"Perceptual service robot attributes affecting customer value co-creation intention in luxury hotels industry"

AUTHORS	Qian Li Songyu Jiang (iD) (R)

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Qian Li, Ph.D candidate, Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology, Thailand.

Songyu Jiang, Ph.D., Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology Rattanakosin, Thailand. (Corresponding author)

Qian Li (Thailand), **Songyu Jiang** (Thailand)

PERCEPTUAL SERVICE ROBOT ATTRIBUTES AFFECTING CUSTOMER VALUE CO-CREATION INTENTION IN LUXURY HOTELS INDUSTRY

Abstract

Service robots have become a trend in hotel services, presenting new opportunities and challenges for the development of the hospitality industry. This study aims to explore how the perceptual attributes of service robots affect customer value co-creation intention in the luxury hotel industry. In China, Shanghai is the city with the most hotels from luxury brands and the city with the highest number of service robots deployed in luxury hotels. Currently, only 11 luxury hotels in Shanghai use service robots. Therefore, this study conducted an online survey of customers who have used service robots in these 11 luxury hotels in Shanghai. A total of 644 responses were collected from customers in luxury hotels in China who have used service robots through convenience sampling. Subsequently, the data underwent a validity analysis, and structural equation modeling was used to process the data. The results indicate that when service robots are perceived as possessing anthropomorphism, animacy, perceived intelligence, and perceived safety, they significantly enhance the customer hospitality experience. These attributes boost the enjoyment and trust customers feel when interacting with the robots, leading to greater engagement during the experience. Notably, likeability lacks significant impact on customer hospitality experience, suggesting that in luxury hotel settings, customers place more emphasis on whether robots possess practical attributes like intelligence and safety. Moreover, the customer hospitality experience serves as a significant mediator, implying the anthropomorphism, as the most critical attribute.

Keywords	anthropomorphism, animacy, intelligence, safety, value co-creation, hospitality experience, luxury hospitality, China
JEL Classification	O31, Z33, M32

INTRODUCTION

The hospitality industry, integral to global tourism, has increasingly integrated technological innovations to enhance service delivery and customer satisfaction. Within this sector, luxury hotels stand out for their commitment to providing high-end services and unique, personalized experiences that cater to the sophisticated demands of their clientele. These establishments aim not only to meet but also exceed the expectations of guests who seek a high-quality lifestyle, necessitating a continuous evolution of service methodologies (Chang et al., 2023). Recent advancements in robotics have introduced service robots as a promising tool to improve service efficiency and customer interaction in luxury hotels. These robots are equipped with advanced functionalities that not only enhance operational efficiencies but also minimize human errors, thus potentially elevating the overall service experience. Continuous technological advancements have enhanced the functionality and intelligence of service robots, enabling them to not only provide more efficient services but also reduce human errors

to a certain extent, offering a more consistent and high-quality service experience (Chiang & Trimi, 2020). The adoption of such technology also aligns with the industry's move towards value co-creation, where guests participate actively in crafting their consumption experiences, thereby enabling hotels to better understand and cater to unique customer needs. Technological progress has become a driving force in promoting collaborative processes for value creation.

In the Chinese region, Shanghai boasts the highest number of luxury brands. Despite technological advancements bringing new service models to the hospitality industry, service robots often face challenges in adapting to complex customer needs and handling unexpected situations in practice (Chevalier & Lu, 2010). Similar to Japan's Henn-na Hotel, some hotels in Shanghai have encountered situations where service robots have failed to meet expectations (Zhong & Verma, 2022). In the "trade-off" connection between service robot application and customer hospitality experience, the perception attributes of service robots play a critical role. These attributes include anthropomorphism, animacy, likability, intelligence, and safety (Bartneck et al., 2009). Some service robots, due to their human-like characteristics, are perceived by customers as service providers with certain social attributes rather than traditional automated technological devices (Ivanov & Webster, 2020). This shift implies that interactions between customers and robots may become more complex and diverse, requiring consideration of the robot's role and performance in social interactions. These issues include robots' inability to effectively handle complex customer requests and the "trade-off" between service experience and human service. Therefore, studying the application of service robots in Shanghai hotels not only provides practical insights for addressing these specific problems but also offers valuable experiences and lessons for the industry.

1. LITERATURE REVIEW

In recent years, the role of service robots in enhancing customer experience and promoting value co-creation has become an important area of academic research. pointed out that lifelike service robots can significantly influence customer emotions and further affect service outcomes. Huang et al. (2021) argued that individuals are more likely to adopt their own perspective rather than that of the robot when interacting with it, suggesting that customers' emotional and cognitive processes play an important role in this interaction. Furthermore, Stepp Jr (2022) introduced the "uncanny valley" effect, which reveals that excessive anthropomorphism in robots may evoke discomfort, further illustrating the profound impact of emotional factors in robot design on customer experience.

In 2022, the production volume of service robots reached 6.458 million units. During the period from August 2021 to August 2022, the production volume of service robots in China was 7.3999 million sets. Shanghai is one of the most internationalized cities in China, attracting a large number of high-end tourists, particularly those

who combine business and leisure travel. In 2022, Shanghai's luxury hotel market share accounted for more than 35% of the national high-end hotel market, making it a hub for luxury hotel brands. Furthermore, Shanghai's luxury hotels actively introduce innovative technologies such as service robots to enhance their competitiveness and customer experience. Shanghai leads the country in the adoption of service robots, especially in five-star and above luxury hotels, where service robots have become key tools for improving service quality, reducing costs, and increasing customer satisfaction. Therefore, choosing these 11 luxury hotels in Shanghai as research subjects effectively reflects the current application of service robots in the high-end hotel market and their impact on customer experience. Appendix B reflects the details of these hotels.

Lifelike robots can profoundly influence customer emotions, thereby further impacting service outcomes (Huang et al., 2021). When interacting with robots, individuals are more likely to adopt their own perspective rather than the robot's perspective (Carlson et al., 2014). Conversely, highly lifelike robots may reduce familiarity and increase emotional distance, leading to a decrease in per-

spective-taking (Park & Whang, 2022). Therefore, designing lifelike service robots requires careful consideration to ensure they can effectively enhance customers' emotional experiences.

