Service robots and hotel guests’ perceptions: anthropomorphism and stereotypes

Xiaoxiao Song, Yunpeng Li, Xi Yu Leung and Dong Mei

Abstract
Purpose — Drawing on anthropomorphism and the stereotype content model, this study aims to explore the impacts of robot anthropomorphism on hotel guests’ word of mouth and continuous usage intention through perceived warmth and competence. This study also investigates the moderating effects of guests’ expertise.
Design/methodology/approach — A total of 524 valid data was collected with Chinese hotel guest through an online survey. Data were analyzed by using structural equation modeling.
Findings — The results indicate that robot anthropomorphism positively affects perceived warmth and competence. Perceived warmth positively affects guests’ word of mouth and continuous usage intention, while perceived competence only positively influences guests’ continuous usage intention. The findings further show that guest expertise weakens the positive relationship between robot anthropomorphism and perceived warmth and competence.
Originality/value — This study advances robot service literature by integrating the stereotype content model with robot anthropomorphism in exploring hotel guests’ perceptions on service robots. This study also discovers the vital boundary role of guest characteristics in human-robot interaction. This study provides valuable information for hoteliers to design and adopt better robots for optimal guest experiences.
Keywords — Stereotype content model, Robot anthropomorphism, Warmth, Competence, Guest expertise

Robots de servicio y percepciones de los clientes de hotel: antropomorfismo y estereotipos

Resumen
Diseño/metodología/enfoque: Se recopiló datos válidos de un total de 524 clientes de hoteles chinos mediante una encuesta en línea. Los datos fueron analizados mediante un modelo de ecuaciones estructurales.
Objetivo: Basándose en el antropomorfismo y en el modelo de contenido estereotipado, este estudio explora el impacto del antropomorfismo de los robots en el boca a boca de los clientes del hotel y en la

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intención de uso continuado a través de la calidez y la competencia percibidas. El estudio investiga también los efectos moderadores de la experiencia de los huéspedes.

**Conclusiones:** Los resultados indican que el antropomorfismo del robot afecta positivamente a la calidez y a la competencia percibidas. La calidez percibida influye positivamente en el boca a boca y en la intención de uso continuado de los huéspedes, mientras que la competencia percibida sólo influye positivamente en la intención de uso continuado de los huéspedes. Los resultados muestran, además, que la experiencia del cliente debilita la relación positiva entre el antropomorfismo del robot y la percepción de calidez y de competencia.

**Originalidad/valor:** Este estudio supone un avance en la literatura sobre robots de servicio al integrar el modelo de contenido estereotipado con el antropomorfismo de los robots, en la exploración de las percepciones de los huéspedes de hoteles sobre los robots de servicio. Este estudio también muestra el papel vital que desempeñan las características de los huéspedes en la interacción humano-robot. El estudio proporciona información valiosa para que los hoteleros diseñen y adopten mejores robots para ofrecer experiencias óptimas a los huéspedes.

**Palabras clave** Modelo de contenido estereotipado, Antropomorfismo del robot, Calidez, Competencia, Experiencia del huésped

**Tipo de papel** Trabajo de investigación

### 1. Introduction

A growing number of service sectors have applied robots and artificial intelligence (AI) technologies to serve guests, ranging from health care to hospitality and tourism. In particular, the outbreak of the coronavirus disease 2019 pandemic has made the hotel industry realize the importance of contactless services (Li et al., 2021b; Zhong et al., 2022). Major hotel chains such as Marriott and Hilton have introduced AI-based technologies such as service robots to attract guests and enhance service quality (Parsons, 2022). An industry report forecasted that the global market for hotel robots would increase from $79m in 2020 to $338m by 2025, at a compound annual growth rate of 32.8% (Allen, 2022).

Studies have revealed a range of factors influencing guests’ adoption of service robots (Goel et al., 2022). Among these factors, anthropomorphism, which is the assignment of human traits or actions to nonhuman objects, can be regarded as a decisive force (Bartneck et al., 2009). The anthropomorphic characteristics of robots are an important consideration for guests in evaluating robotic services and are increasingly used in frontline services such as hospitality and tourism (Lv et al., 2023; Yin et al., 2023). Hotel services are characterized by intensive interpersonal interactions, therefore, guests’ responses to robot anthropomorphism are vital when the anthropomorphic robot interacts directly with guests as the employee, notably in achieving unique service experiences in the hotel industry (Tung and Law, 2017).

