Title: Enhancing intellectual experiences for users: A multi-dimensional model of humanoid service robots in tourism

Abstract

Purpose - Intellectual experiences focus on users' information processing and critical thinking towards stimuli. The deployment of humanoid service robots as novel stimuli in tourism and hospitality has influenced users' perceptions and may affect their intellectual engagement. This paper aims to connect four contemporary theoretical concepts: the service robot acceptance model, technological fear, the uncanny valley theory, and the stereotype content model, to investigate users' perceptions and intellectual experiences toward humanoid service robots.

Design/methodology/approach - Scale development procedures were conducted: literature review, checking face and content validity, factorizing items and dimensions, achieving construct and criterion validity, and testing predictive validity.

Findings - Through literature review and free-response tasks, 43 measurement items were generated. Next, 1,006 samples from two cross-cultural groups refined the scale. Finally, a reliable and valid scale with four dimensions measuring users' perceptions of humanoid service robots was determined.

Practical implications - Humanoid service robots should be designed to enhance functionality and innovativeness while minimizing stiffness, inflexibility, unsafety, and danger to improve users' intellectual engagement.

Originality/value - This study provides a novel examination of users' intellectual experiences towards humanoid service robots by connecting four contemporary theories of users' perceptions. This study enriches human-robot experience through an integrated perspective and presents a rigorous examination of the scale's psychometric properties. A reliable and valid scale for measuring users' perceptions toward humanoid service robots fills the gaps and serves as an effective predictor of intellectual experience in human-robot literature.

Keywords

Stereotype content model; service robot acceptance model; technological fear; uncanny valley; intellectual experiences; humanoid service robots

Paper Type

Original Article

1. Introduction

The increasing popularity and adoption of humanoid service robots in hospitality and tourism have sparked remarkable attention in the academic literature (Borghi & Mariani, 2024). The deployment of humanoid service robots aims to enhance service delivery efficiency, provide better user experiences, and increase overall industry value propositions. Currently, humanoid service robots are used in various operations such as check-in counters, concierge services, and room deliveries, offering novel intellectual experiences for users (Sun et al., 2024), which are crucial and core elements in users' overall evaluation of an organization's brand experience (Brakus et al., 2009; Said et al., 2024).

Intellectual experiences focus on users' cognitive information processing of stimuli (i.e., the humanoid service robots), stimulating their curiosity, problem-solving skills, and thinking abilities when they navigate through the robotic system (Tung & Tse, 2023). On the positive side, the availability of information, ease of navigation, and system-friendliness of service robots could affect users' cognitive thinking and problem-solving skills during human-robot interactions. In contrast, service robots that fail to provide answers to users could be regarded as "stupid" or "unsmart," decreasing users' curiosity, inhibiting their sense of thinking, and ultimately having a detrimental impact on their intellectual experiences.

Given the paramountcy of nurturing intellectual experiences, prior literature has predominantly taken a polarized stance (either positive or negative) regarding humanoid service robots. For instance, studies have indicated that robots endowed with human characteristics can enhance users' perceptions of competence and warmth, aligning with the stereotype content model in social psychology (Song et al., 2022). Conversely, other researchers have examined the "humanness" quotient to assess robotic functionality, trust, and rapport, contributing to the Service Robot Acceptance Model (Akdim et al., 2023). On the flip side, some scholars argue that overly human-like features could evoke discomfort and phobia among users, leading to rejection and negative evaluations, as per the uncanny valley theory (Holthöwer & van Doorn, 2023). Additionally, the notion of technological fear suggests that users' adverse perceptions of new technologies as hazardous could extend to advanced

humanoid service robots. Despite these studies offering valuable insights from diverse perspectives and emphases, they have failed to holistically examine users' intellectual experiences towards humanoid service robots by integrating views across these various concepts and bodies of literature. This is a major conceptual research gap.

The present research seeks to address the research gap through two related studies. Study 1 aims to identify users' perceptions towards humanoid service robots by connecting four contemporary concepts and theories, namely, the service robot acceptance model, technological fear, uncanny valley theory, and the stereotype content model (Akdim et al., 2023; Kang et al., 2023; Liu et al., 2022). While previous studies examined these concepts independently, this research develops an integrated conceptualization and validates it by regressing against users' intellectual experiences. Study 2 provides further empirical evidence by using a cross-cultural sample.

Overall, the present research contributes to the literature on intellectual experiences in hospitality and tourism by presenting an integrated conceptualization that connects concepts and theories from different fields, including the service robot acceptance model, technological fear, uncanny valley theory, and the stereotype content model. The integration of multiple concepts and valences is crucial as users' perceptions towards humanoid service robots are neither singular nor uni-dimensional. From a practical perspective, an integrated view from this research can provide insights on ways that robot designers can focus on functionality and innovativeness while reducing potential risks and stiffness of humanoid service robots. There are also important implications on how tourism and hospitality practitioners may utilize humanoid service robots to stimulate curiosity and information processing that are crucial to users' intellectual experiences.

2. Literature Review

2.1 Intellectual Experiences in Humanoid Service Robots Studies

Intellectual experience relates to users' cognitive, thinking, and problem-solving skills when they interact with a stimulus (i.e., humanoid service robot) (Brakus et al., 2009). It reflects users' thoughts and curiosity during information processing in relation to stimuli. Furthermore, it serves as a crucial aspect in constructing users' experiences, a core element in experiential and service-oriented industries, such as hospitality and tourism. At present, scholars have begun to investigate users' intellectual experiences towards new technologies. Kuo et al. (2019) found that information availability and ease of navigation of hotel mobile application, could stimulate users' curiosity to learn. Similarly, Lew et al. (2020) pointed that user's intention to use mobile wallets was determined by the degree of perceived intellectual experience. Some scholars have studied user's intellectual experiences from robotic staffs in hospitality, and found that its influences towards brand satisfaction, attachment, and loyalty (Hwang et al., 2023). Additionally, users' intellectual experiences could further influence other dimensions of brand experiences, including emotional and sensory experiences (Tung & Tse, 2023).