Likeability is a fundamental theme in human-robot interaction (HRI), as humans naturally develop preferences based on their emotional responses to entities they encounter. According to Prakash and Rogers (2015), a robot's likable appearance can significantly shape users' attitudes and interaction experiences, establishing a crucial relationship between aesthetics and user engagement. This likability stems not only from the robot's physical design but also from its behavioral expressions, such as gestures, tone of voice, and responsiveness. When robots exhibit friendly and approachable characteristics, they enhance users' emotional comfort, leading to more positive interactions. Furthermore, the perception of likeability can influence users' willingness to engage with the robot, fostering a more cooperative atmosphere. Consequently, a robot's design and behavior must be carefully considered to optimize user likability, as these factors collectively contribute to a more enriching and satisfying overall service experience. By prioritizing likeability in the design of service robots, organizations can improve customer satisfaction, increase acceptance, and ultimately enhance the effectiveness of robotic interventions in various service contexts.

Perceived intelligence varies among customers, those who interact more with service robots may recognize their limitations more readily than those with less interaction. When customers perceive a service provider as highly capable, they believe the provider can deliver satisfactory value, encouraging co-creation in the service exchange (Waseem et al., 2018). Capable service robots contribute to meeting customers' psychological needs and providing a pleasant service experience (Jiménez-Barreto et al., 2021). Customers interacting with robots possessing cognitive intelligence perceive these robots as learning from past experiences like employees (Belanche et al., 2021). Skill improvement and adaptability are seen as ideal service outcomes. Therefore, enhancing the perceived intelligence of service robots is crucial for improving customer experience and promoting value co-creation.

Perceived safety is a critical issue in human-robot interaction (HRI) that significantly influences customer acceptance and engagement with service robots. It encompasses not only the feeling of physical security and comfort but also the reduction of fear related to potential errors or harm that robots might cause in a shared environment (Akalin et al., 2022). Establishing a positive perception of safety is especially crucial in settings where robots are intended to act as replacements or colleagues, as a strong sense of safety can alleviate worries about malfunction or unsafe behavior. When customers feel assured about the safety of robots, they are more likely to engage without hesitation, fostering trust and encouraging deeper interactions. Ultimately, enhancing perceived safety not only boosts customer trust and acceptance of service robots but also leads to improved overall service experiences, making it essential for businesses to prioritize this aspect in the design and deployment of robotic services.

The application of anthropomorphism in service robots can significantly enhance customer evaluations, primarily because such designs make robots appear more relatable and trustworthy, thereby improving the quality of interaction with customers. Specifically, anthropomorphic cues can meet customers' social needs, allowing them to feel greater acceptance and trust in their interactions with robots, as well as increasing their tolerance for any errors (Blut et al., 2021). This not only contributes to an improved overall experience for customers but also fosters a more positive emotional connection. However, it is essential to note that while moderate anthropomorphism can enhance customer interactions, overly human-like designs may evoke discomfort or fear (Mende et al., 2019). This phenomenon, known as the "uncanny valley effect," suggests that when robots closely mimic human characteristics, they can inadvertently make people feel uneasy. Therefore, finding the right balance between anthropomorphic design and functional practicality is crucial when developing service robots.

The perceived attributes of service robots can effectively interact with customers, understand their needs, and provide more intelligent and personalized services. In this process, the application of artificial intelligence connects with customer

factors in value co-creation, and customer hospitality experience plays a crucial mediating role (Solakis et al., 2024). This mediating relationship is significant in the practical application of service robots. Therefore, understanding and optimizing these attributes is essential for businesses aiming to foster strong customer relationships and drive collaborative value creation.

Value co-creation between customers and service robots is essential for successful robotic-assisted service experiences. Customer-dominant logic suggests shifting focus from business processes to customer-centered approaches for value creation and experience enhancement (Heinonen & Strandvik, 2020). This value is socially constructed through customer interactions and evolves within service-dominant logic (Bidar et al., 2016). The impact of value co-creation on satisfaction is linked to hotel services and immersive experiences. Hotels use social media and AI to understand customer behaviors and enhance hospitality experiences (Rihova et al., 2018).

This study highlights the transformative impact of service robots on the hospitality industry, particularly within luxury hotel settings. The perception attributes of service robots, such as anthropomorphism, animacy, likeability, intelligence, and safety, play critical roles in shaping customer experiences and their willingness to engage in value co-creation activities. These attributes not only influence the emotional and cognitive responses of customers but also enhance their interaction quality, satisfaction, and overall service outcomes.

Based on the above, this study aims to uncover the relationship between the customers' perception of service robot and customers' intention for value co-creation. Furthermore, this research also aims to validate the mediation role of customer hospitality experience.

This study aims to provide a theoretical foundation and practical guidance for optimizing the design of service robots and enhancing customer experience in luxury hotels by analyzing how the perceptual attributes of service robots influence customers' intention for value co-creation.

Hence, this study proposes the following hypotheses, and Figure 1 portrays the empirical model.

H1: *Customers' perception of service robot anthropomorphism positively affects their hospitality experience.*

H2: *Customers' perception of service robot animacy positively affects their hospitality experience.*

H3: *Customers' perception of service robot likeability positively affects their hospitality experience.*

H4: *Customers' perception of service robot intelligence positively affects their hospitality experience.*
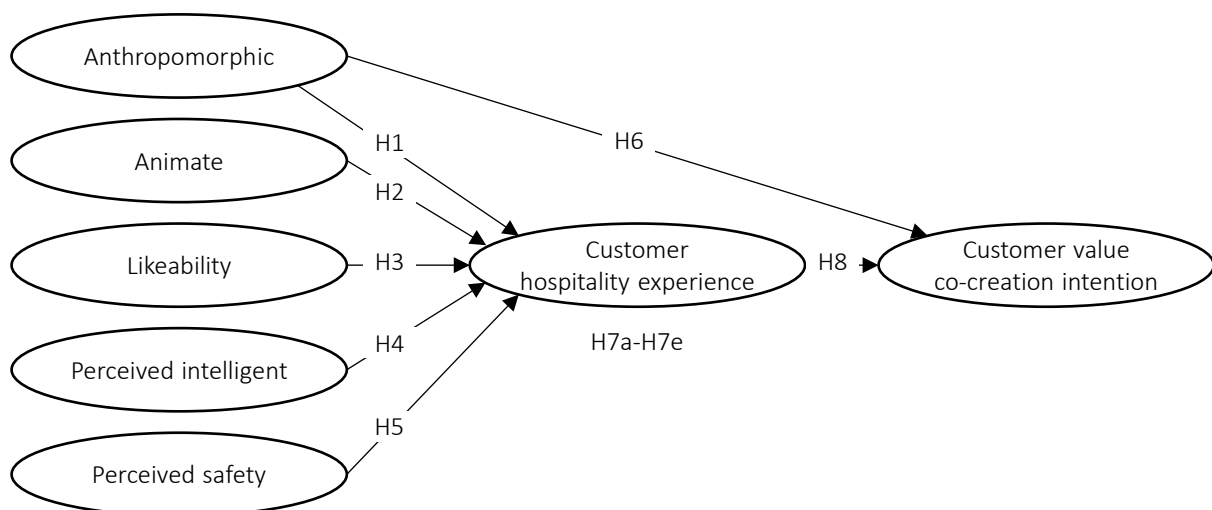

Figure 1. Research model

H5: Customers' perceived safety positively affects their hospitality experience.