However, prior research has produced contradictory findings about guests’ responses to robot anthropomorphism. Several studies support the positive effect of robot anthropomorphism on guests’ responses (Ladeira et al., 2023), whereas some studies reveal that robot anthropomorphism may lead to negative responses from guests (Yu, 2020) or guests’ responses may be unaffected by anthropomorphism (Pozharliev et al., 2021). Therefore, the link between robot anthropomorphism and guests’ responses remains unclear. Furthermore, related research has mostly focused on how robot anthropomorphism affects guests’ cognitive responses such as usage intention (Yang et al., 2022), whereas empirical studies on their affective responses, such as word of mouth (Lu et al., 2021), are still lacking. Therefore, we examine how robot anthropomorphism affects guests’ word of mouth and continuous usage intention.

Anthropomorphism shapes how guests think about and understand nonhuman entities by activating characteristics and expectations typically attributed only to humans (Yang et al., 2020), which suggests that customers may adopt similar social cues, stereotypes and habitual inferences to perceive and evaluate anthropomorphic robots (Liu et al., 2022). Accordingly, when nonhuman entities are seen as having humanlike facial features or
mental capacities, traits fundamental to person perception (e.g. warmth, competence) can be applied to nonhuman entities (Yang et al., 2020), such as service robots. Although several studies have explored the relationship between robot anthropomorphism and perceived warmth and competence, the findings are mixed. Thus, guests’ warmth and competence perceptions in relation to emergent (e.g. anthropomorphic robots) service technologies are not well understood.

Furthermore, warmth and competence as the universal dimensions of the stereotype content model can help explain guests’ responses to robot anthropomorphism (Yoganathan et al., 2021). Čačić et al. (2019) have emphasized the importance of taking into account the universal stereotype content of warmth and competence in human–robot interactions because these two aspects are connected to users’ affective and cognitive evaluations of robots. Therefore, this study investigates the effect of robot anthropomorphism on guests’ word of mouth and continuous usage intention through perceived warmth and competence.

To fill the existing research gaps, this study aimed to explore the underlying mechanism of how robot anthropomorphism influences hotel guests’ responses. Drawing on anthropomorphism and the stereotype content model, the study examines the impacts of robot anthropomorphism on guests’ word of mouth and continuous usage intention through perceived warmth and competence. We also take into account the role that guest traits play in this regard. Specifically, guests’ expertise on robots may affect their perceptions to robot anthropomorphism. Guests’ prior knowledge is usually considered to be an indispensable means of market segmentation (Hong and Sternthal, 2010). Thus, we test the moderating role of guest expertise in the relationship between robot anthropomorphism and perceived warmth, and between robot anthropomorphism and perceived competence.

2. Theoretical background and hypotheses development

2.1 Robot anthropomorphism

With the development of advanced technology, more sophisticated technologies such as robots and other automation technologies have been gradually introduced into hospitality and tourism services (Buhalis, 2020; Leung, 2020). Robot design is particularly critical for service robots and human–robot interaction. Different from traditional service technologies, anthropomorphic robots have more humanized interactive attributes, which are considered to be the key factors affecting human–robot interaction (Murphy et al., 2019; Yoganathan et al., 2021).

Currently, the evolution of humanlike robots has taken the robot service to a higher level, and robot anthropomorphism has become a cutting-edge concept (Yu and Ngan, 2019). Anthropomorphism refers to “the tendency to attribute human characteristics to inanimate objects, animals and others with a view to helping us rationalize their actions” (Duffy, 2003) (p. 180). Anthropomorphism is when nonhuman agents, such as animals and robots, are given human physical traits (such as appearance) or mental states (such as emotions) (Bartneck et al., 2009; Epley et al., 2007). This study emphasizes the subjective feelings of guests, that is, the degree to which guests regard service robots as humanlike, which is consistent with Blut et al.’s (2021) interpretation of anthropomorphism.

Numerous studies have examined guests’ attitudes and reactions toward anthropomorphic robots in hotel service encounters. Some studies have examined the direct effect of robot anthropomorphism on guest responses such as adoption intentions (Pillai and Sivathanu, 2020); however, the underlying influencing mechanisms have not been considered. In addition, the results of existing studies on the effect of robot anthropomorphism are inconsistent. Some researchers suggested that robot anthropomorphism positively affects guests’ hospitality experience (Qiu et al., 2020), attitudes toward service robots (Lin and Mattila, 2021) and value (Zhong et al., 2022), while other studies revealed that robot
anthropomorphism may lead to negative service outcomes or guest responses (Hu and Min, 2023). The uncanny valley theory is frequently used in this stream of literature to explain the detrimental impacts as the high degree of humanlikeness of robots may lead to threats to human identity, psychological discomfort or eeriness (Lu et al., 2019; Yu, 2020). Additionally, some research showed non-significant relationships between robot anthropomorphism and guests’ perceptions and responses (Wang et al., 2021). This insignificant relationship can be explained from the perspective of empathy, that is, because service robots lack the ability to express emotions, guests cannot get emotional feedback or task performance simply through the external anthropomorphic features of service robots (Gursoy et al., 2019; Wang et al., 2021). Therefore, the relationship between robot anthropomorphism and guests’ perceptions and responses remains unclear.

