

Exploring Influential Factors in Customer Perception Humanoid Hotel Service Robots: Unravelling the Impact of Robot Gender Appearance, Anthropomorphic Levels, and Customer Gender

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Abstract

Due to various social factors, such as the global labour shortage and the impact of the COVID-19 pandemic, the widespread utilization of service robots in hotels has become a prevalent trend, demanding careful consideration from hotel managers. Given the customer-centric nature of hotels, the integration of customer-approved service robots serves to enhance overall service quality, customer experience, and satisfaction. While prior research has acknowledged the significant impacts of customers' gender, service robots' gender appearance, and their level of personalization on customer perception, the direction of these impacts remains unclear. Therefore, the primary objective of this research article was to systematically examine the factors influencing customer perception of humanoid hotel service robots. The research employed a quantitative methodology, distributing online questionnaires randomly in Los Angeles (United States), Chengdu (China), and Dublin (Ireland). A total of 111 respondents from diverse cultural and age groups participated in the study. The findings indicate that customers exhibit a greater comfort level with service robots possessing a mid-level anthropomorphic appearance. Social engagement is heightened when robots demonstrate autonomous movements that are not entirely consistent with human behaviour. Moreover, a positive customer perception is associated with the female appearance of robots. Gender-specific impacts on customer perception have been duly validated. This study addresses a research gap and reinforces the validity of the Uncanny Valley Theory and warmth perception theory. The results underscore the pivotal roles played by service robots' morphology and sense of life in shaping customer perception. In the design process of robot appearance, thoughtful consideration should be given to incorporating more female characteristics. The insights derived from this research contribute to informed decision-making regarding the development of adaptable service robots within the hospitality industry.

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Chapter 1. Introduction

Substantial changes have occurred in the tourism and hospitality sector by crisis, leading to more commitment and pioneering views regarding innovation. Digital technologies such as Service robots and AI (Artificial intelligence), AR/VR (Augmented reality/Virtual reality), cloud, blockchain, analytics, and automation are becoming increasingly prevalent (Beyries, 2021). These developing digital channels will improve

customer engagement, contactless payments, and health and hygiene in response to the Covid-19 pandemic. As a result of these changes, continuous service innovation has been identified as an essential component of tourism and hospitality sector nowadays. What is more, service Innovation is identified as an essential factor for service enhancement and development that improves customer experience. In this context, global support for service robots in all facets of people's everyday lives is growing and

this trend has been hastened by social factors such as the aging of the population, the global labour shortage, and the emergence of COVID-19 (Goel et al., 2022, Ivanov et al., 2020).

As a result, the extended use of service robots is a prevalent tendency and should be a crucial consideration for hotel managers. Ivanov and Webster (2019) identified the service jobs for which robots are deemed to be more suitable service delivery methods. Then, researchers began to investigate the variables that influence customers' desire to embrace service robots. Individuals' preferences towards service robots will be influenced by a variety of factors, including those related to the robot itself (such as its appearance, gender, level of interaction, etc.), the demographic background of customers (such as age, culture, education, etc.), and the global environment (such as technological progress, the COVID-19 pandemic, etc.). However, although the factors above were estimated to have significant impacts on customer perception of service robots in the prior research, it is still unclear whether these impacts are positive or negative (Shin and Jeong, 2020; Belanche et al., 2021; Zhang et al., 2021; Seo, 2022). Therefore, the primary objective of this article is to investigate and validate the impact of each identified factor on customer perception of hotel service robots. The research question guiding this study is to examine factors that impact customer perception of humanoid hotel service robots.

To facilitate the research process, three specific objectives have been outlined:

RO1: To examine the impact on customer perception of humanoid hotel service robots' gender appearance.

RO2: Discover how the gender of the customer impacts their perception of humanoid service robots.

RO3: Discover how the anthropomorphic level of service robots would impact customer perception.

Chapter 2. Literature Review

2.1. *Service robots*

A service robot is defined as “a robot that performs useful tasks for humans or equipment” by the International Federation of Robotics and can perform customized service tasks independently and without human input (Tung & Law, 2017). Autonomy, which is an essential characteristic that defines the levels and types of jobs a robot can undertake, hence enhancing its capacity to function in complicated environments (Beer, Fisk, & Rogers, 2012), is considered a

crucial factor that differentiates service robots from other technologies.

Currently, most research on service robots is conducted through technical investigation and application. Regarding technological investigation, research has been conducted on the functions, technology, design, and procedures of robots. In the research on the utilization of service robots, on the one hand, researchers and academics investigate the industrial application of service robots and their development potential and direction (Tung & Law, 2017). On the other hand, the consumer's perception of use, acceptance, and satisfaction with the service provided by the service robot have also been investigated (Ivanov & Webster, 2018).