H6: Customers' perception of service robot anthropomorphism positively affects their intention for value co-creation.

H7a: Anthropomorphism through customer hospitality experience positively influences customers' intention for value co-creation.

H7b: Animacy through customer hospitality experience positively influences customers' intention for value co-creation.

H7c: Likeability through customer hospitality experience positively influences customers' intention for value co-creation.

H7d: Perceived intelligence through customer hospitality experience positively influences customers' intention for value co-creation.

H7e: Perceived safety through customer hospitality experience positively influences customers' intention for value co-creation.

H8: Customer hospitality experience positively affects customers' value co-creation intentions.

2. METHODOLOGY

This research through an online survey for guests with the experience had utilized service robots in 11 luxury hotels in Shanghai (Appendix B). Before the survey, this research contacted the human resource managers and supervisors of the target star-rated hotels via phone or email to confirm their agreement to participate in the sampling and questionnaire survey. During the data collection period, the hotel's human resources department assisted in convenience sampling for a continuous two months, ultimately obtaining 664 customers in luxury hotels in China who have used service robots. Table 1 uncovers the basic information. Males accounting for 48.193% and females for 51.807%. In terms of age, the largest proportion of respondents are 55 years old and above (25.904%), followed by the 45-54 age group (20.633%). Most respondents are currently married (84.187%),

while 15.813% are single. Regarding education level, the highest proportion of respondents hold a Master's degree (53.765%), followed by those with a Bachelor's degree (31.325%). The occupational distribution shows that government officials and employees of state-owned enterprises constitute the largest group (38.253%). Regarding monthly income, the majority of respondents fall within the 9,001-12,000 RMB range (34.337%).

Table 1. Essential information

	Indicator	Frequency	Percent
Gender	Male	320	48.193
	Female	344	51.807
Age	24 years or below	101	15.211
	25-34 years	130	19.578
	35-44 years	124	18.675
	45-54 years	137	20.633
	55 years or above	172	25.904
Marital status	Married	559	84.187
	Currently single	105	15.813
Education level	Diploma or below	56	8.434
	Bachelor's degree	208	31.325
	Master's degree	357	53.765
	Doctorate or higher degree	43	6.476
Occupation	Student	213	32.078
	Government official/ state-owned enterprise	254	38.253
	Owns a business	109	16.416
	Private company	19	2.861
	Other	69	10.392
Monthly income level	Below 6,000 yuan	120	18.072
	6,001-9,000 yuan	146	21.988
	9,001-12,000 yuan	228	34.337
	Above 12,000 yuan	170	25.602

The research utilized a questionnaire to gather data, consisting of 47 items: 6 related to demographic information and 41 pertaining to the research focus. This questionnaire was crafted based on scholarly discussions surrounding the subject of the research and was organized into four distinct sections. The initial section covered participants' fundamental characteristics information. The subsequent section, based on Qiu et al. (2020) and Bartneck (2009), addressed the perceived attributes of service robots, consisting of 22 items. The third section, based on Pijls et al. (2017), measured customer hospitality experience with 13 items. Finally, the value co-creation intention was primarily measured using the scale from Zhang et al. (2023), consisting of 6 items.

3. RESULTS

The key to assessing the quality of a questionnaire lies in the reliability of its items. When this value falls between 0.7 and 0.9, it indicates a high level of consistency in the questionnaire (Asmelash & Kumar, 2019). The reliability indices of this study are shown in Table 2. All Cronbach's α values exceed 0.800, demonstrating a strong degree of internal consistency.

Table 2. Reliability statistics

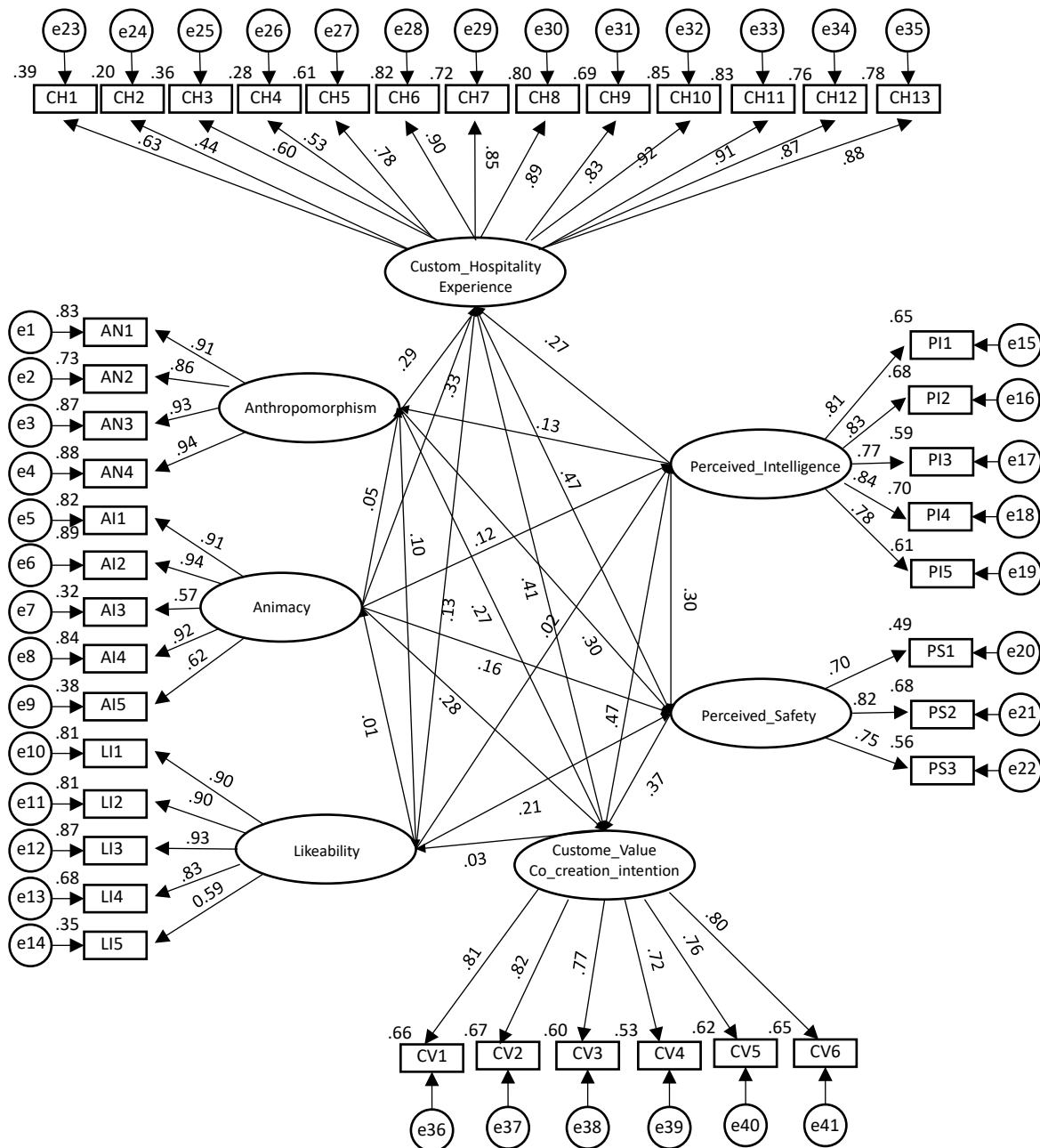| Study variables	Number of questions	Cronbach's α
Anthropomorphism	4	0.949
Animacy	5	0.896
Likeability	5	0.915
Perceived intelligence	5	0.901
Perceived safety	3	0.800
Customers' hospitality experience	13	0.955
Customers' value co-creation intention	6	0.907

