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Emotional Intelligence and Anthropomorphic Design in Service Robots: Effects on Guest Experience in Smart Hospitality

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Abstract

This study examines how service robot design influences customer experiences in hospitality, addressing the limits of technology acceptance models that overlook emotional and relational factors. Focusing on Hangzhou, it investigates how anthropomorphism and perceived emotional intelligence (PEI) shape customer emotions, mediate service experience, and interact with perceived risk of failure. Using survey data from 319 hotel guests and structural equation modeling, results show that anthropomorphism and PEI significantly enhance positive emotions, which fully mediate overall service evaluations. Perceived risk does not moderate these relationships. The study extends acceptance theory and highlights the importance of emotionally intelligent robot design in hospitality.

Keywords: Anthropomorphism; Emotional Intelligence; Guest Experience; Service Robots

DOI:

1.0 Introduction

The global hospitality sector is undergoing rapid technological transformation, with service robots becoming integral to hotel operations. This shift is particularly evident in China, where advances in artificial intelligence and smart tourism have accelerated adoption, driven by rising service expectations, labor shortages, and post-pandemic hygiene concerns. In cities such as Hangzhou, recognized for smart tourism and attracting over 53 million visitors in early 2023, hotels increasingly rely on robotic solutions, including automated check-in, concierge services, and in-room delivery (Licardo et al., 2024).

Despite these operational advantages, a critical challenge remains: robots' ability to deliver emotionally satisfying and culturally appropriate experiences. Evidence shows that failures in emotional responsiveness and communication can lead to customer dissatisfaction, highlighting a gap between technological capability and guest expectations. Existing models largely emphasize functional benefits while overlooking emotional and relational dimensions of human–robot interaction (Song et al., 2022).

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Therefore, the purpose of this study is to examine how anthropomorphism and perceived emotional intelligence influence guest experience in smart hospitality. Specifically, this study aims to (1) analyze their effects on guests' emotional responses, (2) assess the impact of these responses on overall service experience, and (3) evaluate the moderating role of perceived risk.

2.0 Literature Review

2.1 Service robots in Hospitality

Service robots are now central to hospitality innovation, reshaping guest experiences and operations. Defined as autonomous, task-performing mechanisms (IFR, 2025), they are expected to generate over USD40 billion globally by 2025 (Statista, 2025). Adoption has accelerated due to post-pandemic demand for contactless services, labor shortages, and the need for efficiency (AIPRM, 2025). In practice, robots handle concierge, delivery, cleaning, and entertainment roles, with China leading adoption. Yet hospitality remains inherently human-centric. Satisfaction depends on warmth, empathy, and personalization, creating a core tension: robots may improve efficiency, but their success hinges on delivering relational and emotional value.

2.2 Anthropomorphism

Anthropomorphism, the attribution of human traits to non-human agents, is a key design factor. Human-like cues such as facial features, voice, and gestures enhance social presence and acceptance. However, excessive human-likeness can trigger discomfort, as suggested by the uncanny valley. Heightened expectations may also amplify dissatisfaction when robots fail. A balanced design is therefore critical.

2.3 Perceived Emotional Intelligence

Perceived emotional intelligence (PEI) refers to the extent to which users believe robots can recognize and respond to emotions. Advances in affective computing enable robots to detect emotional cues and respond empathetically (ISRF, 2023). In hospitality, PEI enhances perceived competence, trust, and relational quality. Its importance varies culturally, with stronger effects in collectivist contexts. However, its integration with anthropomorphism and risk remains underexplored.

2.4 Customer Emotional Responses

Customer emotions are central to service evaluation. According to Cognitive Appraisal Theory (Lazarus & Folkman, 1984), positive emotions arise when expectations are met, whereas failures trigger frustration or anxiety. These responses mediate outcomes: emotionally intelligent robots can foster satisfaction and loyalty, whereas negative emotions reduce acceptance (Song et al., 2022).