2.2. *Service robots in hospitality industry*

In addition to outlining the growth and advancement of service robots, researchers began to investigate the specific scenario of hotel service robots and their practical influence. In comparison to other commercial service scenarios, hotel service robots are more implementable. Service robots in the tourism and hospitality industries have partially replaced human employees in providing services to customers, which has an impact on the customer service experience and the way services are provided. As a result of the need for collaboration and contact between robot employees, human employees, and human customers, human-robot interaction has emerged. In this context, human-robot interaction has been recognized as a key research topic for understanding customer perception, experience, and adoption. Several scholars in tourism and hospitality have investigated perceptions of the acceptability of service robots in hotel services (Ivanov & Webster, 2019) and their influencing factors (Tung & Law, 2017; Ivanov & Webster, 2018; Shin & Jeong, 2020). The morphology of service robots, human-robot interaction, and customer perception appear to be closely linked. In addition, the demographic differences of customers would also impact their perception of service robots, for example, gender and age. Specifically, Ivanov & Webster (2018) pointed out that younger generations and men have higher adaptations towards service robots. Furthermore, gender differences appear to exist in the preferred level of personification for service robots in the hotel industry, with females being more hedonistically driven than males (Seo, 2022).

2.3. *Humanoid robots and Personalisation*

Several lines of evidence suggest that the two most important aspects of a humanoid robot are its human-like appearance and its autonomous movement or behaviour (Levillain & Zibetti, 2017). If either of these two criteria has a high level of authenticity, it can enable robots to cross the "social threshold," allow humans to see it as playing a social role and interact socially with human users. In prior research, it has been found that the morphology of service robots has an impact on customer perception (Belanche et al., 2021). Simultaneously, the robot's sense of life, i.e., its ability to do tasks in a unique manner and communicate with humans, is equally crucial (Zhang et al., 2021). Consideration and investigation of the two factors are crucial for the service robot sector, researchers, and students.

2.3.1. *Morphology*

While personal factors such as age, gender, and individuals' affinity or aversion towards robots appear to have a greater influence on consumers' adoption intentions, the morphology of robots does play a significant role in shaping consumers' expectations. Notably, it can enhance customers' cognitive perception, personality attribution, and service involvement (Broadbent et al., 2013; Mann et al., 2015).

The research conducted by Tung & Law (2017) divided the morphology of service robots into three categories: anthropomorphic, zoomorphic, and caricatured robots. This article is going to specifically focus on anthropomorphic service robots. Previous research has established that human-like appearance has impact on customers perception, however, yet the nature of this impact remains unclear (Belanche et al., 2021).

On the one hand, several researchers argue that high anthropomorphic level appearance would lead to customers' more positive perception. Once robots are endowed with human-like characteristics, an evaluation of their warmth arises (Kim et al., 2019). Becker, Mahr & Odekerken-Schröder (2022) suggested that humanoid service robots create a greater sense of comfort for customers compared to machine-like robots, fostering companionship development. Kim et al. (2019) found that customers often attribute warm characteristics, such as being nice, gregarious, likable, and kind, to humanoid service robots. However, these studies employed a binary classification, dividing service robots into only two categories (human-like and machine-like), thus limiting a comprehensive exploration of the anthropomorphic degree of humanoid robots.

On the other hand, several studies in the field of service robots' morphology that suggested that a higher anthropomorphic level in the appearance

of service robots may evoke a sense of eeriness or threat among customers (Mende et al., 2019). Research by Shin & Jeong (2020) indicated that customers exhibit a higher preference for cartoon-like robots compared to human-like service robots. Notably, these studies, which present contrasting views on highly anthropomorphic robots, share a common theoretical background—employing the "Uncanny Valley Theory."

2.3.2. *Gender appearance*

Furthermore, several studies have initiated investigations into the potential influence of gendered appearance on customer perception of hotel service robots. Prior research on social behaviour and personality characteristics has demonstrated a significant positive relationship between perceived masculinity and considered competence, along with perceived femininity and reported warmth (Abele & Wojciszke, 2014). As mentioned earlier, customers are more comfortable with service robots with warm characteristics; female appearance seems to be positively linked to customer preference. However, the existing literature on gendered appearance presents divergent perspectives. Seo (2022)'s finding illustrates the benefits of female-appearing service robots in a hospitality context, emphasizing their effectiveness when humanized. Customers express higher satisfaction with female humanoid service robots compared to their male counterparts. In contrast, Zhang et al.'s (2021) study suggests that the gender of humanoid robots does not impact guest perception or attitudes in hotel service, positing that the hospitality sector expects an equal level of capability from both male and female staff. Consequently, the question of whether the gender appearance of humanoid service robots affects customer perception warrants further investigation.

