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Impact of restaurant robot service consumption values on their consequences: The moderating effects of perceived risk and human-robot interaction quality

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Abstract

The present study aimed to develop a new conceptual model on restaurant robot service consumption values (RRSCVs) and investigate their influence on diverse outcome variables. The study collected data from 756 customers who experienced restaurant robot services using convenience sampling techniques. This study employed exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to assess reliability and validity of the data, as well as to evaluate model fit indices. A structural equation modeling (SEM) analysis with a multi-group approach was used to test relationships. The results showed that functional values of performance and quality, humanlike capability, social, emotional, and epistemic values significantly predicted attitude toward robot services, while price, safety, and privacy values did not. Attitude was found to be a significant predictor of perceived brand equity. Finally, perceived brand equity strongly influenced the intention to pay more, loyalty, intention to recommend to others, and intention to participate in value co-creation. Both perceived risk and human-robot interaction quality partially influenced the relationships in the structural model. This study provides insightful academic and practical implications, facilitating a deeper understanding of the role of the RRSCVs in the hospitality business.

1. Introduction

Adoption of service robots in restaurants has become a prevalent phenomenon, as robots help reduce labor costs, provide quick service, and offer novelty to customers (Mejia et al. 2024). Given the widespread adoption of service robots in the hospitality industry, numerous studies have been conducted to examine customers' perceptions of these robots (Song et al. 2024). A rapidly growing number of studies in the hotel and restaurant sectors have explored various research topics, such as willingness to pay (e.g., Chuah et al. 2022; Huang et al. 2021; Ivanov and Webster 2021), customers' experience of robot-assisted food service (e.g., Ivanov and Webster 2023), human-robot interaction and collaboration (e.g., Choi et al. 2020: Wu and Zhang 2024), value co-creation (e.g., Chuah et al. 2022; Lin et al. 2024; Zhang et al 2022), and human-likeness of service robots and their influences (e.g., Chi et al. 2024; Lu et al. 2021).

The current study focusses on examining consumption values of restaurant robot services, as these establishments are among the primary adopters of service robot technologies (Seo and Lee 2021). Despite the expanded body of literature on the application of service robots in the restaurant industries, the following research gaps remain. First, the majority of existing research explored the consumption value within the broader context of consumer behavior (Candan and Yıldırım 2013; Sheth et al. 1991; Sweeney and Soutar 2001). A few studies have examined consumption values, particularly in robotic restaurant settings (Seo and Lee 2021), often targeting potential users of service robot technologies, and relying on hypothetical scenarios to examine their responses (Chuah et al. 2022; Lin and Mattila 2021; Tussyadiah and Park 2018). The current research introduced a novel conceptual model that analyzed the effects of multi-dimensional restaurant robot service consumption values (RRSCVs) on consumers' attitudes, focusing on customers' actual experiences with robot services. In previous studies, perceived values had been shown to shape consumers' attitudes and intention to use a given service or product (Li et al. 2025). Examining customers' attitudes also plays a pivotal role in understanding consumers' cognitive, affective and conative responses to consumption values (Mamman et al. 2016, p.53).

Second, consumption values are recognized as instrumental in enhancing brand equities, which then foster consumers' behavioral intentions toward services (Taylor et al. 2004; Tran et al. 2021). However, there is a gap in literature with regard to conceptualizing the relationships between these factors in robotic restaurant environments. Third, previous studies have predominantly examined the effects of consumption values on single outcomes (e.g., Cha et al. 2020; Kwak et al. 2021; Lin and Mattila 2021). The current study investigated the relative effects of consumption values on multiple outcomes including customers' intention to pay more, loyalty, recommendation to others, and participation in value co-creation, which have spillover effects on service providers' benefits and viability (Sirgy, 2012).

Fourth, there is a paucity of literature exploring the extent to which service robots' interaction abilities and risk levels moderate consumers' perceptions of robotic service values. Nevertheless, these factors have potential to influence consumers' intention to adopt robot technology (Kim et al. 2013; Lin et al., 2025; Zhang et al. 2021). Hence, the current study included perceived risk and human-robot interaction (HRI) quality as moderating variables, to examine their effects on the relationship between consumption values and consumer behavior toward robot service.