Many studies revealed supporting and objecting attributes that users uphold towards humanoid service robots in establishing their intellectual experience (Han et al., 2024; Huang et al., 2024; Khoa et al., 2023). A stream of scholars revealed that perceived usefulness, perceived intelligence and safety of humanoid service robots will spur users' intellectual experience which enhance user's acceptance, interaction, and other positive behavioral intentions (Said et al., 2024; Sun et al., 2024; Xu et al., 2022). Also, empirical findings suggested that higher degree of competence, efficiency in task completeness and ability to communicate would induce user's sense of curiosity and problem solving skills towards humanoid service robots (Ma et al., 2024; Vinoi et al., 2025). While other scholars reflected that stiff kinesics and violation of privacy would lower users' critical thinking towards humanoid service robots, leading to rejection (Park et al., 2023). Users regarded these as risky

and posing dangers, believing that interacting with humanoid service robot is causing more harm, and avoiding them is a way of self-protection (Li & Wang, 2023; Lin et al., 2023).

Integration of technology advancement in hospitality and tourism industry propose the potential of humanoid service robots, as stimuli, to induce novel intellectual experiences for users. The inclusion of human-like features, such as facial expressions and body shape, could stimulate how users perceive robot's abilities and eventually influence the knowledge exchange between them (Mascret et al., 2023). However, Kim and Park (2024) pointed out that these stimuli would induce 'credible' like humans that reduced users' thinking and problem-solving skill. Similarly, Fu et al. (2022) expressed that perceived discomfort and strangeness of humanoid attributes would reject users' intellectual exchanges. Despite the breadth of existing studies, however, research to date has yet to provide a strong, integrated theoretical conceptualization that could collectively influence users' thinking, curiosity, and problem-solving skills, which are crucial for fostering intellectual experiences for users. Hence, this study aims to draw upon contemporary concepts of humanoid service robots and investigate their influence on users' intellectual experiences simultaneously.

2.2 Humanoid Service Robots in Tourism and Hospitality: Theories and concepts

Scholars have examined the influence of humanoid service robots in the tourism and hospitality (Kim et al., 2022; Seyitoğl & Ivanov, 2023; Sharma et al., 2023). Often, humanoid service robots are defined as service robots that integrated with humanistic feature, such as facial expression, movement, body-shape, and voice (Akdim et al., 2023; Jung et al., 2023; Said et al., 2024; Song & Kim, 2022). Humanoid service robots are positioned beyond simple machines but rather social entities (Song et al., 2023) and examined with a number of contemporary concepts and theories, such as, the Service Robot Acceptance Model, concept of technological fear, uncanny valley theory, and the stereotype content model (Table 1).

----- Insert Table 1 Here -----

Service Robot Acceptance Model

Service Robot Acceptance Model is regarded as an extended model of Technology

Acceptance Model in service robot studies. It consists of three dimensions: First, functionality as the perception of usefulness and the degree of usability (Al-Okaily, 2023). Second, social-emotional focuses on the degree of 'humanness' with two sub-elements of interaction and social presence; interaction emphasizes the physical features of the service robot for mimicking humans, while social presence reflects the ability for service robots to interact and socialize (Fuentes-Moraleda et al., 2020). Third, relational centers on users' sense of trust and rapport, which builds upon the degree of reliability of service robots (Fuentes-Moraleda et al., 2020). Collectively, studies indicated their influences on user satisfaction and acceptance towards service robots in various service encounters.

Previous scholars have analyzed and identified attributes corresponding to the three dimensions. Song and Kim (2022) pointed out that reliability has been one of the key attributes among user's perception towards technologies, similar attribute attached to humans in interpersonal relations, that affect user's trust. Similarly, users who interact with humanoid service robots with a higher level of capable, efficiency and accuracy often evaluated with trust-worthy and useful which stimulate users' acceptance (Kao & Huang, 2023). Furthermore, users tend to perceived humanoid service robots based on their competence and intelligence in understanding and completing the assigned tasks while some would even evaluate how knowledgeable is the humanoid service robot in providing solutions and abilities to interact (Li et al., 2022; Said et al., 2024).

Concept of Technological Fear

Scholars have revealed users' negative perception of humanoid service robots due to technology fear which may hinder their acceptance (Fuentes-Moraleda et al., 2020; Talwar et al., 2023). They argued that technological fear reflects users' uncertainty, discomfort, and fears associated with the use of technologies (Jacob et al., 2023; Lan et al., 2022). It reflects users' perceived (in)competence and (un)confidence in their abilities to use and adopt to the new technologies (Subero-Navarro et al., 2022).

The concept of technology fears has been examined across different contexts in tourism and hospitality research with respect to the increasing technologies advancement and adoption.

Existing studies suggested that safety, security and privacy issues with robotic technologies, which have sparked awareness and concerns of stiffness among users when they interact with humanoid service robots (Lin et al., 2022; Said et al., 2024). It should be noted that these fears are associating with the programming used as well as the movement of the humanoid service robots. The sense of insecurity, risky and possible harms induced users' self-protection against these dangers by rejecting humanoid service robots (Song & Kim, 2022). Users' technological fear would reduce their acceptance, usage and preference for online, mobile technology-related tools (Park & Zhang, 2022).

Uncanny Valley Theory

The inclusion of humanoid features into technologies tools sparked investigation in user's perception towards these additions. Users may develop positive feelings of familiarity when an artificial entity (i.e., robot) is incorporated with human-like elements until that entity appears to be too realistic whereby it creates a sense of creepiness, eeriness, and uncanniness (Mori, 1970). In other words, the incorporation of human elements are not always positive and accepted, the humanoid technologies would be labeled as "too human" and rejected by the users (Akdim et al., 2023; Spatola et al., 2021).

At present, scholars are determined to identify the 'highest' users' acceptable point of humanization and its corresponding human-like features (Said et al., 2024), aiming to reduce or even remove creepiness, weirdness or scared (Kang et al., 2023). While previous studies, often, focused on the appearance of humanoid service robots, recent studies suggested that non-visual humanlike elements, such as humor, may reduce user's uncanniness and thus increase positive responses (Park et al., 2023). Other scholars revealed that the inflexibility of humanlike feature may cause user's emotional uncomfortable and develop a sense of inconvenience thus avoiding the humanoid service robots (Li et al., 2022). Similarly, Fu et al. (2022) indicated that uncommunicative pr passive communication from humanoid service robot would stimulate users' strangeness as well as negative emotional response of discomfort.