2.3.3. *Uncanny valley theory*

A seminal contribution to the understanding of the anthropomorphic degree of robots is Mori's (1970) "Uncanny Valley Theory," which posits that individuals' perception of a robot is linked to its degree of anthropomorphism. The theory explains the public concern that as the resemblance of robots to humans increases, so does personal affinity and acceptance; however, once the similarity approaches a certain threshold, a sharp decline in affinity occurs, evoking a strange or unsettling feeling. This phenomenon is graphically represented as a valley-like line depicting the correlation between people's affinity and the lifelikeness of robots. Consequently, robots should not closely mimic humans to avoid entering the "uncanny valley." Observers,

however, have an extremely negative opinion of robots that have a nearly human-like but flawed appearance. The implementation of the uncanny valley hypothesis will be crucial, especially for service robots that must deal directly with customers. In the context of hotel service robots, connecting the uncanny valley hypothesis underscores the inappropriateness of using humanoid robots solely for customer satisfaction. Consequently, it has become apparent that it is necessary to comprehend how the appearance of service robots impacts guests' perceptions towards them.

2.4. *Sense of life*

2.4.1. *Human-Robot Interaction (HRI)*

The study of humanization in robotics is not restricted to the humanoid form of robot appearance. HRI aspects play a more pivotal role than physical avatars in shaping the perceived humanity of robots (Kiesler & Goetz, 2002). Kahn et al. (2007) introduced six HRI standards, encompassing fundamental aspects of human likeness that influence the perception of robots, including autonomy, imitation, intrinsic moral value, moral responsibility, privacy, and reciprocity. Several experimental findings indicate that when a non-human entity exhibits autonomous movements resembling human actions, human engagement tends to be elicited, irrespective of its human-like appearance. This aligns with psychological research emphasizing the dominant role of robot autonomy in fostering human anthropomorphism (Urquiza, Hass & Kortschal, 2015), as humans are predisposed to associate robots with human activities (Damiano & Dumouchel, 2018). Engineers, acknowledging the importance of robots adhering to social standards, integrate psychological and sociological concepts to construct robot models closely mirroring human behaviour through observational learning. Consequently, findings indicate a ready acceptance of robots displaying human-like behaviour (Broadbent, 2017).

In the assessment of HRI effects on customer perception, Shin and Jeong (2020) employed a 3x2x3 research method, investigating that the level of interaction of a robot concierge has no significant impact on customers' perceptions. Notably, the authors incorporated Uncanny Valley Theory as a key element in their theoretical framework. However, their focus was solely on the effect of linguistic interaction levels on customer perception, neglecting the examination of emotional engagement between the robot concierge and the customer. Given that emotional engagement is considered a highly influential variable in the Uncanny Valley theory,

the results obtained without considering all relevant aspects may lack accuracy in this study.

It is worth highlighting that high interaction levels do not always result in positive outcomes. Yogeewaran et al. (2016) suggested that humans view robots with high abilities more favourably than those with weaker capabilities. However, when robots closely resemble humans and surpass human capabilities, they may evoke concerns and unfavourable assessments from humans.

2.4.2. *Emotional characteristics*

Researchers have also been concerned with the emotional characteristics of robots. Emotional expression is one of the most crucial components for determining the validity of anthropomorphic characters, as it is a crucial part of expressing human personality (Vinayagamorthy, Slater & Steed, 2002). In contrast, emotion seems to be more crucial than appearance and action in determining the legitimacy of anthropomorphic characters. However, accurately capturing, and portraying user emotions poses a greater challenge. Sun et al. (2019) highlighted the substantial impact of emotional empathy and humour displayed by service robots on users' trial experiences. Humour, characterized by phrases or behaviours inducing laughter, contributes to relaxation and enhances the overall user experience. Previous studies have affirmed a positive correlation between the sense of humour in service robots and customer perception (Zhang et al., 2021). Compared to the personification of appearance, the personification of interactivity and emotion is more appealing and simpler for customers to associate non-human entities with human-like qualities; yet it is more complex to manage and has greater technical demands.

Existing literature has recognized the significance of various factors related to service robots, including gender appearance, anthropomorphic degree of appearance, HRI, and emotional characteristics. Demographic variations among customers, such as age and gender, have also been considered in relation to customer perception. However, disparate theories existed in prior research underscore the need to ascertain whether the impacts of these factors on customer perception are positive or negative. Consequently, research gaps persist in the current body of literature, and it is the intention of this article to address and contribute to filling these gaps.

Chapter 3. Methodology

According to Saunders, Lewis, and Thornhill (2012), a positivist method will collect data about an observable reality and then look for patterns and linkages in the data to formulate law-like generalizations. As this article aims to examine factors that impact customer perception of humanoid hotel service robots, this study technique will be positivist in nature. Also, it is essential to distinguish between positivist and post-positivist perspectives. Post-positivist techniques try to explain and analyse information from a qualitative perspective, in contrast to positivism's quantitatively oriented methodology (Crossan, 2003). Consequently, for the purpose of this study, the author adopted a positivist methodology to examine how people perceive the research topic. This is since the purpose of this article is to discover factors that influence consumers' perceptions of humanoid hotel service robots, irrespective of the respondent's opinion.