Furthermore, some studies have explored the influencing mechanisms of robot anthropomorphism on guests’ responses. Along these lines, there is growing academic interest in the important role of the stereotype content model (i.e. warmth and competence) in human–robot interaction. Individuals use basic features of human perception, such as warmth and competence, to generate impressions of nonhuman objects when they are believed to have humanlike psychological skills (Yang et al., 2020; Zhou et al., 2019). Thus, guests understand anthropomorphic robots by perceiving them in a similar way to humans. However, existing research has different views on guests’ perceptions of warmth and competence toward robot anthropomorphism. For instance, Zhu and Chang (2020) showed that robotic chef anthropomorphism positively affects warmth, but the effect on competence is not significant. Furthermore, robotic chef anthropomorphism positively influences food quality prediction through the sequential mediating effects of warmth and competence (Zhu and Chang, 2020). However, robotic chefs work in the kitchen without face-to-face interaction with guests. Therefore, it is necessary to examine robot anthropomorphism and its impact on guests’ responses through warmth and competence in human–robot interaction.

2.2 Stereotype content model

The stereotype content model focuses on the relatively fixed ideas or expectations that people have about other individuals or groups (Fiske et al., 2002; Li et al., 2021a). Warmth and competence are the two universal aspects of the stereotype content model (Fiske et al., 2002, 2007). The warmth dimension reflects attributes associated with perceived intention, such as friendliness, sincerity, helpfulness, morality and trustworthiness, while the competence component shows characteristics connected with perceived ability, including skill, efficacy, intelligence and creativity (Gray et al., 2007). For example, nonverbal cues of a robot, such as smiling, can make it warmer (Yu and Ngan, 2019). Similarly, the male robot voice could make users perceive the robot as knowledgeable (Powers and Kiesler, 2006).

In this study, the warmth dimension includes being sociable, warm, friendly and caring, and the competence dimension includes being motivated, intelligent, energetic and organized (Judd et al., 2005).

Individuals attribute minds to infer other people’s personalities, abilities and intentions. Research has demonstrated the important role of warmth and competence perceptions in human-to-human service interactions (Li et al., 2021a). Along with and expanding this literature, scholars have examined the important role of mind perceptions in various nonhuman contexts, such as brands and products. For example, Ivens et al. (2015) illustrated that warmth and competence perceptions are influential in shaping consumers’ responses toward brands. Furthermore, van Doorn et al.’s (2017) conceptual research proposed that perceived warmth and competence could explain customers’ responses to automated social presence (e.g. service robots). Therefore, it is necessary to conduct empirical research to specify the role of perceived warmth and competence in human–robot interactions.
Previous research has suggested that how people react to anthropomorphic robots is determined not only by their functional ability but also by their social capability (Wirtz et al., 2018). That is, people will be more likely to apply their fundamental perceptions – warmth and competence – to a robot when the robot is imbued with humanlike characteristics, and these perceptions will further shape their responses. For example, Yoganathan et al. (2021) showed that robot anthropomorphism positively affects guests’ perceived warmth and competence, and indirectly enhances expected service quality via warmth and competence. Therefore, as anthropomorphism induces people to perceive nonhuman entities like humans, the universal dimensions of social cognition – warmth and competence – offer a theoretical framework for explaining the effect of robot anthropomorphism on guests’ responses.

Previous studies have shown that robot anthropomorphism can increase the perceived warmth of guests (Kim et al., 2019; Yoganathan et al., 2021). For example, guests’ warmth perception of the robotic chef is positively influenced by anthropomorphism (Zhu and Chang, 2020). The human likeness of robots positively affects guests’ perceived affinity (Belanche et al., 2021a). Warmth is more strongly connected with humanoid service robots than nonhumanoid ones (Choi et al., 2021). In terms of perceived competence, due to humanlike characteristics, guests tend to perceive that the anthropomorphic robot is more intelligent and capable. For example, humanlike AI-related technologies could elicit higher competence perception (Sun et al., 2023). Consequently, a high degree of robot anthropomorphism not only increases warmth perception, but also competence perception (Yoganathan et al., 2021). Based on the arguments presented above, the following hypotheses are proposed:

