known as human-like or anthropomorphic. IS literature has provided similar yet distinct definitions of anthropomorphism in robotic research. According to Duffy (2003), Ruijten et al. (2019), and Złotowski et al. (2018), anthropomorphism can be defined as the ascription of human-like characteristics to nonhuman entities.

The existing literature explains different anthropomorphic attributes with regard to robots. For instance, Złotowski et al. (2018) found that anthropomorphic traits (e.g., movements, gestures, embodiment, verbal communication, and emotions of social robots) affect user perception of robots and user behavior during interactions between robots and users. The communication mode, embodiment, and human identity have also been identified to be the main trait that affects user responses to social robots (Diederich et al., 2022).

Moran et al. (2015) argued that autonomy, adaptability, and intelligence are closely related to anthropomorphism, and intelligence is a key factor determining the level of anthropomorphism of social

robots. Doering et al. (2015) stated that embodiment, voice output, social behavior, and movement are the key features of social robots based on the importance of embodiment in the interactions between robots and humans. However, according to the Uncanny valley theory, an excessive human-like embodiment of social robots might also disturb users' robotic experience (Tondu, 2012). Nissen and Jahn (2021) investigated the impact of the visual anthropomorphism of social robots on user acceptance of social robots via perceived trustworthiness based on the Uncanny valley theory. Premathilake et al. (2021) proposed the appearance, voice, and response of social robots as anthropomorphic features of social robots and argued that these features are associated with user perceptions of the technology functions of social robots, such as the utilitarian, hedonic, and social functions of social robots.

Złotowski et al. (2018) investigated robots' anthropomorphism based on the media equation theory and found a dual process that determines the anthropomorphic features. The study explains an intuitive process to determine whether an entity is human-like and an explicit procedure to understand cognitive decoupling and work memory. User perceptions of anthropomorphism can also be related to user-related factors such as their social background, demographic characteristics (age, gender), and motivation to use (Złotowski et al., 2015). Kuchenbrandt et al. (2013) examined how anthropomorphism affects user interaction with a humanoid robot and found that users have a high willingness to cooperate with the robot as an in-group member.

Prior research has examined various effects of different anthropomorphic features on user perception and acceptance regarding social robots from different views. The appearance, voice, and response of social robots have been argued to be three important anthropomorphic features of social robots from the view of verbal, visual, and auditory cues (Premathilake et al., 2021). Following the prior research, the appearance, voice, and response of social robots are selected as the factors reflecting anthropomorphic features of social robots and set as social cues to trigger user response to social robots.

2.3 Social Response Theory

The social response theory initially emerged from the paradigm of "Computers Are Social Actors" (Nass et al., 1994). It posits that humans apply social rules and expectations to anything that displays human-like traits or behavior while responding mindlessly to social cues even though they are rudimentary (Nass & Moon, 2000, p. 92; Reeves & Nass, 1996). Social response theory has been used in IS field to understand human-technology interactions mainly in the context of human-like technologies (Diederich, Lembcke, et al., 2020; Gong, 2008). People equate and socially respond to human-like IS similar to humans if those IS present human behavior or appearance (Siemon et al., 2020). The social response theory offers a theoretical basis to describe the effect of various social cues embedded in social robots design on individuals' perception and behavior regarding social robots.

Nass and Moon (2000, p. 7) state that "the more computers present characteristics associated with humans, the more likely they are to elicit social behavior." Siemon et al. (2020) found that anthropomorphism is a critical factor in understanding robot usage from the view of social response theory. When users interact with anthropomorphized technologies, they tend to get an understanding of the humanness of the technology during the interactions based on the social cues embedded in the artifact design of the technology, such as the anthropomorphic features of robots (Diederich et al., 2020).

Social robots display a variety of social cues, including having a name, turn-taking, or use of self-reference. These social cues can trigger social responses from users, such as perceived humanness regardless of the feeling of eeriness when interacting with human-like technological artifacts (Feine et al., 2019; MacDorman et al., 2009). Different social cues have been applied to measure the human-like designs of robots. For example, Seeger et al. (2018) present three distinguished social cues, including human identity, nonverbal communication, and verbal communication. Social cues such as name or avatar aiming at identifying a human during a computer-mediated communication are regarded as human identity (Cowell & Stanney, 2005). Expressions and emotional states that are not directly conveyed by language (e.g., blinking dots in CAs to represent thinking) are referred to as nonverbal communication, and spoken or written sentences such as small talks and greetings are defined as verbal communication (Seeger et al., 2018).