3.1. *Data collection*

To meet the research objectives and provide an answer to the research question, a questionnaire with closed-ended questions was created after a review of relevant existing research to collect data on the factors that influence customer perception of hotel service robots.

The questionnaire will initially collect the respondent's demographic information, such as cultural identity, education, gender, and age, to study any correlation between these variables and subsequent conclusions. The Likert scale is routinely employed in social research as a four-to-seven-point interval scale (Wu & Leung, 2017), and objections to its validity are unwarranted upon deeper scrutiny (Norman, 2010). This indicates that the Likert scale is a reliable instrument for measuring customer perception. The questionnaire also assesses the respondent's perspectives on tourist impacts and their support for such tourism by employing Likert scales based on social exchange theory, a dependable and well-proven form of data collection (Nunkoo & Gursoy, 2019). Two 1–5 scales (Q 6–7) are adopted in this article in order to understand whether customer perception of each factor is positive or negative intuitively. In the questionnaire of this article, the influencing factors on customer perception (i.e., gender appearance, morphology, sense of life) are included in the scale in Question 6, and the personalized level of service robots will be explored in Question 7. A sample of the questionnaire is provided in Appendix B.

3.2. *Sampling*

Sampling is the process of selecting for research a subset of a population (Bryman and Bell, 2015). Brunt et al. (2019) state that there are two sampling techniques: probability (random) and non-probability (non-random) sampling. Due to time constraints and the size of the population, a complex procedure of probability sampling is impractical for this study; therefore, non-probability sampling approaches are utilized.

Convenience sampling and snowball sampling, two of the four non-probability sampling methods, are suited for this study. To guarantee the diversity of participants, the Survey Monkey-created online questionnaires were randomly distributed on the streets of Los Angeles (United States), Chengdu (China), and Dublin (Ireland). Thus, a convenience sample was employed. In addition, snowball sampling was chosen because the author was unable to contact all 111 Forum participants due to the huge sample size; as a result, this survey was permitted to be forwarded and commented on to reach more prospective respondents.

3.3. *Data Analysis*

As quantitative data in its raw form provides no information without processing and analysis, the data must be processed to transform it into information that is accessible and understandable (Saunders, Lewis, & Thornhill, 2012). The software Microsoft Excel was utilized by the author to process the raw data. The data was imported into Excel spreadsheets for general data analysis using figures and tables. In addition, regression analysis is conducted to explore relationship between independent variables and behavioural intentions. Considering one of the objectives of this research is to analyse the effect of customer gender on their perception of hotel humanoid service robots, the responses of male and female respondents will be compared and analysed separately with other variables. The processed information is provided in the findings chapter below, followed by a discussion in the discussion chapter.

Chapter 4. Findings

The findings of the study are based on 111 complete survey responses collected in Feb 2023, focusing on the profiles and perceptions of respondents regarding hotel service robots. The demographic analysis Table 1 shows the results of the descriptive analysis of the participants' profiles. More than half of the respondents (51.35%) were female. Respondents aged 18–24 take the largest proportion (36.04%), followed by respondents aged 25–34 (24.32%). Varied

educational backgrounds and cultural origins demonstrates a diverse participant group.

Respondent Profile (N=111)	N	(%)
Gender		
Female	57	51.35
Male	49	44.14
Prefer not to say	5	4.50
Age		
18-24	40	36.04
25-34	27	24.32
35-44	20	18.02
45-54	20	18.02
55-64	4	3.60
Education		
High school or below	26	23.42
Bachelors' degree	49	44.14
Masters' or higher	25	22.52
Other	11	9.91
Cultural Group		
Africa	7	6.31
America	23	20.72
Australia	13	11.71
Asia	45	40.54
Europe	23	20.72

Table 1. Respondent Profile

The dimension of customer perception explores respondents' impressions of hotel service robots, covering morphology, gender appearance, and the sense of life. Table 2 summarizes respondents' perceptions, coded on a 5-point Likert scale, where 1 indicates strongly disagree, and 5 indicates strongly agree. Higher mean values indicate higher preference. Mode represents the most chosen option, and median indicates the midpoint of respondents' data. "Appearance looks like human" received the lowest mean (2.69), indicating it was the least favoured aspect. However, respondents positively viewed the "tone of voice" (mean 3.86) and "sense of humour" (mean 3.84), emphasizing the importance of HRI in influencing customer perception.