**H1.** Robot anthropomorphism positively influences guests’ perceived warmth.

**H2.** Robot anthropomorphism positively influences guests’ perceived competence.

Existing research has provided evidence that individuals’ perceptions of the warmth and competence of robot anthropomorphism further shape their responses. Perceived warmth, which indicates that a service robot sociable, friendly and trustworthy, is a crucial construct in human–robot interaction. The positive effects of a robot’s humanlike voice on word of mouth and revisit intention can be explained by positive emotion (Lu et al., 2021). Similarly, customers are more willing to accept humanoid service robots because they build and increase trust in robots through robots’ humanlike characteristics (van Pinxteren et al., 2019). The perceived warmth of anthropomorphic robots will make the guest feel that the robot truly cares about its guests, which can trigger guests’ positive evaluations. Research has showed that guests’ warmth perception of a humanlike robot has a greater effect on attitude and subjective norm than that of the mechanical robot (Picarra and Giger, 2018). Perceived warmth is positively correlated with guests’ emotional value (Belanche et al., 2021b). Higher warmth perceptions help users form better attitudes toward AI musicians (Sun et al., 2023). Accordingly, a service robot that looks warm could increase guests’ positive responses such as willingness to continue using the hotel robot services and actively recommend it to others. Therefore, we propose the following hypotheses:

**H3.** Perceived warmth positively influences guests’ word of mouth.

**H4.** Perceived warmth positively influences guests’ continuous usage intention.

As anthropomorphic robots are imbued with human characteristics, warmth and competence can be used to explain guests’ responses to robots such as satisfaction, repatronage and loyalty (van Doorn et al., 2017; Caić et al., 2019). Humanlike AI-related technologies could generate higher competence perceptions, and competence further facilitate users’ positive attitudes toward AI (Sun et al., 2023). Likewise, a competent robot makes customers perceive more reliable and relaxed, thus leading to more favorable responses from guests. For example, perceived competence positively affects guests’ functional, emotional and monetary value (Belanche et al., 2021b). Robotic competency can
positively impact the epistemic, hedonic and aesthetic values of guests' experience (Wu et al., 2021). Perceived competence has a positive impact on guests' food quality prediction of robotic chefs (Zhu and Chang, 2020). Therefore, the following hypothesis is proposed:

**H5.** Perceived competence positively influences guests' word of mouth.

**H6.** Perceived competence positively influences guests' continuous usage intention.

### 2.3 Moderating role of guest expertise

Technology expertise is “the amount of knowledge with regard to a particular (self-service) technology acquired through experience or training” (Reinders et al., 2015) (p.192). A significant factor influencing the application of automation and AI in the hotel and tourism industries is human knowledge (Jabeen et al., 2021). Epley et al. (2007) pointed out that one of the most vital antecedents of anthropomorphism is individuals’ elicited agent knowledge. Humans’ preconceptions, knowledge and previous experience with a robot (or similar robots) have significant impacts on their perception of robots (Fong et al., 2003).

Goekle et al. (2016) showed that user expertise has a positive effect on technology perceptions and use. However, while guests actively pursue expertise in hedonic domains, such pursuits may have hedonic costs. Developing expertise in the hedonic domains typically predicts that guests will become more emotionally numb, and this numbness can be explained by cognitive structures developed and applied by experts within a domain (Rocklage et al., 2021). Similarly, the hotel robot service has certain hedonic attributes, and when guests have a higher level of expertise about robots, their positive perceptions and responses may become less intense. Additionally, with the rapid spread of information, guests' related knowledge about technology is increasing, making it more difficult for guests to have positive perceptions of robots. Loureiro et al. (2021) demonstrated that higher technology expertise weakens the relationship between guests' perceived value and relationship quality. Therefore, we predict that guest expertise may moderate the relationship between robot anthropomorphism and guests’ perceptions and responses to robots. Based on the discussion, we propose the following hypotheses. Figure 1 depicts the research model:

**Figure 1** The research model

![The research model](image_url)
H7. Guest expertise weakens the impact of robot anthropomorphism on perceived warmth.

H8. Guest expertise weakens the impact of robot anthropomorphism on perceived competence.

3. Method

3.1 Survey design

The study collected data online via Wenjuanxing (www.sojump.com) in China between December 2021 and January 2022. A screening question was used to ensure that the respondents had previously encountered robot services at hotels. A total of 600 questionnaires were distributed and 524 valid questionnaires were analyzed after screening out 76 incomplete or low-quality responses.

Of the 524 participants, 246 (46.9%) were male, and 278 (53.1%) were female. Most of the participants were under 25 years of age (42.7%), followed by 25–34 years of age (37.4%) and above 34 years old (19.9%). This demographic profile is consistent with general hotel guests who use robot services because this age group is the most dominant and influential user of travel and technology (Chen et al., 2022). The majority of respondents had an undergraduate degree (41.2%) or graduate-level degree (37.2%), indicating a high level of education overall. In terms of monthly income, 32.4% earned Chinese Yuan (CNY) 6,000 or more and 26.9% earned CNY 3,001–6,000, indicating a middle-to-high economic position.