Figure 2. Measurement model for the Confirmatory Factor Analysis

Table 3 presents KMO = 0.928 (>0.9), which is considered excellent (Ledesm et al., 2021). This value indicates that the correlations between items are sufficiently high.

Table 3. KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		0.928
Bartlett's test of sphericity	Approx. Chi-squared	23019.935
	df	946
	Sig.	0.000

When the model meets the following criteria, it is considered to have good fit: $\chi^2/df < 3$, GFI > 0.8, RMSEA < 0.08, CFI > 0.8, and IFI > 0.8 (Kong et al., 2016). Table 4 shows that $\chi^2/df = 2.905$, GFI = 0.833, RMSEA = 0.054, CFI = 0.934, and IFI = 0.934.

Table 4. Confirmatory Factor Analysis model fitting index

Indicators	χ^2/df	GFI	RMSEA	CFI	IFI
Judgment criteria	<3	>0.8	<0.08	>0.8	>0.8
value	2.905	0.833	0.054	0.934	0.934

Composite Reliability (CR) and Average Variance Extracted (AVE) serve as two metrics for assessing convergent validity. (Cheung et al., 2024). All latent variables in this study have Composite Reliability (CR) values surpassing the standard threshold of 0.7 (Baharum et al., 2023). AVE assesses the internal consistency of variables, with a preferred value exceeding 0.5 (Cheung et al., 2024). Table 5 shows the convergent validity of each latent variable, confirming that each construct is accurately defined and measured by its respective indicators.

Table 6 compares the square root of the average variance extracted (AVE) of each construct with the correlations between constructs. Through this comparison, one can establish the discriminant validity among the constructs to ensure their independence within the theoretical model (Albelbisi, 2020).

First, Structural Equation Model (SEM) was constructed, and then the model was fitted utilizing software to derive path coefficient estimates, standardized path coefficients, standard errors, and Composite Reliability (CR) values. This indicates that the basic assumptions of the preset model have been validated. Conversely, if these criteria are not met, the hypothesis is deemed invalid (Mueller & Hancock, 2018). Table 7 summarizes the evaluation results.

Table 5. Convergence validity

Latent variables	Observation indicators	Factor loading	CR	AVE
Anthropomorphism	AN1	0.910	0.950	0.828
	AN2	0.857		
	AN3	0.933		
	AN4	0.938		
Animacy	AI1	0.905	0.900	0.651
	AI2	0.943		
	AI3	0.570		
	AI4	0.918		
	AI5	0.615		
Likeability	LI1	0.900	0.921	0.704
	LI2	0.902		
	LI3	0.934		
	LI4	0.825		
	LI5	0.588		
Perceived Intelligence	PI1	0.806	0.901	0.646
	PI2	0.826		
	PI3	0.769		
	PI4	0.836		
	PI5	0.778		
Perceived safety	PS1	0.697	0.803	0.577
	PS2	0.825		
	PS3	0.751		

Table 5 (cont.). Convergence validity

Latent variables	Observation indicators	Factor loading	CR	AVE
Customers' hospitality experience	CH1	0.627	0.954	0.624
	CH10	0.921		
	CH11	0.913		
	CH12	0.874		
	CH13	0.884		
	CH2	0.445		
	CH3	0.604		
	CH4	0.531		
	CH5	0.783		
	CH6	0.904		
	CH7	0.851		
	CH8	0.895		
	CH9	0.829		
Customers' value co creation intention	CV1	0.814	0.908	0.621
	CV2	0.821		
	CV3	0.772		
	CV4	0.727		
	CV5	0.788		
	CV6	0.803		

Table 6. Discriminant validity test

Latent variables	1	2	3	4	5	6	6
Anthropomorphism	0.910						
Animacy	0.053	0.807					
Likeability	0.082	-0.008	0.839				
Perceived intelligence	0.124	0.117	0.009	0.804			
Perceived safety	0.270	0.154	0.183	0.262	0.759		
Customers' hospitality experience	0.309	0.326	0.108	0.283	0.425	0.790	
Customers' value co-creation intention	0.249	0.256	0.025	0.429	0.321	0.422	0.788

The study investigates key constructs, including anthropomorphism, animacy, likeability, perceived intelligence, perceived safety, customer hospitality experience, and customers' value co-creation intention, to assess their interrelationships and significance. The results indicate strong support for most hypotheses, shedding light on the critical pathways influencing customer experiences and intentions in luxury hotel settings.

H1 to *H5* examine the effects of anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety on customers' hospitality experience. The findings demonstrate that anthropomorphism, animacy, perceived intelligence, and perceived safety have significant positive effects on customer hospitality experience, with β values and p-values below 0.001. These results highlight the importance of these perceptual attributes in shaping customer experiences. However, likeability did not exhibit a significant influence in this context.

H6 and *H8* explore the direct effects of anthropomorphism and customer hospitality experience on customers' value co-creation intention. Both hypotheses are supported, with anthropomorphism showing a significant pathway to value co-creation intention, and customers' hospitality experience exerting a strong positive effect on value co-creation intention. These findings underline the pivotal roles of anthropomorphism and enriched customers' experiences in fostering collaborative value creation.