Social cues of robots have been found to affect both perceived human likeness and social presence during interactions (Araujo, 2018; Gnewuch et al., 2018). According to Short et al. (1976), social presence can be defined as "the degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions" (p. 65). Gefen and Straub (1997) defined social presence as "the sense of human contact embodied in a medium" (p. 390). Prior research found that the inclusion of social cues such as personalized greetings in robot designs enhances the perceived social presence (Gefen & Straub, 2003). Therefore, this study integrates both perceived humanness and perceived social presence to evaluate the social responses triggered by social cues, specifically through anthropomorphic features reflected in social robots.

3 Research Model and Hypotheses

The proposed research model is primarily developed based on the social response theory. Following the research of Premathilake et al. (2021), the appearance, voice, and responses of social robots are set as the three different anthropomorphic features. User perceptions of these anthropomorphic features related to social robots are assumed to affect the perceived social presence and perceived humanness (social responses), which motivate individuals' acceptance intention toward social robots. The definitions of the variables included in the research model are presented in Table 1.

Construct	Definition
Appearance	The structures, shapes, or forms of robots that are visible to users (Fong et al., 2003).
Voice	The computer-synthesized voice of social robots that allows the communication with users (Gong & Lai, 2003).
Response	Verbal or non-verbal reactions generated by social robots with respect to the user or the environment (Złotowski et al., 2015).
Perceived social presence	User perception of the salience of social robots during interactions (Schuetzler et al., 2014).
Perceived humanness	User perception of the degree of human-likeness of social robots (Holtgraves & Han, 2007).
Acceptance intention	The willingness of users to use social robots (Davis et al. 1989).

Table 1. Constructs and definitions.

Users respond socially to social robots when the robots present social cues. Social cues refer to the features that act as channels of social information (Lobato et al., 2015). There are four categories of social cues: verbal, visual, auditory, and invisible (Feine et al., 2019). Verbal cues are expressed in written or spoken words (Knapp et al., 2013), such as content, i.e., what is said and style and how something is expressed (Collier & Collier, 2014). Cues that are visible, besides the words or texts in chatbots, are considered visual cues (Feine et al., 2019). Kinesics (body movements), proxemics (role of space, territory, and distance in the communication), agent appearance, and computer-mediated communication (e.g., visual elements that possess the ability to augment or modify the meaning of text-based messages) are included in the category of visual cues (Burgoon et al., 2016; Eaves & Leathers, 2017). According to Eaves and Leathers (2017), auditory cues are often categorized as cues that are heard, except for words. Voice quality (permanent and adjustable characteristics of speech) and vocalizations (non-linguistic vocal sounds or noises) are sub-cues that form auditory cues (Burgoon et al., 2016). Invisible cues are cues that cannot be heard or seen (Eaves & Leathers, 2017), which can be chronemics (role of time and timing in the communication) or haptics, i.e., tactile sensations that are felt by the user's body (Burgoon et al., 2016). These social cues are linked with the anthropomorphic design features (Donath, 2007; Pantic et al., 2011) and elicit social responses from users, which have been argued to enhance the perceptions of social presence (Fogg, 2003).

As Fong et al. (2003) describe, the robots' morphology is linked to the embodiment, which explains the different shapes and forms of robots. Humanoid designs are capable of mimicking human features such as gestures and appearance, especially during interactions (Seeger et al., 2018). Little research has been done to investigate how the social cues of virtual robots such as CAs trigger users' responses to social

robots. The visual cues, such as eye moving, smiling, and locomotion of the CAs, affect users' perception of the degree of interactivity which leads to their acceptance intentions regarding CAs (Schuetzler et al., 2014). A higher degree of human-like appearance is often associated with a higher perception of the humanness of social robots among users (MacDorman et al., 2009). In addition, the appearance of the social robot may be perceived as a social cue that can reflect the humanoid presence and personality of social robots (Fogg, 2002). Therefore, it is reasonable to assume that the appearance of social robots as social cues will trigger individual users' perceived social presence and humanness of social robots, and we propose that:

H1a. The appearance of social robots is positively associated with user perception of the social presence of social robots.

H1b. The appearance of social robots is positively associated with user perception of the humanness of social robots.