3.2 Measures

The measurement items used in this study were adapted from existing research (Table 1). Robot anthropomorphism was measured using five items adapted from Bartneck et al.’s (2009) study. Perceived warmth and competence were both assessed using four items based on Judd et al.’s (2005) study. The four items measuring word of mouth were based on Kong et al.’s (2019) study. Continuous usage intention was measured using three items adapted from the work of Bhattachjee (2001) and Liu et al. (2015). Guest expertise was measured using four items based on the research of Mitchell and Dacin (1996) and that of Flynn and Goldsmith (1999). All items were rated using a five-point Likert scale (1 = strongly disagree and 5 = strongly agree).

The important role of an individual’s sociodemographic characteristics (e.g. gender and age) in the human–robot interaction has been demonstrated by researchers (Ivanov et al., 2018; Law et al., 2021). Therefore, this study added three sociodemographic variables (gender, age and income) as control variables.

3.3 Data analysis

Before conducting data analysis, we performed Harman’s single-factor analysis to test common method bias. The results showed that the variance contribution of the first factor was 32.63%, which is less than the recommended threshold of 50%. Therefore, common method bias was not a problem in this study.

IBM SPSS Statistics 21.0 was used to analyze the descriptive information of respondents. Partial least squares-structural equation modeling (PLS-SEM) was used to examine the measurement model and structural model via SmartPLS 3.3.9. As one of the mainstream research methods, PLS-SEM has been widely used in hospitality and tourism research (Ali et al., 2018; Becker et al., 2022). Additionally, PLS-SEM is applicable to our study because the current study includes multiple constructs and is an extension and test of existing theories (Hair et al., 2019). We used a three-step PLS-SEM process to validate the model. First, the measurement model was evaluated for construct loadings, reliability and validity.
Table 1 Descriptive statistics, factor loadings and reliability (N = 524)

<table>
<thead>
<tr>
<th>Constructs/Items</th>
<th>Mean</th>
<th>SD</th>
<th>Factor loading</th>
<th>Cronbach’s alpha</th>
<th>Composite reliability</th>
<th>rho_A</th>
<th>Averaged variance extraction</th>
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<tbody>
<tr>
<td><strong>Robot anthropomorphism</strong></td>
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<td>I think the hotel robot is:</td>
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<tr>
<td>Fake vs natural</td>
<td>3.479</td>
<td>1.158</td>
<td>0.829</td>
<td>0.865</td>
<td>0.902</td>
<td>0.872</td>
<td>0.649</td>
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<tr>
<td>Machine-like vs human-like</td>
<td>3.502</td>
<td>1.161</td>
<td>0.813</td>
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<tr>
<td>Unconscious vs conscious</td>
<td>3.162</td>
<td>1.216</td>
<td>0.783</td>
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<tr>
<td>Artificial vs lifelike</td>
<td>2.998</td>
<td>1.202</td>
<td>0.772</td>
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<tr>
<td>Moving rigidly vs moving elegantly</td>
<td>3.429</td>
<td>1.146</td>
<td>0.831</td>
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<tr>
<td><strong>Perceived warmth</strong></td>
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<td>I think the hotel robot is sociable</td>
<td>3.622</td>
<td>0.959</td>
<td>0.812</td>
<td>0.859</td>
<td>0.904</td>
<td>0.861</td>
<td>0.702</td>
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<tr>
<td>I think the hotel robot is warm</td>
<td>3.607</td>
<td>0.981</td>
<td>0.844</td>
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<td>I think the hotel robot is friendly</td>
<td>3.719</td>
<td>0.932</td>
<td>0.854</td>
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<tr>
<td>I think the hotel robot is caring</td>
<td>3.481</td>
<td>0.996</td>
<td>0.840</td>
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<td><strong>Perceived competence</strong></td>
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<tr>
<td>I think the hotel robot is motivated</td>
<td>3.618</td>
<td>1.010</td>
<td>0.708</td>
<td>0.845</td>
<td>0.896</td>
<td>0.860</td>
<td>0.684</td>
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<tr>
<td>I think the hotel robot is intelligent</td>
<td>3.773</td>
<td>0.960</td>
<td>0.862</td>
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<td>I think the hotel robot is energetic</td>
<td>3.716</td>
<td>0.986</td>
<td>0.877</td>
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<td>I think the hotel robot is organized</td>
<td>3.740</td>
<td>0.959</td>
<td>0.850</td>
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<tr>
<td><strong>Word of mouth</strong></td>
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<td>I would tell others positive things about hotel robots</td>
<td>3.550</td>
<td>0.792</td>
<td>0.762</td>
<td>0.773</td>
<td>0.854</td>
<td>0.785</td>
<td>0.595</td>
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<td>I would provide others with information on hotel robots</td>
<td>3.384</td>
<td>0.797</td>
<td>0.820</td>
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<tr>
<td>I am likely to recommend hotel robots to my friends or others</td>
<td>3.609</td>
<td>0.758</td>
<td>0.804</td>
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<tr>
<td>I am likely to encourage others to consider using hotel robots</td>
<td>3.252</td>
<td>0.862</td>
<td>0.694</td>
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<td><strong>Continuous usage intention</strong></td>
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<tr>
<td>I plan to continue using hotel robots in the future</td>
<td>3.502</td>
<td>0.873</td>
<td>0.882</td>
<td>0.840</td>
<td>0.903</td>
<td>0.845</td>
<td>0.757</td>
</tr>
<tr>
<td>I intend to continue using hotel robots</td>
<td>3.569</td>
<td>0.873</td>
<td>0.876</td>
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<tr>
<td>I predict that I will continue using hotel robots</td>
<td>3.422</td>
<td>0.866</td>
<td>0.853</td>
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<tr>
<td><strong>Guest expertise</strong></td>
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<tr>
<td>I am very familiar with robot technologies</td>
<td>4.027</td>
<td>0.915</td>
<td>0.891</td>
<td>0.830</td>
<td>0.887</td>
<td>0.851</td>
<td>0.663</td>
</tr>
<tr>
<td>I have a clear idea about which characteristics of robot technologies are important in providing me maximum usage satisfaction</td>
<td>3.912</td>
<td>0.962</td>
<td>0.797</td>
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<tr>
<td>I know a lot about robot technologies</td>
<td>3.990</td>
<td>1.043</td>
<td>0.825</td>
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<tr>
<td>I am an expert on robot technologies in my circle of friends</td>
<td>4.105</td>
<td>0.916</td>
<td>0.736</td>
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</table>