Stereotype Content Model

Contemporary research in social robotics regarded humanoid service robot beyond

machinery tools but as human beings with social characteristics (Song et al., 2022). These studies connect with stereotype content model (SCM) from social psychology to examine the social capabilities of humanoid service robots along two distinctive dimensions of warmth and competence (Fiske et al., 2018; Liu et al., 2022). Warmth focuses on technologies' social skills of friendliness, sincerity, and kindness while competence emphasizes on technologies' abilities and intelligence that aligning with the service robot acceptance model.

Scholars have begun to investigate the effect of stereotype content model in shaping user's perception of humanoid robotic service providers in the hospitality and tourism industry (Liu et al., 2022). Such adoption regarded humanoid service robots as social entities and uphold similar attributes of social capabilities as human beings. Users perceived robots with humanoid feature tend to be friendly, helpful, polite and with compassion during interactions (Huang et al., 2023; Nakanishi et al., 2020). These features would determine the degree of being approachable and politeness of humanoid service robots which form users' perception and affect their companionship with these technologies (Filieri et al., 2022; Grazzini et al., 2023; Spatola et al., 2021). In some studies, these humanlike characteristics of service robot generate users' perception of cool, trendy, stylish and novelty that stimulate human-robot interactions (Huang et al., 2024; Kang et al., 2023; Wang et al., 2022).

3. Methodology

This research includes two related studies. Study 1 seeks to: (a) integrate the concepts of service robot acceptance, technological fear, uncanny valley theory, and the stereotype content model within the tourism and hospitality context, and (b) assess how these concepts impact users' intellectual experiences with humanoid service robots, via a sample (n = 706) from Hangzhou, China. Hangzhou was selected due to its status as a leading destination (Lin et al., 2022) and its focus on robotic technology, including the establishment of China's first "Robot Town" (Hangzhou Municipal Bureau of Culture, Radio, TV and Tourism, 2023). The city's widespread use of humanoid robots and the presence of Alibaba Group, a key player in service and robotics, hosting the robot-staffed FlyZoo hotel since 2018, make it an ideal study location.

Study 2 aims to provide further empirical evidence for the integrated conceptualization

with a new sample from Singapore (n = 300), a city-state with well-developed service-oriented economy that is remarkedly different from China. China has the world's fastest growing service robot sector, occupying more than 25% of the global share, and is the world's largest robot manufacturer (OECD, 2023a). On the other hand, although Singapore is advancing in robot and smart technologies, it is mainly situated in functional robots rather than service robots although the service industry is the largest contributor to Singapore's economic growth in 2022 (OECD, 2023b). Evidence from contrasting countries in economic development and dependencies would provide more robust validation.

Respondents from both studies were recruited with their consent to participate. Those who disagreed were terminated. Furthermore, they were informed that all collected questionnaires are anonymous, data is kept confidential, and used solely for research purposes. Finally, respondents were allowed to terminate at any time.

3.1 Study 1

To achieve Study 1's objective, an initial pool of items related to users' perceptions towards humanoid service robots was generated through the aforementioned literature review on service robot acceptance model, technological fear, uncanny valley theory, and the stereotype content model. To ensure valid coverage of items, a supplementary exploratory study was conducted through a free response task to identify additional items, in case they were not mentioned in the existing studies. The supplementary exploratory study adopted the process suggested by Hall et al. (2015), and respondents (n=35) were asked to list traits that they would describe from their experiences with humanoid service robots. Traits that were mentioned by three or more participants were kept, and traits with similar meanings but were listed with variations were revised to only one version (e.g., smart and clever). Ultimately, 43 items (i.e., 19 positive and 24 negative) covering the four concepts of users' perception towards humanoid service robots encounter in tourism and hospitality were found (Appendix 1). Prior to data collection, a pilot testing was conducted with 20 Chinese to ensure clarity and readability. Further amendments were made to ensure ease of understanding of the questions, all items were used in the main data collection.

Sample

An online, self-administrated questionnaires in Chinese with the 43 initial pool of items were distributed to Hangzhou residents to measure their perception towards humanoid service robots based on their personal experiences on a 7-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). Finally, the last section collected respondents' demographic information. Using a gender-balanced and non-student sampling approach, 216 respondents were recruited (e.g., 77.32% under 35 years old; 92.59% with bachelor-level degree and above) (Table 2).

----- Insert Table 2 Here -----

Results

The collected data was examined through a multistage analysis in order to specify the constructs and items. Item-to-total correlations were calculated and coefficient lower than 0.40 were regarded as poorly correlated and were eliminated. No items were removed. Next, reliability analysis was conducted and Cronbach's alpha for positive and negative attributes were 0.88 and 0.89, respectively, exceeding the threshold value of 0.70 with good internal consistency among items (Nunnally, 1978). All items for positive and negative attributes were retained for subsequent analysis.

Exploratory Factor Analysis with principal components analysis and varimax rotation were employed to determine the dimensions of the attributes (Table 3). Items with communality lesser than 0.50, factor loading lower than 0.60, and factors with eigenvalues less than 1.0 were discarded. Cross-loaded items were also removed. For positive attributes, Bartlett's test of sphericity was 342.18 ($p < 0.0001$) and Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.78, which suggest the data is suitable for factor analysis. Two factors were extracted with three items respectively and accounted for 67.15% of the total variance. The first factor contained Functional aspect (i.e., "Capable," "Efficient," and "Competent") while the second factor consisted of attributes that represented the Innovativeness (i.e., "Trendy," "Stylish," and "Novel"). Both factors had Cronbach's alpha values of 0.77 and 0.73 respectively.

For negative attributes, Bartlett's test of sphericity was 331.87 ($p < 0.0001$) and KMO value was 0.71. Two factors accounted for 66.90% of the total variance. First factor involved the Rigidity (i.e., "Inflexible," "Uncommunicative" and "Inconvenient"). Second factor involved Risk (i.e., "Unsafe", "Dangerous" and "Risky"). Both factors achieved Cronbach's alpha values of 0.70, and 0.76 respectively.