Factor	Median	Mean	Mode
Appearance looks like a human	3.00	2.69	3.00
Female appearance than male	4.00	3.46	4.00
Tone of voice appropriateness	4.00	3.86	4.00
High level of interaction	4.00	3.83	5.00
Body language	3.00	3.37	3.00
Sense of humour	4.00	3.84	5.00

Table 2. Central Tendency for Customer Perception of Service Robots

Gender impacts were observed, not only illustrating a preference for female appearance service robots of respondents (Figure 1), but also differences in perception between female and male respondents. Females favoured a high level of interaction (Figure 2), and rated factors like "tone of voice" and "body language" more positively than males (Figures 3 and 4). Conversely, males showed higher acceptance of human-like appearance (Figure 5) and humour (Figure 6). Regarding the degree of personification, emotional capability was considered the most anthropomorphic feature (mean 3.41), while appearance had the lowest anthropomorphic degree (mean 2.78) as shown in Table 3. Notably, respondents preferred a 50% anthropomorphic degree (Figure 7), emphasizing a balance between human-likeness and machine-likeness. All of the figures are presented in Appendix A.

Factor	Mean	Median	Mode
Appearance	2.78	3.00	3.00
Interactivity	3.40	3.00	3.00
Emotional capability	3.41	3.00	3.00

Table 3. Degree of Personification

Gender impacts on personification showed differences in expectations between female and male respondents. Females favoured higher anthropomorphic degrees for interactivity (Figure 8), while males showed more acceptance of emotional personification (Figure 9).

Regression Analysis on Behavioural Intentions
Multiple linear regression was conducted to explore the predictive relationship between independent variables (appearance, interactivity, emotional capability, and perceived utility) and

the dependent variable (behavioural intentions), as shown in Table 4.

Variable	Coefficient	Std. Error	t-Value	P-Value	95% CI
Constant	1.021	0.284	3.595	0.000	[0.461, 1.582]
Appearance	0.103	0.078	1.323	0.187	[-0.050, 0.257]
Interactivity	0.375	0.074	5.062	0.000	[0.230, 0.520]
Emotional capability	0.281	0.078	3.628	0.000	[0.128, 0.435]
Perceived utility	0.267	0.072	3.692	0.000	[0.125, 0.409]

Table 4. Regression Analysis Results

The regression model was statistically significant ($F(4, 475) = 95.139, p < 0.001$), indicating that the model could predict behavioural intentions based on appearance, interactivity, emotional capability, and perceived utility.

Interactivity had the highest positive coefficient (0.375), followed by emotional capability (0.281) and perceived utility (0.267). Appearance had a positive but non-significant coefficient (0.103).

Overall, respondents favoured service robots with appropriate tones of voice, high interaction levels, and a sense of humour. Female respondents generally preferred female-looking robots and showed higher preferences for interactivity, tone of voice, and body language. Male respondents displayed higher agreement with a human-like appearance.

The degree of personification analysis showed that respondents preferred a moderate anthropomorphic degree for appearance, interactivity, and emotional capability. Behavioural intentions were positively influenced by interactivity, emotional capability, and perceived utility, while appearance had a non-significant effect.

Chapter 5. Discussion

The primary aim of this research is to investigate how the gender appearance of humanoid hotel service robots influences customer perception. The findings of this article signify that the gender appearance of humanoid hotel service robots does influence customer perception of them, which is in line with Seo (2022)'s study that customers show higher level of satisfaction with female humanoid service robots compared with

male service robots. This phenomenon can be explained by the connection between femininity, warmth perception, and positive characteristics, highlighting the positive correlation between female appearance and consumer choice (Abele & Wojciszke, 2014; Kim et al., 2019).

Contrary to Zhang et al.'s (2021) study, which suggested no significant impact of humanoid robots' gender on guest perception, this research identifies potential reasons for this contradiction. Firstly, different sampling method is considered in this article as Ivanov and Webster (2018) has estimated that demographic differences lead to various perception and attitude. Firstly, variations in sampling methods are considered, as demographic differences can lead to diverse perceptions. Zhang et al.'s (2021) participants were exclusively university students from Southwest University in China, while this study involved 111 respondents from diverse cultural, age, and education groups. Additionally, methodological differences, such as the use of a 5 Likert scale in this article versus customer performance expectancy metrics in Zhang et al.'s study, contribute to disparate results. Finally, the focus on warmth perception in this research, as opposed to customer expectancy in Zhang et al.'s study, underscores the different theoretical backgrounds.

The second research objective explores how the gender of customers impacts their perception of humanoid hotel service robots. While Ivanov & Webster (2018) argued that males exhibit higher adaptation toward service robots, this article finds that, although differences exist in perceptions of various characteristics, there is no significant difference in acceptance between female and male customers. Female respondents show greater adaptability to specific robot characteristics, while male respondents prefer different features. The research by Seo (2022) can be a strong support of this phenomenon that females being more hedonistically driven than males. The study criticizes Ivanov & Webster's (2018) generalization, attributing the differing outcomes to demographic variations and a lack of consideration for various robot functions in their study.