**Source:** Table by authors
Second, we tested the structural model with the significance of the path coefficients. Third, the moderating effect of guest expertise was examined.

### 4. Results

#### 4.1 Measurement model

To test the measurement model, the assessment of indicator reliability, internal consistency reliability, convergent validity and discriminant validity were performed. First, the factor loadings ranged from 0.694 to 0.891, confirming adequate indicator reliability. We keep the indicator with a loading of 0.694 because removing the indicator does not significantly increase the composite reliability (Hair et al., 2016). Second, Dijkstra–Henseler’s rho (pA), Cronbach’s alpha and composite reliability (CR) were used to evaluate internal consistency reliability. As shown in Table 1, the values of Cronbach’s alpha ranged from 0.773 to 0.865, and the values of CR ranged from 0.854 to 0.904, which suggested that the constructs have good reliability. Dijkstra–Henseler’s rho (pA) is a more accurate measure of construct reliability that lies between Cronbach’s alpha and CR (Hair et al., 2019). As depicted in Table 1, the values of rho (pA) ranged from 0.785 to 0.872, indicating good internal consistency reliability. Third, the values of average variance extracted for all constructs ranged from 0.595 to 0.757, exceeding 0.5 (Fornell and Larcker, 1981), which indicated good convergent validity. Fourth, the discriminant validity of the measurement scale was evaluated by Fornell–Larcker criterion and heterotrait–monotrait (HTMT) ratio. As shown in Table 2, the square root of average variance extracted values for all constructs were larger than the correlations between the constructs, which confirmed adequate discriminant validity. The HTMT values were all lower than the rigorous threshold of 0.85 (Henseler et al., 2015), which further confirmed the acceptable discriminant validity.

#### 4.2 Structural model

Before analyzing the structural model, collinearity was checked by examining whether the values of variance inflation factors were lower than 10 (O’Brien, 2007). Multicollinearity was not a problem in our research, as shown by the VIF values, which ranged from 1.015 to 2.133. Then, we assessed the structural model and tested the significance of the path coefficients by running a bootstrapping procedure with 5,000 samples (Hair et al., 2011). As shown in Figure 2, robot anthropomorphism was positively associated with perceived warmth (β = 0.467, p < 0.001) and perceived competence (β = 0.476, p < 0.001), supporting H1 and H2. Perceived warmth was also significantly related to guests’ word of mouth (β = 0.371, p < 0.001) and guests’ continuous usage intention (β = 0.192, p < 0.01). Thus, H3 and H4 were supported. Perceived competence was positively associated with guests’ continuous usage intention (β = 0.195, p < 0.01), supporting H6. However, perceived competence was not significantly associated with guests’ word of mouth (β = 0.087, p > 0.05), rejecting H5. Gender, age and income were added in the model as control variables. The results showed that the effects of the three control variables on guests’ continuous usage intention were insignificant.