----- Insert Table 3 Here -----

----- Insert Table 4 Here -----

After Exploratory Factor Analysis, Confirmatory Factor Analysis was conducted to assess the aforementioned 4-dimensional framework (i.e., Functional and Innovative versus Rigid and Risky). A new sample of Hangzhou respondents (n = 490) was recruited to ensure rigor and robustness. Pilot testing was conducted with 25 Chinese to ensure the added measured items of user's intellectual experience. The sample size (n = 490) was determined with the consideration in number of measured items and based on Cochran's (1977) suggested with an anticipated 0.20 effect size, 0.80 statistical power and a 0.05 probability level This validation sample was collected via a gender-balanced and non-student sampling approach by using an online and self-administrated questionnaire.

The evaluation of overall mode fit was based on various model indices without modification. Maximum degrees of freedom $\chi 2/df$ was 3.07 ($\chi 2 = 147.51$; $df = 48$) fall within the acceptable range (Bollen, 1989). Model fit indices of Comparative Fit Index, CFI = 0.97, Goodness of Fit, GFI = 0.95, and Tucker–Lewis index, TLI = 0.95, all exceeded the threshold value of 0.90, and the value of RMSEA is 0.06, indicating the model is reasonable (Hu & Bentler, 1999). The Average Variance Extracted (AVE) values for all four dimensions surpassed the minimum value of 0.50, which confirms convergent validity (Kline, 2005). The composite reliability of the four dimensions ranged between 0.75 to 0.87, indicating good to excellent internal consistency. The values of squared root AVE were higher than inter-factor correlations and no correlation coefficients exceeded 0.85, fulfilling the discriminant validity (Tables 5 and 6).

----- Insert Table 5 Here -----

----- Insert Table 6 Here -----

Predictive Validity: Intellectual experiences

Study 1 also test the predictive validity of the integrated model by evaluating how it could affect user's intellectual experiences. Predictive validity refers to evaluation of a variable to an antecedent or consequence (Bagozzi, 1981). The four dimensions (i.e., functional, innovative, rigid, and risky) were regressed against the concept of intellectual experience as the dependent variable (n = 490 as per validation sample).

The items used to measure intellectual experience were adapted from Brakus et al. (2009) and refined according to the present study (e.g., "Humanoid service robots in tourism and hospitality induces my thinking"; "humanoid service robots in tourism and hospitality stimulates my curiosity"; and "humanoid service robots in tourism and hospitality engages my problem-solving skills") and measured with 1 = strongly disagree to 7 = strongly agree.

Respondents were not asked, specifically, to recall a memory of an intellectual experience with humanoid service robots in tourism and hospitality. However, existing literature suggested that the measure of user's intellectual experience is based on their evaluated capabilities of the humanoid service robots (Said et al., 2024). Furthermore, users would be interested in them, which stimulates their curiosity and problem-solving skills as part of intellectual engagement (Huang et al., 2024; Li et al., 2024; Ma et al., 2024).

The results indicated significant relationships across the four dimensions of user's perception onto their intellectual experience. Also, multicollinearity was examined through calculation of values of the variance inflation factor (VIF), which were all less than 3.0. Furthermore, the tolerance levels were no less than 0.2 (Hair et al. 2010) (Table 7).

----- Insert Table 7 Here -----

Brief Discussion on Study 1

Study 1 offered initial evidence for an integrated conceptualization of users' perspectives of humanoid service robotics in tourism and hospitality. It identified four key dimensions (i.e., functional, innovative, rigid, and risky), which corresponds to four contemporary theoretical

concepts, respectively (i.e., service robot acceptance model, the stereotype content model, technological fear, and uncanny valley theory). For example, functionality and innovativeness have been regarded as essential characteristics of humanoid service robots (Wang et al., 2022). In contrast, risk and rigidity reflects individuals' views arising from the uncanny valley of humanoid service robots and technological fear. Also, these four dimensions affected individuals' intellectual experiences, which is a core element for enhancing tourism and hospitality experiences.

3.2 Study 2

Study 2 validates the integrated conceptualization from Study 1 with a new sample from Singapore, a service-driven economy contrasting China's manufacturing-led growth (OECD, 2023b). Although Singapore has developed and incorporated robotics for economic development, robotics has often been situated in functional areas, such as transportation and cleaning, rather than the service sector although services contributed most to Singapore's economic growth in 2022 (OECD, 2023a). Contextually, evidence in Study 2 from Singapore, a country that is vastly different in economic development and dependencies as compared to the Chinese sample in Study 1, could provide more robust validation for the integrated model. Methodologically, Study 2 employs an English version of the model, thereby enhancing the research's applicability and robustness across different linguistic contexts.

Participants and procedure

A pilot testing with 30 Singaporeans to ensure the clarity and readability of the English version measured items. No amendment were made. The online, self-administrated, English survey was distributed to Singaporeans using a gender-balanced quota and non-student sampling approach (n = 300). The sample size was determined based on Cochran's (1977) suggestion that exceed the minimum number of 156.

----- Insert Table 8 Here -----

Model assessment

The results indicated good model fit with maximum degrees of freedom ($\chi 2/df = 105.63/48$

= 2.20), CFI = 0.97, NNFI = 0.95, GFI = 0.94, TLI = 0.96, and RMSEA= 0.06 without modification indices. The standardized factor loading for the items were ranged between 0.64 to 0.92, and the composite reliability (CR) values for each dimension were between 0.79 and 0.89. AVE exceeded the threshold value of 0.50, indicating convergent validity, and the inter-dimension correlation coefficients were lower than the square root of AVE (Fornell & Larcker, 1981) (see Tables 9 and 10). The regression analysis results indicated significant relationships between user's perception and intellectual experience, supporting the predictive validity of the integrated model.

Brief Discussion of Study 2

Study 2 provided further support for the integrated model via a sample from Singapore, a country that is significantly different from China in terms of robotic development, economic development and dependencies. Furthermore, Study 1 and 2 tested both Chinese and English versions of the integrated model, which provided additional robustness to the applicability of the research.