2.5 Perceived Risk of Service Failure

Perceived risk involves anticipated failures, including functional, psychological, or social risks. High risk intensifies negative emotions and weakens trust, particularly in complex service interactions (Sun et al., 2025). Cultural differences also matter, with higher uncertainty avoidance linked to greater skepticism (Chang et al., 2022). Despite its importance, perceived risk remains under examined as a moderating factor in hospitality human–robot interaction.

2.6 Underlying Theories: Service Robot Acceptance Model, Anthropomorphism Theory, and Cognitive Appraisal Theory (only one theory)

This study integrates three complementary theoretical perspectives to explain how service robot design influences guest experience. First, the Service Robot Acceptance Model (SRAM), extending the Technology Acceptance Model, incorporates both utilitarian and affective drivers of acceptance. This makes it particularly relevant in hospitality, where emotional and relational elements are as important as functionality and ease of use. Second, Anthropomorphism Theory explains how human-like design cues—such as voice, appearance, and gestures- enhance perceptions of warmth and trust. However, the uncanny valley effect warns that excessive human likeness can lead to discomfort. Third, Cognitive Appraisal Theory (CAT) posits that emotions arise from individuals' evaluations of how well an experience aligns with their goals and expectations. In hospitality settings, these emotional responses act as key mechanisms linking robot attributes to service outcomes. Collectively, these theories establish a framework connecting anthropomorphic design and perceived emotional intelligence to guest emotions and service outcomes, while recognizing the moderating role of perceived risk.

2.7 *Conceptual Framework and Hypotheses Development*

The model assumes that these benefits are not guaranteed. If guests expect robots to malfunction or fail to respond appropriately, then even well-designed machines may not deliver the intended emotional or relational value.

2.7.1 Anthropomorphism and Customer Emotional Response

Human-like cues such as voice, facial features, and gestures enhance warmth and social presence, making interactions more comfortable. However, excessive realism may trigger unease due to the uncanny valley. In hospitality, moderate anthropomorphism is

expected to foster positive emotions by reducing perceived distance.

H1. Anthropomorphism of service robots positively influences customer emotional response.

2.7.2 Perceived Emotional Intelligence and Customer Emotional Response

Perceived emotional intelligence (PEI) reflects the extent to which robots are seen as recognizing and responding appropriately to emotions. Emotionally adaptive behaviors enhance empathy, trust, and reassurance, particularly in collectivist contexts.

H2. Perceived emotional intelligence of service robots positively influences customer emotional response.

2.7.3 Customer Emotional Response and Service Experience

Based on Cognitive Appraisal Theory, emotions arise from evaluations of service encounters and shape overall judgments (Lazarus & Folkman, 1984). Positive emotions enhance satisfaction, while negative emotions reduce trust and diminish quality of experience

H3. Customer emotional response positively influences overall service experience.

2.7.4 The Mediating Role of Customer Emotional Response

Customer emotions act as key mechanisms linking robot attributes to service outcomes. Anthropomorphism and PEI influence evaluations by eliciting emotions.

H4a. Customer emotional response mediates the relationship between anthropomorphism and service experience.

H4b. Customer emotional response mediates the relationship between perceived emotional intelligence and service experience.

2.7.5 The Moderating Role of Perceived Risk of Service Failure

Perceived risk, including functional, psychological, or social concerns, can weaken the positive effects of anthropomorphism and PEI (Sun et al., 2025). Lower risk strengthens the translation of these attributes into positive emotions and evaluations.

H5a. Perceived risk of service failure negatively moderates the relationship between anthropomorphism and customer emotional response.

H5b. Perceived risk of service failure negatively moderates the relationship between perceived emotional intelligence and customer emotional response.

These hypotheses form an integrated model (see Figure 1) in which anthropomorphism and PEI shape emotional responses that drive service experience, with mediation and moderation clarifying these relationships.