The third research objective investigates how the level of personalization of service robots influences customer perception. Personalization is examined in terms of appearance and sense of life. Regarding appearance, the study identifies a preference for mid-level anthropomorphic robots (approx. 50% human features), supporting previous literature on the positive correlation between human-like features and customer attitudes (Kim et al., 2019; Becker, Mahr & Odekerken-Schröder, 2022). The study also

confirms the "Uncanny Valley Theory," suggesting that too much similarity between robots and humans leads to negative perceptions (Mori, 1970; Mende et al., 2019). In terms of sense of life, higher interactivity and emotional capabilities positively impact customer attitudes, aligning with prior research that customers are more likely to build companionships with lifelike service robots (Urquiza, Hass & Kortschal, 2015; Damiaono & Dumouchel, 2018; Sun et al., 2019; Zhang et al., 2021). However, the findings emphasize that complete human-like features are not preferred by customers, aligning with Yogeeswaran's (2016) research.

Contradictory theories on the Human-Robot Interaction (HRI) level are discussed, with Shin & Jeong's (2020) findings suggesting that higher interactivity does not necessarily lead to more positive customer perception. The article attributes this contradiction to Shin & Jeong's limited consideration of all relevant aspects, such as emotional engagement, in the Uncanny Valley Theory. In contrast, this research comprehensively examines verbal and non-verbal interactions, leading to different results.

Chapter 6. Conclusion and Recommendations

This study explores factors influencing customer perceptions of humanoid hotel service robots. Previous research has presented conflicting views on the impact of robot gender appearance (Zhang et al., 2021; Seo, 2022). This research fills a gap by establishing a positive relationship between female robot appearance and positive customer perception. Warmth perception theory supports this finding, emphasizing the comfort customers feel with robots exhibiting female features (Abele & Wojciszke, 2014; Kim et al., 2019).

Examining the impact of customer gender on perceptions of humanoid service robots reveals nuanced preferences. While previous studies suggested a more positive perception among male customers (Ivanov & Webster, 2018), this article finds varied preferences among both genders. Specific characteristics, such as appearance, interactivity, and tone, influence perceptions differently for female and male respondents. The study underscores the need for a comprehensive understanding of how customer gender impacts various aspects of robot perception.

Addressing the level of personalization, the research aligns with the majority of customers feeling more comfortable with mid-level anthropomorphic appearance robots (Uncanny Valley Theory). Customers express willingness to adopt robots with a high sense of life but not identical to humans. The positive correlation

between increased personification, interactivity, and emotional capabilities of service robots and customer attitudes supports previous research (Urquiza, Hass & Kortschal, 2015). However, excessive personification may lead to customer discomfort, aligning with findings from Yogeeswaran (2016).

Addressing a gap in existing literature, the research investigates the impact of different anthropomorphic levels on customer perception. By delving into the Uncanny Valley Theory using warmth perception and technical anxiety theories, the study explains the valley-like pattern in individuals' perception of robots. This exploration is crucial for guiding the design of service robots to maximize positive customer attitudes.

Looking ahead, this study suggests several avenues for future research. First, to overcome the limitations of online questionnaires, researchers could consider providing specific scenario assumptions or images to standardize the anthropomorphic degree of service robots, minimizing bias in respondents' perceptions. Additionally, expanding the sample size to include a more diverse representation would validate and strengthen the findings. The study encourages further investigation into additional variables that may influence the explored linkages, with a particular focus on cultural differences. Finally, employing diverse methodologies, such as qualitative research, can provide a more in-depth understanding of the design aspects of hotel service robots.