4. Discussion and Conclusion

4.1 Conclusion

Deploying humanoid service robots offers novel experiences, especially users' intellectual experiences, which spark significant attention among academics and practitioners. Intellectual experience focuses on users' cognitive information processing, which is influenced by their perception of humanoid service robots. This research provides empirical results regarding users' perceptions by connecting four contemporary theories and concepts from the literature, namely the service robot acceptance model, technological fear, uncanny valley theory, and the stereotype content model. In addition, the predictive powers of users' perceptions on intellectual experiences were explored. The results are discussed as follows:

The first key objective is to develop an integrated conceptualization of users' perceptions of humanoid service robots in the tourism and hospitality industry. Through a literature review and multiple statistical analyses, a list of positive and negative perception attributes was

identified and factorized into four distinctive dimensions: functionality, innovative, rigid, and risky. Specifically, functionality and innovative reflect positive perceptions, while rigid and risky mirror negative perceptions of users towards humanoid service robots. The results highlight the dependence, instead of independence, of robotic design, risk management, and social psychology in forming users' perceptions of humanoid service robots.

Empirical findings from both Hangzhou and Singapore indicated both positive and negative users' perceptions of humanoid service robots in tourism and hospitality affect intellectual experiences. For positive perceptions, efficiency, competency, and capability were reflected under functionality, while novelty, trendiness, and stylishness were regarded as the innovative aspects of humanoid service robots that could enhance intellectual experiences for users. Specifically, the Hangzhou sample emphasized hard skills, while the Singapore sample focused on the modernity and creativity of humanoid service robots.

On the contrary, for negative perceptions, the stiffness and insecurity from humanoid service robots could reduce intellectual experiences for users. In other words, inflexibility and fears of danger from robots could reduce users' problem-solving and intellectual engagement as they navigate a robotic system. For instance, if a humanoid service robot fails to communicate with users effectively or violates users' privacy, this could trigger perceptions of risk, thereby lowering users' cognitive and intellectual experiences during human-robot interaction.

The negative dimensions, rigidity and risk, could hinder users' intellectual experiences with humanoid service robots in tourism and hospitality. When robotic technologies are dangerous, stiff, and inflexible, users' critical thinking and willingness to learn about a robotic system could be reduced (Chang et al., 2024). Additionally, risky behaviors from service robots, such as collecting users' information prior to consent via photo-taking, may elicit negative perceptions, thereby inhibiting users' curiosity and intellectual experience. These findings echo previous studies that suggested violations of privacy issues, performing unsafe actions, and failure to deliver information are seen as stiff and dangerous to users of service robotics (Sun et al., 2024; Zhang et al., 2022).

This study provides deeper insights into existing research examining how psychological theories of human-robot interaction shape users' perceptions and experiences. Specifically, Bagheri (2023) leverages the Theory of Mind to comprehend users' mental states of perception and evaluation towards service robots, ultimately influencing their stance, interactions, and experiences, thereby fostering acceptance. Other scholars have explored users' attitudes towards service robots using diverse psychological theories, including self-determination theory, the theory of basic psychological needs, and regret theory (Janssen & Schadenberg, 2024). Their findings underscore how aspects such as risk-awareness, functionalities, and feasibility of social robots intellectually engage users. In tourism literature, scholars have utilized social exchange theory to investigate users' psychological states with service robots, revealing the significant impact of perceived intelligence and interactions on human-robot interaction (Kim et al., 2022). Huang et al. (2024) employed cognitive-oriented theories to identify coolness, utility, and flexibility as key factors influencing users' perceptions in human-robot interactions.

4.2 Theoretical implications

First, this research uncovers the complex and multi-dimensional nature of users' perspectives towards humanoid service robotics in tourism and hospitality, thereby enriching the broader topic of smart technology in the field. While existing literature has primarily focused on either the positive or negative aspects of robotics this research considers both aspects simultaneously by addressing robotic design orientations and the social elements of humanoid service robots (Song et al., 2023). In other words, this research captures and balances both positive and negative aspects concurrently, demonstrating the complexity of users' perceptions of humanoid service robots in tourism and hospitality. More broadly, the framework presents an integrated and holistic conceptualization that contributes to the theoretical advancement of smart technology in tourism and hospitality.

Second, based on four contemporary theories and concepts, namely service robot acceptance model, technological fear, uncanny valley theory, and the stereotype content model. Moreover, our study identified four key dimensions: functionality, innovation, rigidity, and risk

(Kim et al., 2023). This comprehensive approach moves beyond isolated views of these concepts, offering a broader perspective on robot perception. Instead, it suggests that research on humanoid service robots in tourism and hospitality literature should not only consider the physical attributes derived from information technology research but also incorporate social elements from socio-psychology research (Song & Kim, 2022).

Third, this research enriches the literature on users' *intellectual experience* towards humanoid service robot in tourism and hospitality, which is a crucial aspect of overall brand experiences in marketing and management (Tung & Tse, 2023). By emphasizing the predictive power of each of the four distinct dimensions on intellectual experiences, the research contributes to the literature by establishing antecedent-consequence relationships of users' experience towards humanoid service robots in tourism and hospitality. Specifically, this research shows that users' critical thinking can be positively stimulated when a humanoid service robot is efficient and innovative, thereby inducing users' curiosity. Conversely, concerns over rigidity and risk could negatively impact users' intellectual experiences.

Finally, this research contributes to the literature by showing the robustness of the integrated model in terms of both context and applicability. Evidence from China and Singapore, two contrasting countries in economic development and dependencies, provided validation for the integrated model. Methodologically, both English and Chinese versions of the model offered additional robustness to the applicability of the research. Overall, this research shows that the four dimensions in the integrated model are reliable and valid from both contextual and linguistic perspectives, and offer confidence to future adaptations in different markets and across different languages.

4.3 Practical Implications

The integrated conceptualization of users' perception offers several practical implications for marketing in tourism and hospitality, and for design in humanoid robotics. From a marketing perspective, humanoid service robots have been employed as stimuli for creating novel experiences (Rancati & Maggioni, 2023). Often, marketers focus on promoting humanoid features, such as faces, body shapes, and vocals, with an aim to stimulate human-

robot interactions. This research suggests, however, that marketers need to move beyond humanoid features or fun aspects and highlight a humanoid robot's functionality and innovativeness in their promotional messages to align with the gradual adoption of technology in the industry. These are the two key dimensions that stimulate users' thoughts, critical thinking, and curiosity when they are navigating and interacting with humanoid service robots. These are also the two dimensions that can enhance users' intellectual experiences, which is a crucial component of overall brand experience in marketing (Kim et al., 2022).