The mediating role of customer hospitality experience is further explored in hypotheses *H7a* to *H7e*. *H7a*, which examines the mediating role of customer hospitality experience in the relationship between anthropomorphism and value co-creation intention, is supported. The mediation effect is statistically significant, with an effect size of 0.051, a standard error of 0.012, and a confidence interval ranging from 0.030 to 0.079, excluding zero. *H7b*,

Table 7. Structural equation model path test

Hypothesis	Path	β	S.E.	C.R.	P	Results
H1	AN→CH	0.190	0.022	5.132	***	Supported
H2	AI→CH	0.279	0.022	7.209	***	Supported
H3	LI→CH	0.059	0.022	1.632	0.103	Unsupported
H4	PI→CH	0.143	0.029	3.812	***	Supported
H5	PS→CH	0.349	0.051	7.715	***	Supported
H6	AN→CV	0.160	0.030	4.053	***	Supported
H7a	AN→CH→CI	0.051	0.012	0.030	0.079	Supported
H7b	AI→CH→CI	0.074	0.014	0.049	0.103	Supported
H7c	LI→CH→CI	0.017	0.011	-0.003	0.040	Unsupported
H7d	PI→CH→CI	0.050	0.016	0.024	0.085	Supported
H7e	PS→CH→CI	0.181	0.036	0.122	0.265	Supported
H8	CH→CV	0.355	0.057	8.069	***	Supported

Note: AN: Anthropomorphism; AI: Animacy; LI: Likeability; PI: Perceived Intelligence; PS: Perceived Safety; CH: Customers' Hospitality Experience; CV: Customers' Value Co creation Intention.

which investigates the mediating role of customer hospitality experience in the relationship between animacy and value co-creation intention, is also supported, with an effect size of 0.074, a standard error of 0.014, and a confidence interval of 0.049 to 0.103. These results confirm the significance of the mediating role of customers' hospitality experience in these relationships.

Conversely, *H7c*, which examines the mediating role of customer hospitality experience in the relationship between likeability and value co-creation intention, is not supported. The mediation effect is not statistically significant, as indicated by an effect size of 0.017, a standard error of 0.011, and a confidence interval of -0.003 to 0.040, which includes zero. This suggests that likeability does not significantly influence value co-creation intention through customers' hospitality experience.

H7d, assessing the mediating role of customers' hospitality experience in the relationship between perceived intelligence and value co-creation intention, is supported. The mediation effect is significant, with an effect size of 0.050, a standard error of 0.016, and a confidence interval of 0.024 to 0.085. Similarly, hypothesis *H7e*, which investigates the mediating role of customers' hospitality experience in the relationship between perceived safety and value co-creation intention, receives strong support. The mediation effect is substantial, with an effect size of 0.181, a standard error of 0.036, and a confi-

dence interval of 0.122 to 0.265, underscoring the critical role of perceived safety in fostering trust and deeper customer engagement through customers' hospitality experience.

Overall, these findings emphasize the nuanced relationships between service robot attributes, customers' experiences, and value co-creation intentions, providing valuable insights into the effective design and deployment of service robots in luxury hospitality settings.

Figure 2 shows significant direct paths from Anthropomorphism, Animacy, Perceived Intelligence, and Perceived Safety to Customers' Hospitality Experience, with standardized path coefficients of 0.19, 0.28, 0.14, and 0.35, respectively. These coefficients indicate that these factors positively affect the overall customer hospitality experience, with Animacy and Perceived Safety having particularly significant effects. However, there is no significant direct path between Likeability and Customers' Hospitality Experience, suggesting that Likeability does not have a direct impact on hospitality experience within the context of this study. Additionally, the figure shows that Customers' Hospitality Experience has a direct positive impact on Customers' value co-creation intention, with a path coefficient of 0.35. Furthermore, the path coefficient of anthropomorphism is 0.16, which further emphasizes its importance in driving customer engagement (AL-Fadhali, 2024).
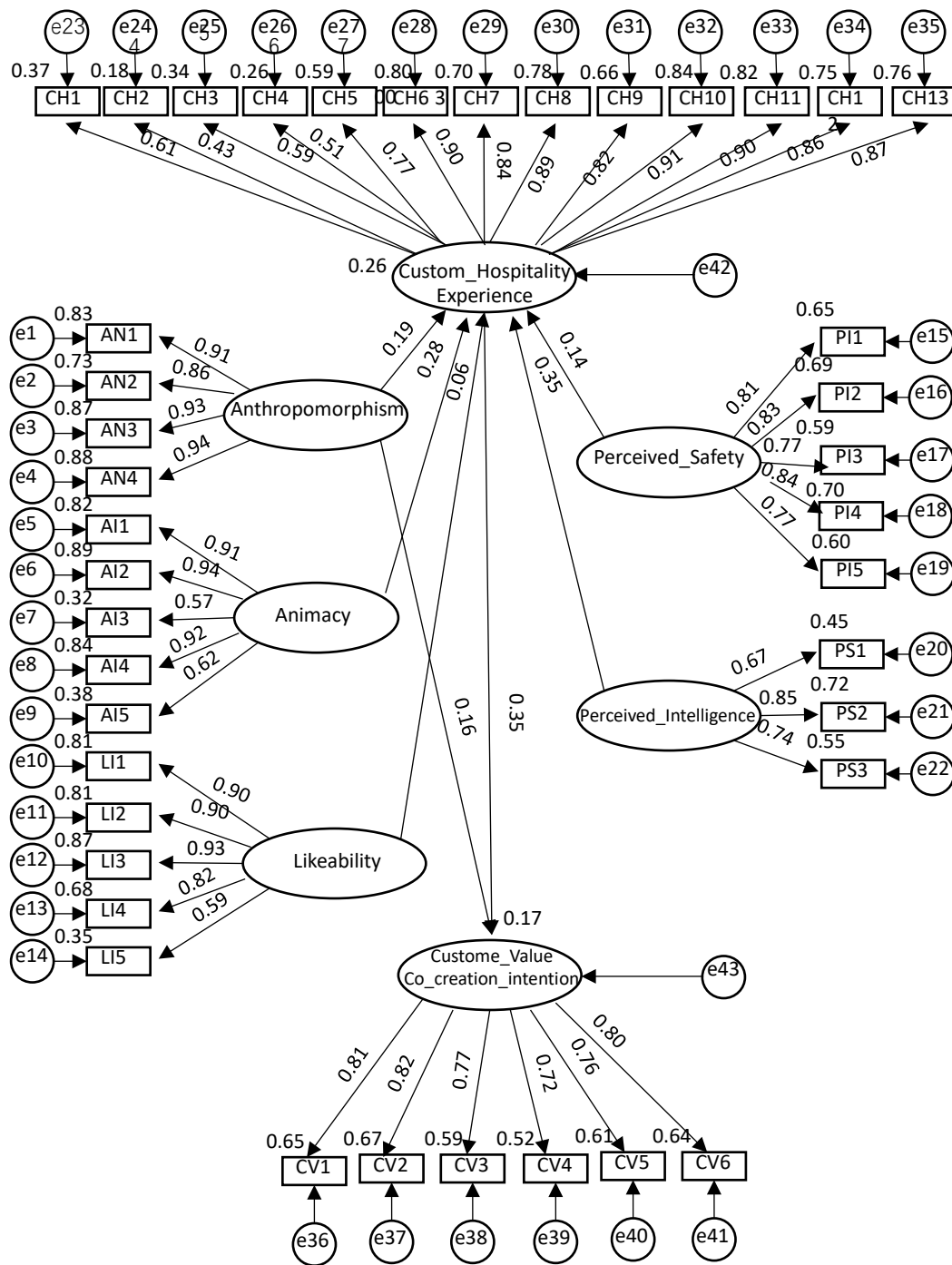
Figure 3. Structural equation model diagram