To address the research gaps, this study aimed to 1) examine the influence of RRSCVs on attitude toward robot services; 2) analyze the influence of RRSCVs on perceived brand equity; 3) examine the influence of attitude toward robot services on perceived brand equity; 4) examine the effects of perceived brand equity on the outcome variables; and 5) investigate the moderating effects of perceived risk and human-robot interaction quality in the structural model of this study. This research utilized quantitative methods to analyze the

data. Findings provided valuable insights for the key stakeholders including robot-assisted service restaurant managers, robot manufacturers, and robot suppliers.

2. Literature review and hypothesis development

2.1 Theoretical foundation

The theory of consumprion values introdcued by Sheth et al. (1991), presents multidimensional framework that comprises five determinants of consumer choice: functional, social, emotional, conditional and epistemic values. This theoretical model has been extensively utilized in academic literature as a foundation for developing a comprehensive model that accounts for multiple consumption values (Assarut & Eiamkanchanalai, 2015). For example, Maleki and Sheikhesmaeili (2016) employed this framework to build an analytical approach for examining customers' decision-making when they are presented with a wide array of goods and services. Gonçalves et al. (2016) also adopted this framework to examine the effects of consumption values on consumers' green buying behavior.

Adoption of technologies, such as robots can provide distinct values that affect the consumers' choice behavior (Fuentes-Moraleda et al. 2020; Hong et al. 2023; Wu et al. 2021). The current study used theory of consumption values as a study framework and considered the consumption value dimensions as antecedent factors. As specified above, the theory of consumption value encompasses the five major values. However, aiming to enrich the dimensionality of consumption values, particularly in robot services, this study considered price value, safety and privacy value and humanlike capability value as distinct constructs; factors that were neglected in most prior studies. Thus, the values identified for this study include performance and quality, price, safety and privacy, humanlike capability, social, emotional, and epistemic values. Performance and quality, price, safety and privacy values have been used to measure functional aspect, as indicated in the literature (Candan & Yıldırım 2013; García et al. 2014; Kaldewei & Stummer 2019; Okada et al.2005). Particulry, performance and quality dimentions are fundamental components of fucntional consumption values and serve as pivotal dimensions impacting consumer decision-making (Candan & Yıldırım 2013; Gonçalves et al. 2016; Yan 2019). Price value, safety and privacy value also influence attitude and behavioral intentions of customers (Hong et al. 2023; Ivanov and Webster 2021; Lin and Mattila 2021; Zeng et al. 2020).

Previous studies have investigated the human-likeness of robots, predominantly focusing on their appearance (Grazzini et al. 2023; Yang and Chew 2021). However, human-likeness of service robots can also be conceptualized in terms of their agency (ability to think) and experience (ability to feel) (Cha 2020; Park et al. 2024). Furthermore, it has been suggested that researchers can investigate whether service robots can undertake complex tasks (Grazzini et al. 2023). Examining customers' perceptions of capabilities of robots compared to human staff will also provide valuable insights for service providers, allowing them to strategically integrate robot technologies along with human staff (Rosete et al 2020). The present study systematically investigated the relative capability of service robots compared to human staff. Consequently, robots' human-like capability value was conceptualized through factors, such as professionalism, service standardization, convenience, accuracy, promptness, pleasantness, and responsiveness, which are used to assess functional attributes of robots (Choi et al. 2021; Zailani et al. 2019). These indicators of humanlike capability value were also suggested by experts who participated in the scale development process for the present study. Consequently, the current study extends the theory of consumption values by integrating price value, safety and privacy value and humanlike capability value into the proposed research model and examining their effects on behavioral intentions.

2.2. Relationship between consumption values and attitude toward robot services

Consumption value is defined as the level of satisfaction or overall benefit that a consumer gains from a purchased product or service and facilitates explanation of the reasons behind consumers' choices of specific products, services, or brands (Sheth et al. 1991; Sweeney and Soutar 2001). Research indicates that values shape an individual's preferences and evaluations relating to specific products or behaviors (Rizkalla and Setiadi 2020).

Consumption values have been studied within the context of technology for their impact on consumers' purchasing behavior (Chuah et al. 2022; Hong et al. 2023). Hur et al.'s (2012) study indicated that functional, emotional, and epistemic values positively affected consumers' purchase intentions relating to home robots, while social and conditional values were not significant contributors to explaining the relationship. Chuah et al. (2022) found that functional, emotional, social, epistemic, co-creation, and conditional values

significantly influenced attitude towards robotic restaurants. Hong et al. (2023) highlighted that functional, price, and emotional values explained satisfaction with food delivery robot service, while social and novelty values could not explain customers' satisfaction.