Users are able to interact with social robots via spoken language rather than written text (Diederich, Janßen-Müller, et al., 2019). Schuetzler et al. (2014) found apart from the face design of social robots, the voice of social robots provides a greater sense of social interactions and leads to a high level of social responses. As the appearance of social robots can vary from low human-likeness to high human-likeness, so can computer-synthesized voices (Gong & Lai, 2003). Moran et al. (2015) argued that personality and voice are closely linked. The human-like voice is capable of eliciting more anthropomorphic interferences compared to a synthetic voice (Kuchenbrandt et al., 2013). Robotic voice has been found to affect user perception of the cognitive intelligence of social robots identical to the human voice, which intensifies the social presence (Duffy, 2003). Based on the above ground, we assume that the voice of social robots positively affects the perceived social presence and humanness of social robots and suggest the following hypotheses:

H2a. The voice of social robots is positively associated with user perception of the social presence of social robots.

H2b. The voice of social robots is positively associated with user perception of the perceived humanness of social robots.

Verbal, non-verbal, or both verbal and non-verbal responses are generated by social robots according to the environmental situation. When users give similar commands to different robots, the responses from different robots might be different. Also, the expectations from users might vary. For example, users might expect formal and touch-avoiding gestures in the case of humanoid robots (Złotowski et al., 2015). According to Diederich et al. (2020), responses generated through traditional graphical user interfaces in chatbots diminish the natural feeling of a human-to-human conversation. However, as per the findings of Gnewuch et al. (2018), users perceive chatbots with dynamically delayed responses to be more human-like than those with near-instant responses, and they also perceive a stronger social presence of social robots. Social robots have been argued to arouse social responses similar to human-human reactions (Kuchenbrandt et al., 2013). Social robots will not be considered "social" if the responses are mindless (Złotowski et al., 2018). Therefore, it is reasonable to assume that timely and human-like responses from social robots will make users perceive the strong social presence and high humanness of social robots, and the following hypotheses are proposed:

H3a. The response of social robots is positively associated with user perception of the social presence of social robots.

H3b. The response of social robots is positively associated with user perception of the humanness of social robots.

The concept of social presence has been utilized to explain the social aspects of technologies such as websites and recommendation agents (Gnewuch et al., 2018). Perceived social presence triggered by social cues regarding social robots might lead individual users to perceive the high usefulness and social functions of the social robots, such as friendliness, warmth, companionship, and trust in social robots (Feine et al., 2019). Prior literature also suggested that when individual users perceive robots to be more useful, they are more likely to accept the robots (Turja et al., 2020). Based on the above ground, we

argue that the higher the perceived social presence of social robots, the higher perception of the humanness of social robots and the higher intention for individuals to accept social robots, and propose the following hypotheses:

H4a. The perceived social presence is positively associated with users' acceptance intention towards social robots.

H4b. The perceived social presence is positively associated with users' perceived humanness of social robots.

Prior research has demonstrated that the humanness of an IS can influence users' perceptions and behaviors toward the IS (Araujo, 2018; Gong, 2008). Lankton et al. (2015) argued that when users perceive the high humanness of an IS, they will have high trust in the IS and positive perceptions about the functions of such IS, such as the perceived usefulness. An increase in perceived humanness has been found to affect perceptions of usefulness positively (Araujo, 2018). For example, when social robots are perceived to be more human-like companions in healthcare, the users are more willing to accept the robots (Robinson et al., 2014). Based on the above ground, we propose the following hypothesis:

H5. The perceived humanness is positively associated with users' acceptance intention toward social robots.

In addition, prior studies have found that users' personal innovativeness and previous technology use experience moderates the relationship between antecedents and user acceptance of a new IS (Frennert & Östlund, 2014; Turja et al., 2020). Additionally, users' demographic factors such as age and gender influence user acceptance of a new IS (Pfeuffer et al., 2019). Thus, in this study, the personal innovativeness and previous use experience of any social robots are considered moderators, whereas age and gender are set as control variables. The research model is presented in Figure 1.