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Appendix A - Figures

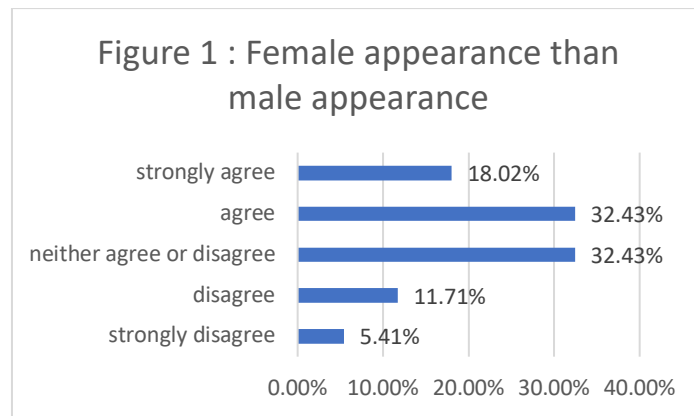


Figure 1

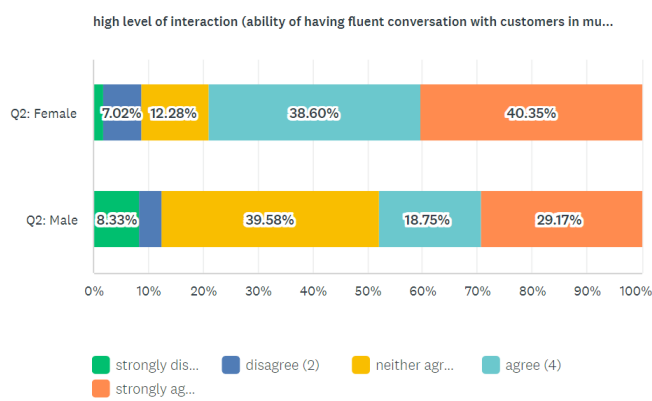


Figure 2

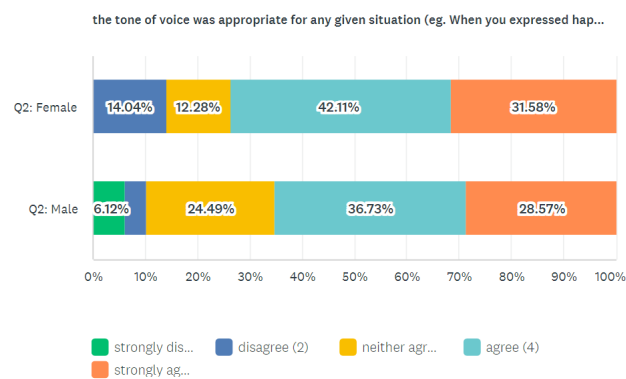


Figure 3

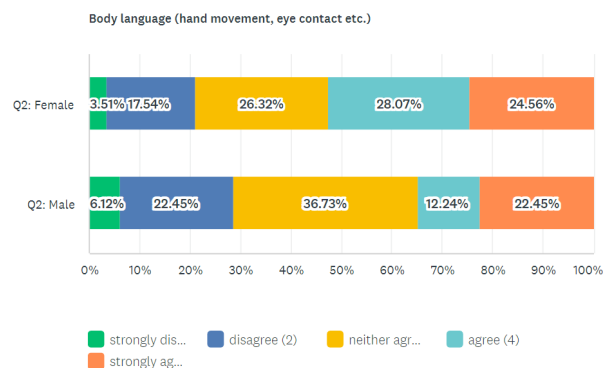


Figure 4

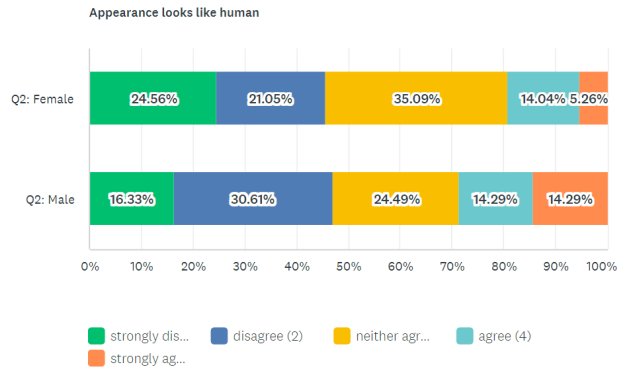


Figure 5

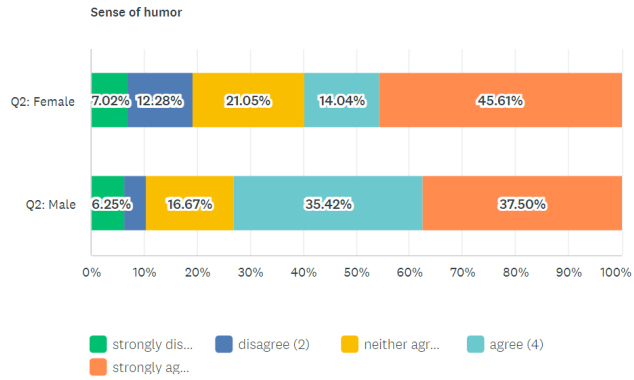


Figure 6

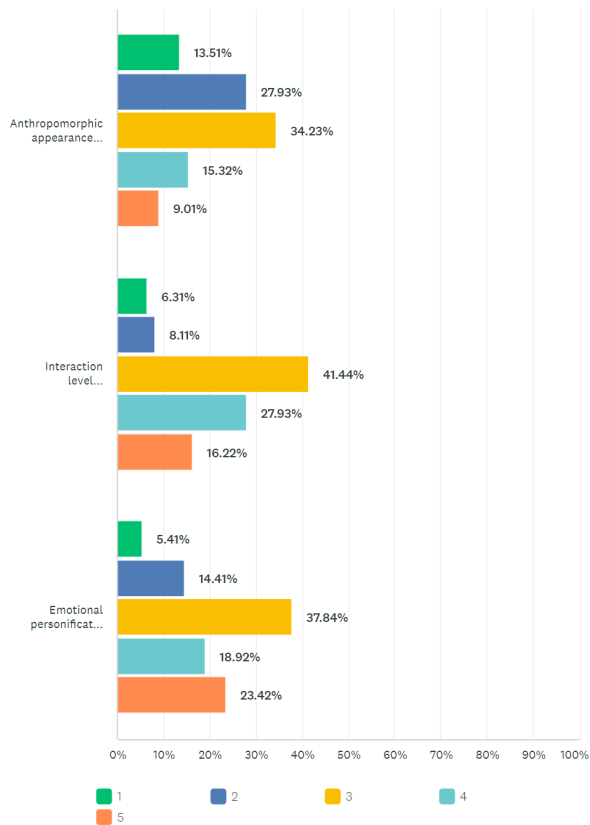


Figure 7

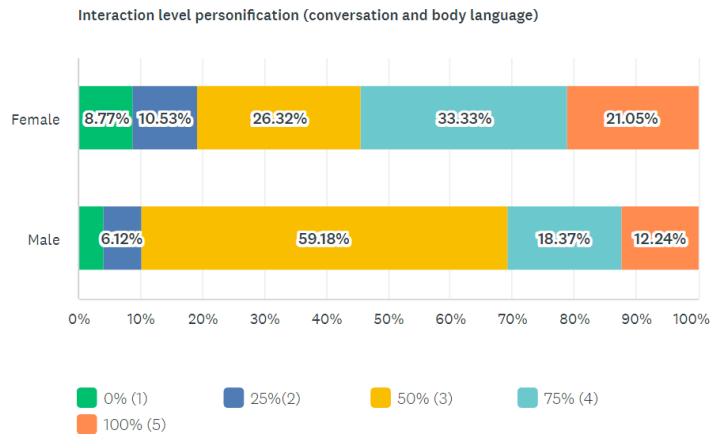


Figure 8

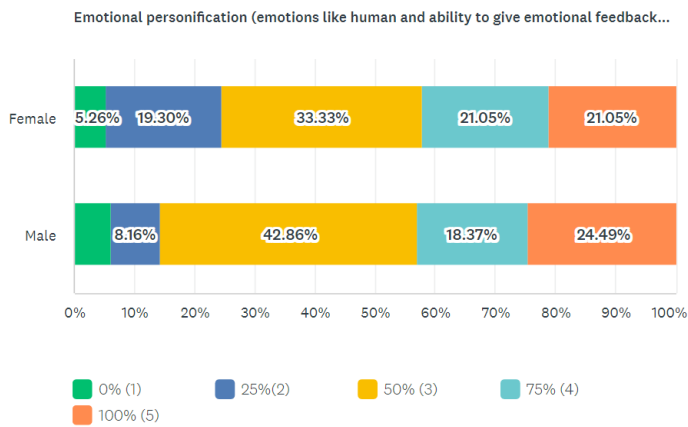


Figure 9

Appendix B - Questionnaire

Customer perception of hotel service robots

This survey is a part of a dissertation done during the final year of a Bachelor's degree at Technological University Dublin Ireland. It is done to understand the influencing factors of customer perception of humanoid service robots in hotels. The survey covers questions about elements of customer perception specific to the morphology and emotional interactions of service robots in addition to the overall customer perception. You don't have to have experience with usage of service robots in hotels to answer this survey.

Your responses will remain anonymous and all data collected will remain confidential. It will take roughly 3 minutes to complete. You are invited to take a survey for research. This survey is completely voluntary. There is no negative consequence and you can feel free to opt out of the survey at any given point in time if you do not feel comfortable.

The record of your survey responses does not contain any identifying information about you, unless a specific survey question is explicitly asked for it.

This survey is anonymous.

The record of your survey responses does not contain any identifying information about you, unless a specific survey question explicitly asked for it.

If you used an identifying token to access this survey, please rest assured that this token will not be stored together with your responses. It is managed in a separate database and will only be updated to indicate whether you did (or did not) complete this survey. There is no way of matching identification tokens with survey responses.