4. DISCUSSION

The results show that the perceived attributes of service robots significantly affect customers' value co-creation intentions, with customer hospitality experience playing a mediating role. This underscores the importance of optimizing the design and functionality of service robots in luxury hotels to enhance customer interaction experiences and value co-creation.

Compared to previous studies, this research further enriches the understanding of service robot attributes by focusing specifically on perceptual attributes rather than functional attributes, exploring their impact on customer value co-creation intention, and examining the mediating role of customer hospitality experience. The study also confirms the findings of Kim et al. (2022), showing that perceived intelligence of service robots indeed enhances cus-

tomers' willingness to use them. Additionally, the positive relationship between customer experience and value co-creation intention highlighted by Wei et al. (2020) is reinforced in this study, especially in the context of the impact of service robot perceptual attributes. This research also extends Zhang et al. (2023) study by emphasizing the significant effect of non-functional attributes such as anthropomorphism and animacy on customer value co-creation intention.

Notably, the attribute of likeability (LI) did not have a significant effect on customer hospitality experience. This study found that likeability ($\beta = 0.059$, $p > 0.05$) did not significantly affect customer hospitality experience. Likeability is typically reflected in the appearance design of service robots, but customer hospitality experience and value co-creation intention may be more influenced by the quality of interaction with the robots, rather than their "likeability." If a robot's interaction quality, response speed, and accuracy are high, customer experience and value co-creation intentions may be more easily enhanced, with likeability being a relatively secondary factor.

Regarding these results, attributes such as anthropomorphism, perceived safety, and perceived intelligence may influence customer hospitality experience by enhancing customers' sense of trust and interaction quality. This suggests that the design of service robots should focus more on user experience, improving their performance in interactions to achieve higher customer satisfaction and engagement.

As service robot technology continues to advance and its adoption in luxury hotels becomes more widespread, the hospitality industry is poised to embrace a new service model. Hotels that proactively invest in enhancing the key attributes of service robots will not only be better equipped to meet the increasing demands of discerning customers but also improve the overall guest experience through personalized and efficient robotic services. In this process, service robots will evolve from mere auxiliary tools to integral components in shaping the brand image of luxury hotels and enhancing customer loyalty.

CONCLUSION

This study investigated the impact of perceptual attributes of service robots – such as anthropomorphism, animacy, perceived intelligence, perceived safety, and likeability – on customer hospitality experiences and value co-creation intentions within luxury hotels in Shanghai. The findings highlighted that while anthropomorphism, animacy, perceived intelligence, and perceived safety significantly enhance customer hospitality experiences, likeability was found to have a negligible effect in this specific context. The mediating role of customer hospitality experience further underscored the importance of these attributes in fostering deeper customer engagement and collaboration in value co-creation.

The novelty of this research lies in its focus on the perceptual rather than functional attributes of service robots and their implications for customer interactions in high-end hospitality settings. By applying the S-O-R framework and value co-creation theory, this study provides a nuanced understanding of how customer perceptions shape their interactions with service robots and subsequent behavioral intentions. These insights not only validate existing theoretical models but also extend their applicability to the hospitality industry.

From a practical perspective, the findings offer actionable recommendations for developers and hotel managers. Enhancing robot attributes like animacy, anthropomorphism, and perceived safety can significantly elevate customer trust and interaction quality. Hotel managers can strategically leverage these technological advancements to enhance brand loyalty, refine service delivery, and create memorable guest experiences.

Despite its contributions, the study has limitations, including its geographic focus on Shanghai and reliance on quantitative methods, which may restrict the generalizability of the findings. Future research

could expand to other regions and incorporate qualitative approaches to gain a more comprehensive understanding of the interplay between service robots and customer engagement across diverse cultural and economic contexts. These extensions would further enrich the theoretical and practical implications of robotic services in the hospitality industry.

AUTHOR CONTRIBUTIONS

Conceptualization: Qian Li.
Data curation: Songyu Jiang.
Formal analysis: Qian Li, Songyu Jiang.
Funding acquisition: Qian Li, Songyu Jiang.
Investigation: Qian Li.
Methodology: Qian Li.
Project administration: Songyu Jiang.
Resources: Qian Li, Songyu Jiang.
Software: Qian Li, Songyu Jiang.
Supervision: Songyu Jiang.
Validation: Qian Li, Songyu Jiang.
Visualization: Qian Li, Songyu Jiang.
Writing – original draft: Qian Li, Songyu Jiang.
Writing – review & editing: Qian Li, Songyu Jiang.