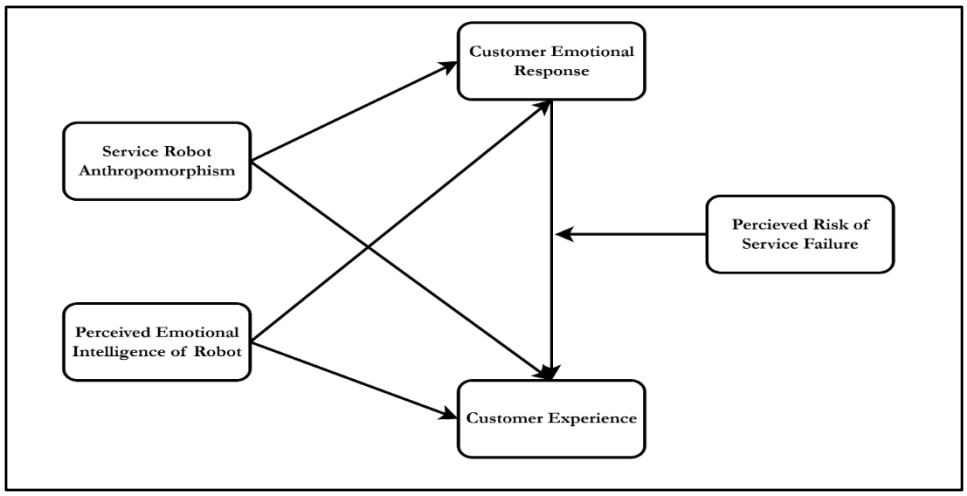

Figure 1. Theoretical model

3.0 Methodology

We adopted a quantitative, cross-sectional survey to examine how service robot anthropomorphism and perceived emotional intelligence (PEI) shape customers' emotional responses and their overall service experience, and whether the perceived risk of service failure alters these relationships. The target population consisted of hotel guests who had interacted with service robots during their stays. We used purposive sampling, in which familiarity with the focal phenomenon is important for obtaining valid responses (Hair et al., 2019). Data were gathered through both online and on-site channels. In total, 350 questionnaires were issued, and 319 were returned in a form deemed valid and usable, yielding a 91 percent response rate. This size exceeds the minimum commonly recommended for structural equation modeling (SEM), satisfying the rule of at least ten responses per indicator variable.

*The measurem*ent scales were adapted from previously validated instruments, with wording adjusted to suit the hotel-robot interaction context. All items used a five-point Likert scale from 1 to 5. Pre-testing with a pilot group confirmed item clarity, and minor adjustments were made to ensure cultural appropriateness. Data analysis followed a two-step SEM approach. Preliminary diagnostics, including descriptive statistics, missing data checks, and common method variance assessment, were conducted in SPSS 26.0 The main analysis was conducted using SmartPLS 4.0, which is suitable for complex models with multiple latent constructs and modest sample sizes (Hair et al., 2019). Reliability was evaluated using Cronbach's alpha and composite reliability, with thresholds of 0.70 or higher considered acceptable. Convergent validity was assessed through factor loadings above 0.70 and average variance extracted (AVE) above 0.50, while discriminant validity was tested using the Fornell–Larcker criterion and heterotrait–monotrait ratios.

The structural model was then tested to evaluate the hypothesized relationships among constructs. Path coefficients, explained variance (R^2), and effect sizes (f^2) were examined, with significance established through a bootstrapping procedure of 5,000 resamples. Mediation analysis was performed to assess whether customer emotional response served as a mechanism linking anthropomorphism and PEI to overall service experience, consistent with Cognitive Appraisal Theory (Lazarus & Folkman, 1984). Moderation analysis tested whether perceived risk of service failure altered the relationships between robot design features and customer emotional responses, in line with risk perception frameworks in hospitality and service robotics (li et al., 2025).

4.0 Results

The measurement model (see Table 1) was assessed for reliability and validity following established SEM procedures. Cronbach's alpha and composite reliability (CR) values for all constructs exceeded the threshold of 0.70, demonstrating internal consistency. As shown in Table 2, convergent validity was supported, as all item loadings were greater than 0.70 and statistically significant, and the average variance extracted (AVE) values for each construct were above 0.50. Discriminant validity was confirmed using both the Fornell–Larcker criterion and heterotrait–monotrait ratios (HTMT). The square root of each construct's AVE was higher than its correlations with other constructs, and all HTMT values (see Table 3) were below the conservative threshold of 0.85, indicating adequate discriminant validity.