Moreover, we reported the $R^2$ values to assess the model’s in-sample explanatory power. The $R^2$ values of the endogenous constructs in this study ranged from 0.130 to 0.281, representing moderate to strong effects according to Cohen’s (1988) guidelines. We also assessed the relative impact of a certain predictor construct on the $R^2$ value by reporting the $f^2$ effect size. The $f^2$ effect sizes for the supported hypotheses ranged from 0.020 to 0.309, indicating small to medium effects (Hair et al., 2016).

#### 4.3 Moderating effect of guest expertise

The PLS-SEM results demonstrated that guest expertise was positively related to perceived warmth (β = 0.122, p < 0.01) and perceived competence (β = 0.134, p < 0.01). The
interaction effect between guest expertise and robot anthropomorphism on perceived warmth was significant and negative ($\beta = -0.126$, $p < 0.01$), supporting $H7$. The interaction terms of guest expertise and robot anthropomorphism also had a significant and negative effect on perceived competence ($\beta = -0.120$, $p < 0.01$). Therefore, $H8$ was supported. Specifically, when the level of guest expertise is low, the positive effect of robot anthropomorphism is obvious, but with the improvement of guest expertise, the positive impact of robot anthropomorphism gradually decreases. This suggests that there is an obvious substitution relationship between guest expertise and robot anthropomorphism in guests’ warmth and competence perception.

To investigate the interaction term further, we conducted a simple slope analysis. As shown in Figure 3 and 4, for low guest expertise ($-1$ SD), the positive linkage between robot anthropomorphism and perceived warmth is stronger than for high-level expertise ($+1$ SD). Similarly, the positive link between robot anthropomorphism and perceived competence is also stronger for low guest expertise than for high-level expertise.
5. Discussion and implications

5.1 Discussion

Drawing on anthropomorphism and the stereotype content model, this study examines the impacts of robot anthropomorphism on guests’ word of mouth and continuous usage intention through perceived warmth and competence. The moderating role of guest expertise is also identified in the study. Data were collected from China to test the proposed framework.

First, the findings indicate that robot anthropomorphism is positively related to guests’ perceived warmth. The finding is consistent with prior studies suggesting that warmth perception is linked to anthropomorphism (Yoganathan et al., 2021; Zhu and Chang, 2020). Furthermore, perceived warmth positively influences guests’ word of mouth and continuous usage intention. This result provides empirical evidence supporting the view that warmth is one of the central dimensions for predicting guests’ emotions and behaviors (Belanche et al., 2021a; Choi et al., 2021).
Second, the results show that robot anthropomorphism positively affects competence perception, which is in line with previous studies supporting the positive effect of anthropomorphism (Sun et al., 2023). Moreover, perceived competence could positively influence guests’ intention to continuously use robots. However, the effect of perceived competence on guests’ word of mouth is insignificant. The fact that hotels are using robots to replace some of their staff suggests that robots must have the capabilities to help guests solve problems. However, due to the level of intelligent technology, the capability of service robots at this stage may not fully meet guests’ expectations (Belanche et al., 2020), and this sense of disparity makes it more difficult for guests to give positive word of mouth based on their competence perception of robots.

Third, this study reveals that guest expertise weakens the positive effect of robot anthropomorphism on perceived warmth and competence. This result could be explained by the possibility that guests with limited technological expertise may more readily develop emotional bonds with the AI technology (Loureiro et al., 2021). People tend to use their knowledge to estimate the knowledge of others (Powers et al., 2005). Therefore, knowledgeable guests assume a robot should be knowledgeable and have higher expectations for the performance of robots. Consequently, when the performance of the robot meets the guests’ expectations, it can satisfy their needs. However, when it does not, it can lead to disappointment (Young et al., 2009). We posit that individuals with lower levels of guest expertise have lower expectations for robot services, which will make it easier for them to achieve psychological identity and produce more positive perceptions.

5.2 Theoretical implications

First, this study responds to growing calls for understanding the impacts of using anthropomorphic robots by examining the positive effects of robot anthropomorphism on guests’ perceptions and responses in the hotel industry. Despite numerous studies focusing on anthropomorphism (Blut et al., 2021; Kim and Im, 2023), existing research is inconclusive in terms of the impact of robot anthropomorphism. This study provides evidence on the critical role that robot anthropomorphism plays in hospitality services, acknowledging its value in guest service. The findings of this study corroborate and enrich the stream of literature that highlights the positive effects of robot anthropomorphism on guests’ attitudes, perceptions and responses (Ladeira et al., 2023).