REFERENCES

1. Akalin, N., Kristoffersson, A., & Loutfi, A. (2022). Do you feel safe with your robot? Factors influencing perceived safety in human-robot interaction based on subjective and objective measures. *International Journal of Human-Computer Studies, 158,* 102744. https://doi.org/10.1016/j.ijhcs.2021.102744

2. AL-Fadhali, N. (2024). An AMOS-SEM approach to evaluating stakeholders' influence on construction project delivery performance. *Engineering, Construction and Architectural Management, 31*(2), 638-661. https://doi.org/10.1108/ECAM-09-2021-0780

3. Asmelash, A. G., & Kumar, S. (2019). Assessing progress of tourism sustainability: Developing and validating sustainability indicators. *Tourism Management, 71,* 67-83. https://doi.org/10.1016/j.tourman.2018.09.020

4. Baharum, H., Ismail, A., Awang, Z., McKenna, L., Ibrahim, R., Mohamed, Z., & Hassan, N. (2023). The study adapted instruments based on Confirmatory Factor Analysis (CFA) to validate measurement models of latent constructs. International *Journal of Environmental Research and Public Health, 20*(4), 2860. http://dx.doi.org/10.3390/ijerph20042860

5. Bartneck, C., Kanda, T., Mubin, O., & Al Mahmud, A. (2009). Does the design of a robot influence its animacy and perceived intelligence? *International Journal of Social Robotics, 1,* 195-204. Retrieved from https://link.springer.com/article/10.1007/s12369-009-0013-7

6. Bartneck, C., Kulić, D., Croft, E., & Zoghbi, S. (2009). Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots. *International Journal of Social Robotics, 1,* 71-81. Retrieved from https://link.springer.com/article/10.1007/s12369-008-0001-3

7. Belanche, D., Casaló, L. V., Schepers, J., & Flavián, C. (2021). Examining the effects of robots' physical appearance, warmth, and competence in frontline services: The Humanness-Value-Loyalty model. *Psychology & Marketing, 38*(12), 2357-2376. https://doi.org/10.1002/mar.21532

8. Bidar, R., Watson, J., & Barros, A. (2016). *Literature review to determine environmental and cognitive factors underlying user value co-creation behaviour.* Proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS) 2016. Retrieved from https://aisel.aisnet.org/pacis2016/327/

9. Blut, M., Wang, C., Wünderlich, N. V., & Brock, C. (2021). Understanding anthropomorphism in service provision: a meta-analysis of physical robots, chatbots, and other AI. *Journal of the Academy of Marketing Science, 49,* 632-658. https://psycnet.apa.org/doi/10.1007/s11747-020-00762-y

10. Carlson, L., Skubic, M., Miller, J., Huo, Z., & Alexenko, T. (2014). Strategies for Human-Driven Robot Comprehension of Spatial Descriptions by Older Adults in a Robot Fetch Task. *Topics in cognitive science, 6*(3), 513-533. https://doi.org/10.1111/tops.12101

11. Carvalho, P., & Alves, H. (2023). Customer value co-creation in the

hospitality and tourism industry: a systematic literature review. *International Journal of Contemporary Hospitality Management, 35*(1), 250-273. https://doi.org/10.1108/IJCHM-12-2021-1528

12. Chang, V., Liu, L., Xu, Q., Li, T., & Hsu, C. H. (2023). An improved model for sentiment analysis on luxury hotel review. *Expert Systems, 40*(2), e12580. https://doi.org/10.1111/exsy.12580

13. Cheung, G. W., Cooper-Thomas, H. D., Lau, R. S., & Wang, L. C. (2024). Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. *Asia Pacific Journal of Management, 41*(2), 745-783. Retrieved from https://link.springer.com/article/10.1007/s10490-023-09871-y

14. Chevalier, M., & Lu, P. X. (2010). *Luxury China: Market opportunities and potential.* John Wiley & Sons.

15. Chiang, A.-H., & Trimi, S. (2020). Impacts of service robots on service quality. *Service Business, 14*(3), 439-459. Retrieved from https://link.springer.com/article/10.1007/s11628-020-00423-8

16. Heinonen, K., & Strandvik, T. (2020). *Customer-dominant service logic.* Routledge New York.

17. Huang, D., Chen, Q., Huang, J., Kong, S., & Li, Z. (2021). Customer-robot interactions: Understanding customer experience with service robots. *International Journal of Hospitality Management, 99,* 103078. https://doi.org/10.1016/j.ijhm.2021.103078

18. Ivanov, S., & Webster, C. (2020). Robots in tourism: A research agenda for tourism economics. *Tourism Economics, 26*(7), 1065-1085. http://dx.doi.org/10.1177/1354816619879583

19. Jiménez-Barreto, J., Rubio, N., & Molinillo, S. (2021). "Find a flight for me, Oscar!" Motivational customer experiences with chatbots. *International Journal of Contemporary Hospitality Management, 33*(11), 3860-3882. https://doi.org/10.1108/IJCHM-10-2020-1244

20. Kim, H., So, K. K. F., & Wirtz, J. (2022). Service robots: Applying social exchange theory to better understand human–robot interactions. *Tourism Management, 92,* 104537. https://doi.org/10.1016/j.tourman.2022.104537

21. Kong, H. M., Ko, E., Chae, H., & Mattila, P. (2016). Understanding fashion consumers' attitude and behavioral intention toward sustainable fashion products: Focus on sustainable knowledge sources and knowledge types. *Journal of Global Fashion Marketing, 7*(2), 103-119. https://doi.org/10.1080/20932685.2015.1131435

22. Mende, M., Scott, M. L., van Doorn, J., Grewal, D., & Shanks, I. (2019). Service robots rising: How humanoid robots influence service experiences and elicit compensatory consumer responses. *Journal of Marketing Research, 56*(4), 535-556. https://doi.org/10.1177/0022243718822827

23. Park, S., & Whang, M. (2022). Empathy in human–robot interaction: Designing for social robots. *International Journal of Environmental Research and Public Health, 19*(3), 1889. https://doi.org/10.3390/ijerph19031889

24. Pijls, R., Groen, B. H., Galetzka, M., & Pruyn, A. T. (2017). Measuring the experience of hospitality: Scale development and validation. *International Journal of Hospitality Management, 67,* 125-133. https://doi.org/10.1016/j.ijhm.2017.07.008

25. Prakash, A., & Rogers, W. A. (2015). Why some humanoid faces are perceived more positively than others: effects of human-likeness and task. *International Journal of Social Robotics, 7*(2), 309-331. Retrieved from https://link.springer.com/article/10.1007/s12369-014-0269-4

26. Qiu, H., Li, M., Shu, B., & Bai, B. (2020). Enhancing hospitality experience with service robots: The mediating role of rapport building. *Journal of Hospitality Marketing & Management, 29*(3), 247-268. https://doi.org/10.1080/19368623.2019.1645073

27. Rihova, I., Buhalis, D., Gouthro, M. B., & Moital, M. (2018). Customer-to-customer co-creation practices in tourism: Lessons from Customer-Dominant logic. *Tourism Management, 67,* 362-375. https://doi.org/10.1016/j.tourman.2018.02.010

28. Solakis, K., Katsoni, V., Mahmoud, A. B., & Grigoriou, N. (2024). Factors affecting value co-creation through artificial intelligence in tourism: A general literature review. *Journal of Tourism Futures, 10*(1), 116-130. https://doi.org/10.1108/JTF-06-2021-0157

29. Stepp Jr, D. C. (2022). *Investigating Variables to Reduce the Uncanny Valley Effect in Human-Robot Interaction: A Systematic Literature Review.* University of Arizona Global Campus.