Table 1: Measurement model results (reliability and validity)

		Internal Consistency Reliability			
Construct	**Items**	**Loadings**	**Cronbach's Alpha**	**Composite reliability**	**AVE**
Customer Experience	CE1	0.807	0.820	0.824	0.646
	CE2	0.811			
	CE3	0.793			
	CE4	0.805			
Customer Emotional Response	CER1	0.673	0.819	0.844	0.649
	CER2	0.856			
	CER3	0.864			
	CER4	0.813			
Perceived Emotional Intelligence of the Robot	PEIR1	0.787	0.897	0.905	0.520
	PEIR10	0.762			
	PEIR2	0.659			
	PEIR3	0.737			
	PEIR4	0.695			
	PEIR5	0.669			
	PEIR6	0.796			
	PEIR7	0.695			
	PEIR8	0.779			
	PEIR9	0.676			
Perceived Risk of Service Failure	PRSF1	0.847	0.905	0.914	0.603
	PRSF2	0.824			
	PRSF3	0.720			

	PRSF4	0.662			
	PRSF5	0.807			
	PRSF6	0.822			
	PRSF7	0.747			
	PRSF8	0.764			
Service Robot Anthropomorphism	SRA1	0.825	0.832	0.834	0.750
	SRA2	0.896			
	SRA3	0.874			

Table 2: Fornell-Larcker Criterion

	CE	CER	PEIR	PRSF	SRA
CE	**0.804**				
CER	0.610	**0.805**			
PEIR	0.633	0.626	**0.721**		
PRSF	0.697	0.709	0.695	**0.776**	
SRA	0.649	0.573	0.629	0.736	**0.866**

Table 3: HTMT Ratio of Correlation

	CE	CER	PEIR	PRSF	SRA
CE					
CER	0.724				
PEIR	0.857	0.817			
PRSF	0.787	0.808	0.763		
SRA	0.769	0.679	0.730	0.847	

The structural model (refer Table 4) was evaluated using SmartPLS 4.0. Collinearity diagnostics confirmed that variance inflation factors (VIFs) were below the recommended cutoff of 3.3, suggesting that multicollinearity was not a concern (Hair et al., 2019). The model explained substantial variance in customer emotional response and overall service experience, as indicated by R^2 values exceeding the recommended minimum of 0.25. Effect sizes (f^2) indicated that anthropomorphism and perceived emotional intelligence (PEI) contributed meaningfully to predicting customer emotional response. Predictive relevance (Q^2), assessed using blindfolding procedures, was also established, confirming the model's robustness.

Path coefficient analysis revealed that anthropomorphism exerted a significant positive effect on customer emotional response, supporting H1. Similarly, PEI was found to significantly enhance customer emotional response, supporting H2. Customer emotional response was a significant predictor of overall service experience, providing support for H3. These findings confirm that both anthropomorphic design features and perceptions of emotional intelligence are critical in shaping affective reactions, which subsequently drive overall service evaluations.

Table 4: Structural Model

	Path Coefficients	T Statistics	P Values	CI (LL)	CI (UL)	Significance (p<0.05)?
				2.50%	97.50%	
CER -> CE	0.236	3.329	0.001	0.087	0.364	Yes
PEIR -> CER	0.604	10.026	0.000	0.483	0.721	Yes
SRA -> CER	0.193	2.682	0.007	0.055	0.334	Yes

Mediation analysis (refer Table 5) was conducted using a bootstrapping procedure with 5,000 resamples. The results demonstrated that customer emotional response mediated the relationships between anthropomorphism and overall service experience (H4a supported) and between PEI and overall service experience (H4b supported). In both cases, indirect effects were statistically significant, and the bias-corrected confidence intervals did not include zero, indicating robust mediation effects.

In contrast, the moderation analysis (see Table 6) did not support the hypothesized effects of perceived risk of service failure. Neither the interaction between anthropomorphism and perceived risk nor that between PEI and perceived risk was statistically significant in predicting customer emotional response (H5a and H5b not supported). These findings suggest that concerns about potential service failures did not meaningfully alter the influence of robot design features on emotional reactions in this sample.