Second, this study advances service robot literature and the stereotype content model by exploring the effect of robot anthropomorphism on guests’ word of mouth and continuous usage intention through perceived warmth and competence. Previous literature has shown that warmth and competence can help explain guests’ responses to robot anthropomorphism (Zhu and Chang, 2020; Yoganathan et al., 2021). Based on anthropomorphism and the stereotype content model, this study deepens the understanding of the impact of anthropomorphism on guests’ responses by discovering the underlying mechanism of warmth and competence. Moreover, the current study provides empirical support for the applicability of the stereotype content model to service robots in contexts of hospitality service.

Finally, this study discovers the vital boundary role of guest characteristics in human–robot interaction. Many studies have highlighted the essential role of guest characteristics in determining technology perceptions or usage (Chen et al., 2022; Jabeen et al., 2021). The results indicate that higher levels of guest expertise do not always lead to positive results. This study echoes Shi et al.’s (2021) call for future research to examine the moderating effects of possible factors, such as expertise, to enhance our knowledge of the boundary conditions that influence guests’ perceptions in human–robot interaction.

5.3 Managerial implications

The present research offers several managerial implications. First, the findings of this study suggest that hotel and tourism managers should pay attention to the anthropomorphic
features of robots and introduce robots with more anthropomorphic characteristics. The anthropomorphic features of robots have many aspects, including voice traits (Chang et al., 2018), language style (Choi et al., 2019), physical appearance (Stroessner and Benitez, 2019), among other features. Managers could implement humanlike robots because this study shows that robot anthropomorphism is the enabler of positive guest perceptions and responses. For example, managers can use robots with the voice feature to confer liveliness. Hotels in different regions can incorporate local specialties and use robots in local dialects to accentuate regional tourism and tailor to cultural features.

Second, warmth should be considered a crucial element because our findings demonstrate that perceived warmth is significantly affected by robot anthropomorphism and can further influence guests’ word of mouth and continuous usage intention. The essence of the hotel and tourism sector is delivering extraordinary and memorable guest experiences (Rahimian et al., 2020; Ritchie et al., 2011). Therefore, the hospitality and tourism sector cannot ignore the entertainment attributes of robots. For instance, robots can be designed with anthropomorphic features such as smiling faces and having names to increase guests’ familiarity and interaction with them.

Third, with more media coverage and the rapid spread of information, guests’ related knowledge about robots is increasing, making it more difficult for them to perceive the warmth and competence of highly anthropomorphic robots. Based on this finding, we recommend that hotels and tourism companies provide personal services for individuals with expertise. For example, hotels can introduce service robots with both high and low anthropomorphic characteristics, and customers can choose the robot that suits their needs and preferences.

5.4 Research limitations and future research

The study has several limitations. First, the results obtained by questionnaires might not be generalizable to real hotel and tourism robot service scenarios. Future studies could conduct both laboratory and field experiments or mixed methods to test the proposed framework. Second, the study focuses on a Chinese sample; it is recommended that future studies use samples from other countries or multiple countries to ensure the robustness of the results. Third, this study did not delineate different levels of robot anthropomorphism. Future research could manipulate and examine the impact of different levels of anthropomorphism on guest responses. Fourth, this study only identifies the effects of warmth and competence in the mechanism. Future research might consider other interesting mechanisms such as trust, rapport and human identity threat. Finally, the specific needs and desires of Generation Z customers may differ from those of higher age groups; we encourage future research to compare generational differences in robot adoption.

References


**About the authors**

Xiaoxiao Song is a PhD candidate at the College of Business Administration at the Capital University of Economics and Business, Beijing, China. Her research focuses on big data, sharing economy, the interrelation between consumers and new technology and hotel management. Her publications have appeared in journals such as *International Journal of Contemporary Hospitality Management, Journal of Management Studies, Frontiers in Psychology* and *Tourism Tribune*.

Yunpeng Li is a Professor in the College of Business Administration in the Capital University of Economics and Business, Beijing, China. His main research areas include sharing
economy, smart tourism and big data. His publications have appeared in journals such as *Tourism Management, International Journal of Contemporary Hospitality Management, Tourism Review, Journal of Destination Marketing & Management* and several international conferences such as 2015 IEEE First International Conference on Big Data Computing Service and Applications. Yunpeng Li is the corresponding author and can be contacted at: liyunpeng@cueb.edu.cn


Dong Mei is a PhD candidate at the Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, China. His research focuses on new technology applications, food security, green production and consumption and agricultural economic management. His publications have appeared in journals such as *Chinese Journal of Eco-Agriculture, Chinese Journal of Agricultural Resources and Regional Planning and Journal of Agricultural Resources and Environment.*

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