For instance, the South Korean telecom company KT utilizes service robots at hotels in Seoul that incorporate humanoid features such as voice and touch receivers, mimicking human senses of hearing and touch. These advanced sensors efficiently capture queries and instructions from both hotel staff and guests. Additionally, these robots are equipped with AI translation services, catering to non-Korean-speaking guests by providing information and services in English, Chinese, and Japanese. The deployment of these robots necessitated additional training for employees to familiarize themselves with the robotic technologies and enhance the quality of service and intellectual experience for hotel guests. Similarly, Brick Hospitality, a prominent hospitality company in San Diego, has integrated humanoid service robots into their daily operations. They prioritize the safety of these robots by installing sophisticated camera systems, sensitive sensors, and real-time surveillance to ensure a secure environment for staff and guests. However, hotels must inform guests and obtain their consent before capturing their images on camera, as failure to do so could adversely impact guests' experience, satisfaction, and the hotel's reputation.

This research also offers practical insights for robot designers. While robot designers have been focusing on human-like features from appearance to movements (Kim & Im, 2023), the findings of this research suggest that in addition to humanoid enhancements, designers should also focus on the flexibility as well as safety of the service robots in service settings. Specifically, the dimensions of rigidity and riskiness can negatively influence users' evaluations and reduce their willingness to interact with service robots. To address these dimensions, robot designers can incorporate 'on-the-job training' programs (Li et al., 2024; Park et al., 2023). Robots can learn from 'on-the-job training' programs (i.e., at the front end

of hotels) through artificial intelligence and machine learning so that they can accumulate knowledge and ‘work experience’. This would allow for continuous improvements while reducing inflexibility and perceptions of risk and rigidity by users. At the same time, such ‘work experience’ could increase the competence, reliability, and credibility of humanoid service robotics, thereby enhancing users’ intellectual experiences in the long term.

However, the deployment of humanoid service robots and other robotic technologies is influenced by a multitude of factors that must be taken into account. One significant consideration is the affordability of these robotic systems. The industry must weigh the costs and benefits of incorporating such advanced technologies into their operations. Additionally, employees' willingness to accept and their perception of humanoid service robots play a crucial role. They may perceive these robots as either competitors (foes) or as allies (friends), which can affect their emotional attachment, attitude, and subsequent interactions with them (Akdim et al., 2023; Pan et al., 2025). Therefore, it is essential for managers to mentally prepare employees before deploying humanoid service robots. Guests should also be informed through signage or announcements about the presence of these robots, allowing them to prepare for this novel technological experience. Furthermore, legislation concerning robotic technologies must be carefully considered, particularly regarding data privacy, user confidentiality while using the robots, and the environmental impacts of their production, such as pollution.

4.4 Limitations and Future Research

This research has limitations and suggests avenues for future study. The samples were taken from high-tech Asian cities, Hangzhou and Singapore, where residents may have more exposure to robotics than those from less technologically advanced areas. The extrapolation of these empirical findings to regions with different technological readiness or cultural attitudes towards technology could be challenging and might not provide a complete picture of global perceptions. As such, future research may replicate and extend this study to areas with different contextual factors (e.g., cultural differences and technological maturity) (Kao & Huang, 2023). These empirical findings would offer additional insights to the current results, providing a more

complete picture of users' perceptions and intellectual experiences towards humanoid service robots globally.

Despite efforts to collect cross-cultural samples across the two studies, future studies may replicate this research by considering the distribution and wide range of respondents' demographics that could further enhance the generalizability of the empirical findings. Furthermore, future research could compare diverse demographic groups to identify potential differences in users' perceptions towards humanoid service robots. Additionally, future studies would collect samples with larger sizes to enhance the robustness of empirical findings, especially in cross-cultural comparisons.

Furthermore, this research suggested that future studies should compare the empirical findings from this research with traditional human service interactions to evaluate how perceptions and experiences differ with respect to different service providers in tourism and hospitality. A comparative analysis with human service providers may offer insights into how humanoid service robots stack up against them in terms of user satisfaction and experiences, hence providing a more nuanced perspective in human-robot research.

This research relies on a self-administered questionnaire using a Likert-type scale. While it is a common and suitable approach for measuring users' perceptions, future research could incorporate qualitative interviews or focus groups to reveal richer findings, especially in the areas of users' emotional responses or nuanced perceptions that extend beyond the scale's options. Moreover, future research could explore implicit measures to validate findings further and examine their impact on experiences with humanoid robots in tourism and hospitality.

Finally, future research may replicate this study by adopting a longitudinal approach in examining users' perceptions towards humanoid service robots. Data from a longitudinal study would provide insights into how users' perceptions may evolve over time, and whether they remain stable or change as users gain more experience with humanoid service robots. Findings from a longitudinal approach may offer continuous examination of individual changes, which would advance knowledge development in the area of human-robot interaction.

References

Akdim, K., Belanche, D., and Flavián, M. (2023), "Attitudes toward service robots: analyses of explicit and implicit attitudes based on anthropomorphism and construal level theory", *International Journal of Contemporary Hospitality Management*, Vol. 35 No. 8, pp.2816-2837. https://doi.org/10.1108/IJCHM-12-2020-1406

Al-Okaily, M. (2023), "The influence of e-satisfaction on users'e-loyalty toward e-wallet payment apps: a mediated-moderated model", *International Journal of Emerging Markets*, https://doi.org/10.1108/IJOEM-08-2022-1313

Bagheri, E. (2023), "A Mini-survey on Psychological Pillars of Empathy for Social Robots: Self-Awareness, Theory of Mind, and Perspective Taking", *International Journal of Social Robotics*, Vol. 15 No. 7, pp.1227-1241. https://doi.org/10.1007/s12369-023-01022-z

Bagozzi, R.P. (1981), "Attitudes, intentions, and behavior: A test of some key hypotheses", *Journal of Personality and Social Psychology*, Vol. 41 No. 4, pp.607-627. https://doi.org/10.1037/0022-3514.41.4.607

Bollen, K.A. (1989), "A new incremental fit index for general structural equation models", *Sociological Methods & Research*, Vol. 17 No. 3, pp.303-316. https://doi.org/10.1177/0049124189017003004

Borghi, M. and Mariani, M.M. (2024), "Asymmetrical influences of service robots' perceived performance on overall customer satisfaction: an empirical investigation leveraging online reviews", *Journal of Travel Research*, Vol. 63 No. 5, pp.1086-1111. https://doi.org/10.1177/0047287523119061

Brakus, J. J., Schmitt, B. H., and Zarantonello, L. (2009), "Brand experience: what is it? How is it measured? Does it affect loyalty?", *Journal of Marketing*, Vol. 73 No. 3, pp.52-68. https://doi.org/10.1509/jmkg.73.3.052

Chang, Y., Zhang, C., Li, T., and Li, Y. (2024), "Social cognition of humanoid robots on customer tolerance of service failure", *International Journal of Contemporary Hospitality Management*, Vol. 36 No. 7, pp.2347-2366. https://doi.org/10.1108/IJCHM-02-2023-0250

Cochran, W. G. (1977), *Sampling Technique*, John Wiley & Sons. New York.