30. Waseem, D., Biggemann, S., & Garry, T. (2018). Value co-creation: The role of actor competence. *Industrial Marketing Management, 70,* 5-12. https://doi.org/10.1016/j.indmarman.2017.07.005

31. Wei, G., He, X., Wang, H., Rui, L., Jialing, L., & Jingyi, L. (2020). Research on the relationship between Fresh Food E-commerce Consumption Experience and Customer Fit from the Perspective of Value Co-creatio. E3S Web of Conferences.

32. Zhang, X., Lee, S. K., Kim, W., & Hahn, S. (2023). "Sorry, it was my fault": Repairing trust in human-robot interactions. *International Journal of Human-Computer Studies, 175,* 103031. https://doi.org/10.1016/j.ijhcs.2023.103031

33. Zhong, L., & Verma, R. (2022). Rise of humanoid robots in hospitality services. In *Research Handbook on Services Management* (pp. 331-345). Edward Elgar Publishing. Retrieved from https://ideas.repec.org/h/elg/eechap/20189_22.html

APPENDIX A

QUESTIONNAIRE

Dear Sir/Madam!

We are conducting a survey on hotel service robots. We invite you to fill out this questionnaire based on your experience with robot services. The questionnaire will take approximately 4 to 7 minutes of your time. This survey is for academic research purposes only, and your responses will remain anonymous. Thank you for your valuable time and opinions. In this questionnaire, the term "robot" specifically refers to physical robots applied in hotel customer services, such as welcoming robots, delivery robots, front desk inquiry robots, etc. It does not include virtual robots online (such as website customer service robots). Thank you for your kind cooperation.

PART 1: General information on personal data

Explanation: Please place a checkmark √ inside the circle ○ and ensure that all data provided in the form is accurate.

1. Gender:

☐ Male
☐ Female

2. Age:

☐ 24 years or below
☐ 25-34 years
☐ 35-44 years
☐ 45-54 years
☐ 55 years or above

3. Marital Status:

☐ Currently single
☐ Married

4. Educational Level:

☐ Diploma or below
☐ Bachelor's degree
☐ Master's degree
☐ Doctorate or higher degree

5. Occupation:

☐ Student
☐ Government official/state-owned enterprise
☐ Owns a business
☐ Private company
☐ Other, please specify:

6. Monthly income level:

☐ Below 6,000 yuan
☐ 6,001-9,000 yuan
☐ 9,001-12,000 yuan
☐ Above 12,000 yuan

PART 2: The related evaluation of customers' intention for co-creating value with service robots based on the perceived attributes of service robots

1. Please evaluate the following statements based on your perception of the hotel service robot. The options range from 5 to 1, where 5 represents "strongly agree" and 1 represents "strongly disagree." Please check the option you find most appropriate.

Perceived attributes of service robots	Level of agreement				
	1	2	3	4	5
Anthropomorphism					
The service robots in luxury hotels are natural.					
The service robots in luxury hotels resemble humanlike.					
The service robots in luxury hotels are conscious.					
The service robots in luxury hotels are moving elegantly.					
Animacy					
The robots in luxury hotels are alive.					
The robots in luxury hotels are lively.					
The robots in luxury hotels are vibrant.					
The robots in luxury hotels are communicative.					
The robots in luxury hotels are responsive.					
Likeability					
The robots in luxury hotels are likable.					
The robots in luxury hotels are friendly.					
The robots in luxury hotels are kind.					
The robots in luxury hotels are delightful.					
The robots in luxury hotels are charming.					
Perceived Intelligence					
The robots in luxury hotels are competent.					
The robots in luxury hotels are knowledgeable.					
The robots in luxury hotels are responsible.					
The robots in luxury hotels are intelligent.					
The robots in luxury hotels are sensible.					
Perceived Safety					
The robots in luxury hotels are relaxing.					
The robots in luxury hotels evoke a sense of calmness.					
The robots in luxury hotels convey a sense of gentleness.					

2. Please evaluate the following statements based on your experience with the service robot. The options range from 5 to 1, where 5 represents "strongly agree," and 1 represents "strongly disagree." Please check the option you find most appropriate.

Customers' hospitality experience	Level of Agreement				
	1	2	3	4	5
Inviting					
I feel invited by the hotel.					
I feel this hotel is open.					
During my visit I experience freedom.					
Care					
The hotel provides me with support.					
The hotel makes me feel involved.					
I feel as I am treated like a king/queen at this hotel.					
The hotel makes an effort to take care of me.					
The hotel makes me feel relieved of tasks or worries.					
31. The hotel is interested in me.					
32. In this hotel, I feel important.					

Customers' hospitality experience	Level of Agreement				
	1	2	3	4	5
Comfort					
I feel at ease in this hotel.					
I feel comfortable in this hotel.					
I feel relaxed in this hotel.					

3. Please evaluate the following statements based on your experience with the service robot. The options range from 5 to 1, where 5 represents "strongly agree," and 1 represents "strongly disagree." Please check the option you find most appropriate.

Value co-creation intention	Level of agreement				
	1	2	3	4	5
Value Co-creation Intention					
I am willing to share my experiences with the service robot in my social circle.					
I am willing to provide the hotel with ideas and suggestions related to the service robot.					
If there are any issues during the use of the service robot, I am willing to provide feedback to the hotel.					
I am willing to provide necessary information for the service robot to effectively assist me during my hotel stay.					
During usage, I am willing to answer any relevant questions from the service robot.					
I am willing to provide necessary feedback information for the service robot.					

APPENDIX B

Table B1. Luxury hotel statistics for shanghai applied service robots

Brand name	Hotel name	Presence of service robots (Y/N)
INTERCONTINENTAL	InterContinental Shanghai Sheshan Shimao	Y
	Holiday Inn Shanghai Hongqiao Dahua	Y
	Crowne Plaza Shanghai Fudan	Y
	HUALUXE Shanghai Changfeng Park	Y
	Holiday Inn Shanghai Nanjing Road	Y
	Crowne Plaza Shanghai Xiayang Lake	Y
	Crowne Plaza Shanghai Anting	Y
	The Seagull on the Bund Hotel	Y
	Crowne Plaza Shanghai Pudong Minhang	Y
WANDA REIGN	Wanda Reign on the Bund Shanghai	Y
INDIGO	Hotel Indigo Shanghai on the Bund	Y

Explanation: Y represents that the service robot is applied, and N represents that the service robot is not applied.