Table 5: Variance Accounted for (VAF) Method for Mediation Analysis

Constructs	VAF (P12P23)/(P12P23+P13)	%	P Values (< 0.05)	Type of mediation
PEIR → CER → CE	1.000	100	0.002	Full
SRA → CER → CE	1.000	100	0.043	Full

Table 6: Moderation Effect

Interaction Path	Path Coefficient (β)	t-value	p-value	95% Confidence Interval	Result
PRSF x CER → CE (H5)	0.005	0.104	0.917	[-0.110 0.063]	Not Supported

5.0 Discussion and Implications

Theoretically, this study advances human–robot interaction (HRI) research in hospitality by integrating anthropomorphism, perceived emotional intelligence (PEI), customer emotions, and perceived risk into a unified framework. It demonstrates that anthropomorphic design and PEI enhance customers' emotional responses, which, in turn, shape overall service experiences. This extends prior research focused on functional and cognitive factors by emphasizing emotional and relational dimensions in high-contact services. Grounded in the Service Robot Acceptance Model (SRAM), the findings confirm that both utilitarian and relational attributes influence customer responses, moving beyond traditional models such as TAM and UTAUT. Consistent with Anthropomorphism Theory, human-like cues significantly influence affective reactions. Cognitive Appraisal Theory further explains how customer evaluations translate into emotional responses that mediate overall service experiences (Lazarus & Folkman, 1984). Interestingly, perceived risk of service failure did not significantly moderate these relationships, challenging prior assumptions. Managerially, the study highlights the importance of balanced anthropomorphic design, emotionally intelligent robots, and strong human–robot integration, supported by transparency and reliable backup systems to sustain trust.

Practically, the findings provide important managerial insights for hospitality practitioners. First, anthropomorphic design features are not merely aesthetic but central to shaping customer experiences; even moderate human-like cues such as gestures, facial expressions, and voice modulation can enhance warmth and relatability, consistent with Anthropomorphism Theory. Managers should therefore invest in such features while avoiding excessive mimicry that may cause discomfort. Second, the study highlights the importance of emotional intelligence in robotic service delivery, showing that customer emotional responses mediate the relationship between robot attributes and service experience, as explained by Cognitive Appraisal Theory (Lazarus & Folkman, 1984). Robots capable of recognizing and responding to guest emotions can improve satisfaction and long-term loyalty. Third, consistent with the Service Robot Acceptance Model (SRAM), relational benefits are key drivers of robot acceptance; thus, managers should prioritize relational engagement through staff training, transparent communication, and seamless integration of robots into service environments. Finally, although perceived risk of service failure was not a significant moderator, managers should still address potential concerns by ensuring backup systems, human oversight, and effective service recovery to maintain trust and reduce uncertainty in robotic services.

This study, like all empirical research, has several limitations that offer directions for future research. First, it was conducted in Hangzhou, China, a technologically advanced yet culturally specific context, which may limit generalizability to societies with different expectations of emotional engagement or anthropomorphism; future cross-cultural studies could test the applicability of the Service Robot Acceptance Model (SRAM) across varying cultural dimensions such as individualism–collectivism and uncertainty avoidance. Second, the cross-sectional design captures relationships at a single point in time and cannot reflect the dynamic nature of emotional evaluations emphasized by Cognitive Appraisal Theory (CAT) (Lazarus & Folkman, 1984); thus, longitudinal studies are needed to examine how emotional responses evolve into trust, loyalty, or resistance over repeated interactions. Third, the use of purposive sampling ensures relevance but limits representativeness, suggesting the need for broader probability-based sampling; additionally, future research could incorporate variables such as trust in artificial intelligence, ethical concerns, and service recovery strategies to enhance the explanatory power of SRAM. Finally, although perceived risk of service failure was not a significant moderator, this finding suggests that emotional engagement may remain resilient in advanced service contexts; future studies should explore boundary conditions such as technological maturity and customer familiarity to better understand how Anthropomorphism Theory and CAT operate under different environmental conditions.

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Paper Contribution to Related Field of Study

This article contributes to the field of hospitality and smart tourism research.

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