Fiske, S.T., Cuddy, A.J., Glick, P. and Xu, J. (2018), "A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition", Fiske S (Ed.), *Social Cognition*, Routledge, pp. 162-214 .

Fornell, C. and Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), pp.39-50. https://doi.org/10.1177/002224378101800104

Fu, S., Zheng, X. and Wong, I.A. (2022), "The perils of hotel technology: The robot usage resistance model", *International Journal of Hospitality Management*, Vol. 102, p.103174.

https://doi.org/10.1016/j.ijhm.2022.103174

Fuentes-Moraleda, L., Díaz-Pérez, P., Orea-Giner, A., Muñoz-Mazón, A. and Villacé-Molinero, T. (2020), "Interaction between hotel service robots and humans: A hotel-specific Service Robot Acceptance Model (sRAM)", *Tourism Management Perspectives*, Vol. 36, p.100751. https://doi.org/10.1016/j.tmp.2020.100751

Hair, Jr. J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2010), *Multivariate data analysis* (7th ed.). Upper Saddle River, New Jersey: Pearson Education International.

Hall, E. V., Phillips, K. W., and Townsend, S. S. 2015, "A rose by any other name?: The consequences of subtyping "African-Americans" from "Blacks"", *Journal of Experimental Social Psychology*, Vol. 56, pp.183-190.. https://doi.org/10.1016/j.jesp.2014.10.004

Hangzhou Municipal Bureau of Culture, Radio, TV and Tourism. 2023, "*Tourism of Digital Intelligence*", available at: https://wgly.hangzhou.gov.cn/en/wh/di/index.html (accessed 21 December 2023).

Holthöwer, J. and van Doorn, J. (2023), "Robots do not judge: service robots can alleviate embarrassment in service encounters", *Journal of the Academy of Marketing Science*, Vol. 51 No. 4, pp.767-784. https://doi.org/10.1007/s11747-022-00862-x

Hu, L.T. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives", *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 6 No. 1, pp.1-55. https://doi.org/10.1080/10705519909540118

Huang, D., Chen, Q., Huang, S. and Liu, X. (2024), "Consumer intention to use service robots: a cognitive–affective–conative framework", *International Journal of Contemporary Hospitality Management*, Vol. 36 No. 6, pp.1893-1913. https://doi.org/10.1108/IJCHM-12-2022-1528

Hwang, J., Joo, K.H., Kim, H. and Lee, J.S.H. (2023), "The difference between service robots and human staff in the extended TPB model in airports", *Current Issues in Tourism*, pp.1-14. https://doi.org/10.1080/13683500.2023.2215975

Janssen, S., and Schadenberg, B. R. (2024), "A Psychological Need-Fulfillment Perspective for Designing Social Robots that Support Well-Being", *International Journal of Social Robotics*, 1-22. https://doi.org/10.1007/s12369-024-01102-8

Jung, I., Quan, W., Yu, J. and Han, H. (2023), "Are you ready for robot services? Exploring robot-service adoption behaviors of hotel-goers", *International Journal of Hospitality Management*, Vol. 109, p.103404. https://doi.org/10.1016/j.ijhm.2022.103404

Kang, S.E., Koo, C. and Chung, N. (2023), "Creepy vs. cool: Switching from human staff to service robots in the hospitality industry", *International Journal of Hospitality Management*, Vol. 111, p.103479. https://doi.org/10.1016/j.ijhm.2023.103479

Kao, W.K. and Huang, Y.S.S. (2023), "Service robots in full-and limited-service restaurants:

Extending technology acceptance model", *Journal of Hospitality and Tourism Management*, Vol. 54, pp.10-21. https://doi.org/10.1016/j.jhtm.2022.11.006

Kim, H. and Park, M. (2024), "When digital celebrity talks to you: How human-like virtual influencers satisfy consumer's experience through social presence on social media endorsements", *Journal of Retailing and Consumer Services*, Vol. 76, p.103581. https://doi.org/10.1016/j.jretconser.2023.103581

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

Kim, H.M., Abbas, J., Haq, M.Z.U., Lee, J. and Hwang, J. (2023), "Differences between robot servers and human servers in brand modernity, brand love and behavioral intentions in the restaurant industry", *Asia Pacific Journal of Marketing and Logistics*, Vol. 35 No. 7, pp.1774-1788. https://doi.org/10.1108/APJML-03-2022-0214

Kim, J. and Im, I. (2023), "Anthropomorphic response: Understanding interactions between humans and artificial intelligence agents", *Computers in Human Behavior*, Vol. 139, p.107512. https://doi.org/10.1016/j.chb.2022.107512

Kline, T.J. (2005), *Psychological testing: A practical approach to design and evaluation*. Sage Publications.