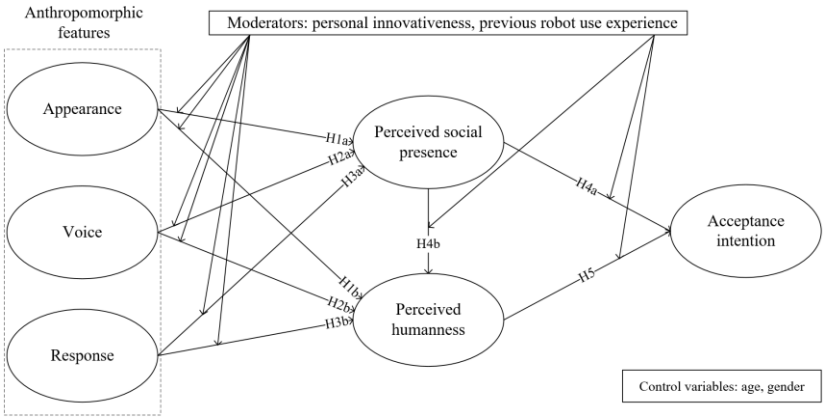

Figure 1. The proposed research model.

4 Planned Research Method

An experiment is planned to collect empirical data via an online survey. The potential research participants will be the customers of the hospitality industry. The hospitality industry has become interesting in applying social robots in services because of the Covid-19 pandemic and the advantages of minimizing human contact. There is a necessity of knowing whether customers would like to accept social robots in hospitality service for hotel managers.

A hotel that plans to deploy service robots in business will help with empirical data collection among its current customers via sending an email invitation to their current customers. We plan to collect about 300 responses. The online survey includes three parts: i) informed consent, which informs respondents of the research objectives, the voluntariness of participation, the confidentiality of the collected data, and the researchers' contact information. The research participants will proceed to complete the online survey only after they have agreed and signed the consent form electronically; ii) a video will be presented to show the research participants how social robots provide services to customers in a hotel, such as a check-in, guidance, room delivery, and communication. The social robots shown in the video

will be human-like in voice and in appearance; iii) questions about user demographic information, personal innovativeness, prior social robot use experience in another service setting, and user perceptions and behavior regarding social robots in hotel service. The research participants will answer a couple of questions (attention check) about the robotic services shown in the video to decide whether the research participants are qualified to continue to answer the questionnaire. Only those who have passed the attention check questions will move to complete the questionnaire. Each respondent who completes the online survey will receive an incentive for their participation. The collected data will be analyzed based on structural equation modeling via the software Smart PLS 3.0.

The constructs in the research model are assessed based on the construct items in prior literature. Measurement items of the constructs response, voice, and appearance are developed based on the study of Bührke et al. (2021). The measurement items for perceived social presence are adapted from the work of Gefen and Straub (1997). The items of perceived humanness and acceptance intention are taken from the works of Holtgraves and Han (2007) and Davis (1989), respectively.

5 Expected Contributions

This study will provide theoretical contributions to social robot acceptance research. First, the findings in this study could potentially enrich the social robot acceptance literature by applying the social response theory to explain how the anthropomorphic features (e.g., appearance, voice, and response) of social robots as visual, auditory, and verbal cues induce users' human-oriented responses, such as perceived social presence and humanness, which in turn predict users' intention to accept social robots. Second, this study could provide explanations for the different perceptions and behavior among different user groups via the moderating test of users' innovativeness and prior use experience of any social robots. These findings could also potentially advance the human-robot interaction research by examining the role of anthropomorphic design in inducing individuals' different perceptions and responses toward social robots.

This study may also offer practical implications. First, the findings on the effects of anthropomorphic features on perceived social response and humanness could offer social robot designers suggestions on how to design and develop social robots' anthropomorphic features, specifically the appearance, voice, and response of social robots as visual, auditory, and verbal cues, to induce user perceptions of the social presence and humanness of social robots, which may arouse user acceptance intention. Second, the findings on the moderating effect of users' prior use experience of any social robot in other service contexts might provide hotel managers practical guidelines on the trial of social robots in hotel service to facilitate customers and encourage customers to try social robots, which might trigger their acceptance of social robots in hotel service.

6 Limitations

This study has its limitations which should be acknowledged. First, the data collection is planned to be implemented only in the hotel industry. Future research could consider collecting empirical data in different service industries to increase the generalizability of the research findings. Second, social robots are developed with different anthropomorphic features for different service contexts. In this study, only the appearance, voice, and response features of social robots are considered; future research could consider other factors related to the anthropomorphism of social robots. Lastly, this study mainly examines the effects of anthropomorphic features on social response and humanness from the social response view. Other theories could be considered in future research to extend the investigation of social robot acceptance.

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