Please confirm that you are over 18 to answer this survey.

* 1. I confirm that I'm over 18.

- Yes
 No

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General questions

* 2. What is your gender?

- Female
 Male
 Prefer not to say

* 3. What is your age?

- 18-24
 25-34
 35-44
 45-54
 55-64
 65+

4. What is the highest level of education you have completed?

- high school or below
 bachelor's degree
 masters' degree or higher
 other

* 5. Which cultural group do you think you belong to?

- Africa
 America
 Australia
 Asia
 Europe

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Dimension of customer perception in service robots

please rate the following elements on the scale of 1-5 (1= strongly disagree and 5= strongly agree).

6. I feel more comfortable with service robots with...

	1	2	3	4	5
Appearance looks like human	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Female appearance than male appearance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
the tone of voice was appropriate for any given situation (eg. When you expressed happiness, the robot reciprocated with a happy voice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
high level of interaction (ability of having fluent conversation with customers in multiple languages)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Body language (hand movement, eye contact etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sense of humor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Degree of personification

Please rate the following elements of the personification degree of the service robots on the scale of 1-5 (1=no human characters and 5= exactly like human being).

7. I feel more comfortable with service robots with the personification degree of...

	1	2	3	4	5
Anthropomorphic appearance (human look)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Interaction level personification (conversation and body language)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Emotional personification (emotions like human and ability to give emotional feedback)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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