Kuo, T.S., Huang, K.C., Nguyen, T.Q. and Nguyen, P.H. (2019), "Adoption of mobile applications for identifying tourism destinations by travellers: an integrative approach", *Journal of Business Economics and Management*, Vol. 20 No. 5, pp.860-877. https://doi.org/10.3846/jbem.2019.10448

Lew, S., Tan, G.W.H., Loh, X.M., Hew, J.J. and Ooi, K.B. (2020), "The disruptive mobile wallet in the hospitality industry: An extended mobile technology acceptance model", *Technology in Society*, Vol. 63, p.101430. https://doi.org/10.1016/j.techsoc.2020.101430

Li, P., Lv, Y., Wang, R., Chen, T., Gao, J. and Huang, Z. (2024), "How do illegitimate tasks affect hospitality employees' adaptive performance? An explanation from the perspective of cognitive-affective system theory of personality", *International Journal of Contemporary Hospitality Management*, Vol. 36 No. 9, pp. 3032-3051. https://doi.org/10.1108/IJCHM-04-2023-0538

Li, T., Wang, L., Liu, J., Yuan, J. and Liu, P. (2022), "Sharing the roads: Robot drivers (vs. human drivers) might provoke greater driving anger when they perform identical annoying driving behaviors", *International Journal of Human–Computer Interaction*, Vol. 38 No.4, pp.309-323. https://doi.org/10.1080/10447318.2021.1938392

Lin, V.S., Qin, Y., Li, G. and Jiang, F. (2022), "Multiple effects of "distance" on domestic tourism demand: A comparison before and after the emergence of COVID-19", *Annals of Tourism Research*, Vol. 95, p.103440. https://doi.org/10.1016/j.annals.2022.103440

Liu, F., Wei, H., Zhu, Z. and Chen, H.A. (2022), "Warmth or competence: Brand

anthropomorphism, social exclusion, and advertisement effectiveness", *Journal of Retailing and Consumer Services*, Vol. 67, p.103025. https://doi.org/10.1016/j.jretconser.2022.103025

Ma, C., Fan, A. and Lee, S.A. (2024), "Unveiling the role of congruity in service robot design and deployment", *International Journal of Contemporary Hospitality Management*, https://doi.org/10.1108/IJCHM-11-2023-1686

Mori, M. (1970), "*The uncanny valley: the original essay by Masahiro Mori*", IEEE Spectrum, Vol. 6, pp.1-6.

Nunnally, J.C. (1978), "An overview of psychological measurement", *Clinical Diagnosis of Mental Disorders: A Handbook*, pp.97-146. https://doi.org/10.1007/978-1-4684-2490-4_4

Organisation for Economic Co-operation and Development OECD. (2023a), "*Chapter 12. China and the next production revolution*", available at: https://www.oecd-ilibrary.org/sites/9789264271036-16-en/index.html?itemId=/content/component/9789264271036-16-en#:~:text=For%20example%2C%20China%20is%20now,of%20digital%20technologies%20in%20manufacturing. (accessed on 21 December 2023).

Organisation for Economic Co-operation and Development OECD. (2023b), "*Economic Outlook for Southeast Asia, China and India 2023: Reviving Tourism Post-Pandemic*" OECD Publishing, https://doi.org/10.1787/f677c529-en. (accessed on 21 December 2023).

Pan, S. Y., Lin, Y., and Wong, J. W. C. (2025), "The dark side of robot usage for hotel employees: An uncertainty management perspective", *Tourism Management*, Vol. 106, p.104994. https://doi.org/10.1016/j.tourman.2024.104994

Park, H.J. and Zhang, Y. (2022), "Technology readiness and technology paradox of unmanned convenience store users", *Journal of Retailing and Consumer Services*, Vol. 65, p.102523. https://doi.org/10.1016/j.jretconser.2021.102523

Park, J., Yoo, J.W., Cho, Y. and Park, H. (2023), "Examining the impact of service robot communication styles on customer intimacy following service failure", *Journal of Retailing and Consumer Services*, Vol. 75, p.103511. https://doi.org/10.1016/j.jretconser.2023.103511

Rancati, G. and Maggioni, I. (2023), "Neurophysiological responses to robot–human interactions in retail stores", *Journal of Services Marketing*, Vol. 37 No. 3, pp.261-275. https://doi.org/10.1108/JSM-04-2021-0126

Said, N., Ben Mansour, K., Bahri-Ammari, N., Yousaf, A., and Mishra, A. (2024), "Customer acceptance of humanoid service robots in hotels: moderating effects of service voluntariness and culture", *International Journal of Contemporary Hospitality Management*, Vol. 36 No. 6, pp.1844-1867. https://doi.org/10.1108/IJCHM-12-2022-1523

Song, C.S. and Kim, Y.K. (2022), "The role of the human-robot interaction in consumers'

acceptance of humanoid retail service robots", *Journal of Business Research*, Vol. 146, pp.489-503. https://doi.org/10.1016/j.jbusres.2022.03.087

Song, M., Xing, X., Duan, Y., Cohen, J. and Mou, J. (2022), "Will artificial intelligence replace human customer service? The impact of communication quality and privacy risks on adoption intention", *Journal of Retailing and Consumer Services*, Vol. 66, p.102900. https://doi.org/10.1016/j.jretconser.2021.102900

Subero-Navarro, Á., Pelegrín-Borondo, J., Reinares-Lara, E. and Olarte-Pascual, C. (2022), "Proposal for modeling social robot acceptance by retail customers: CAN model+ technophobia", *Journal of Retailing and Consumer Services*, Vol. 64, p.102813. https://doi.org/10.1016/j.jretconser.2021.102813

Sun, S., Ye, H., and Law, R. (2024), "Cognitive–analytical and emotional–social tasks achievement of service robots through human–robot interaction", *International Journal of Contemporary Hospitality Management*, https://doi.org/10.1108/IJCHM-12-2023-1880

Tung, V.W.S. and Tse, S.W.T. (2023), "A patterns perspective of customers' brand experiences with robotics in hospitality", *Journal of Travel & Tourism Marketing*, Vol. 40 No.1, pp.75-89. https://doi.org/10.1080/10548408.2023.2215268

Vinoi, N., Shankar, A., Agarwal, R., and Alghafes, R. (2025), "Revolutionizing retail: The transformative power of service robots on shopping dynamics", *Journal of Retailing and Consumer Services*, Vol. 82, 104085. https://doi.org/10.1016/j.jretconser.2024.104085

Wang, Y., Kang, Q., Zhou, S., Dong, Y. and Liu, J. (2022), "The impact of service robots in retail: Exploring the effect of novelty priming on consumer behavior", *Journal of Retailing and Consumer Services*, Vol. 68, p.103002. https://doi.org/10.1016/j.jretconser.2022.103002

Xu, S., Stienmetz, J. and Ashton, M. (2020), "How will service robots redefine leadership in hotel management? A Delphi approach", *International Journal of Contemporary Hospitality Management*, Vol. 32 No. 6, pp. 2217-2237. https://doi.org/10.1108/IJCHM-05-2019-0505