Regarding consumption value of robot services, it is essential to consider the safety (Leo and Huh 2020; Zeng et al. 2020) and privacy of customers (Lin and Mattila 2021; Tussyadiah and Park 2018; Zeng et al. 2020). Additionally, Choi et al. (2020) emphasized that safety of service robots, encompassing security, reliability and overall safety, is crucial in the hospitality industry for formulating customers' attitudes. Some studies (Hong et al. 2023; Ivanov and Webster 2021) found that customers' responses to pricing differ when comparing robot services with human staff services because they expect lower prices for robot services than for human-delivered services. Based on the literature review, the following hypotheses were formulated:

H 1–1 to 1–7

RRSCVs significantly influence customers' attitudes toward robot service usage.

2.3. Relationship between attitude toward robot service and perceived brand equity

Measuring consumer attitudes is crucial when assessing brand equity (Chang et al. 2008). A consumer's overall attitude toward a brand encompasses both cognitive elements, such as brand knowledge, and affective components, such as feelings and emotions (Fishbein and Ajzen 1975). Previous studies proved that brand attitude affected brand equity (Chang et al. 2008). A study on travelers' attitudes toward culinary experiences and the role of social media highlighted that brand attitude is among the factors that influence brand equity (Huang 2024). This study attempted to test the direct relationship between attitude and perceived brand equity in applying robot services in restaurants. Hence, the following hypothesis was proposed:

H2-1

Attitude toward robot service positively and significantly affects perceived brand equity.

2.4. Relationship between consumption values and perceived brand equity

Brand equity represents brand value that influences attitudes and increases the benefits that businesses gain from a comparative advantage, such as successful extensions, resilience to competitors' promotional pressures, and creation of barriers to competitive entry (Matthews et al. 2014). Past studies have shown the relationship between consumption values and brand equity in various research contexts. Tran et al. (2021) established that value in use led to brand equity, which comprises three key aspects including perceived quality, brand loyalty, and brand awareness and associations. Functional and emotional values are considered core consumption values that contribute to building brand equity (Yan 2019). Furthermore, the social benefits of service robots influenced consumers' choices and overall hotel experiences (Ivanov and Webster 2021). Consumers also associate brands with innovation and novelty, and emotional value (Holt 2002; Yan 2019).

Price is also a key element that drives consumers' choice of products (Degeratu et al., 2000). Yan (2019) observed that cost positively affected brand equity. In the context of casual dining establishments, it was found that customers expected robot-assisted services to be cost-effective and efficient (Moriuchi and Murdy 2024). In service encounters, consumers also associate perceived brand equity with safety, product quality, high benefits and strong reputability (Manning 2007).

Previous studies used positive traits such as competence, warmth, responsiveness, and adaptability to customers' requests to evaluate whether customers would prefer to dine at restaurants staffed by robots or humans (Cha 2020; Chi et al. 2024; Moriuchi and Murdy 2024). Similarly, Lu et al. (2021) used human-likeness attributes of service robots, including visual, verbal, and vocal attributes, to examine their impact on consumption outcomes such as service encounter evaluation, revisit intentions, and positive word-of-mouth intentions. Considering the findings of the literature review, this study proposed the following hypotheses:

H 3 – 1 to 3–7

RRSCVs positively and significantly influence perceived brand equity.

2.5. Relationship between perceived brand equity and outcome variables of service robot consumption

Perceived brand equity is a crucial business concept that has captured the interest and focus of both industry professionals and academic researchers. This is because having a successful and well-known brand can provide marketers with a competitive edge in the marketplace (Holt 2002). Naeini et al. (2015) demonstrated that brand equity leads to purchase intention and willingness to pay a premium price, indicating the capacity of a brand to encourage customers to pay a higher price. Furthermore, it was found that technology enhanced service quality and lifted the image of the hotel industry (Choi et al. 2021).

Perceived brand equity also helps to enhance customer loyalty toward service providers because customer loyalty represents a strong and enduring commitment through consistently using a particular product or brand (Oliver 2010). Loyalty persists even in the face of situational factors and marketing efforts by competitors that could potentially lead customers to switch to a different brand (Matthews et al. 2014). Customer satisfaction, brand equity and trust are very important antecedents of customer loyalty (Taylor et al. 2004). In a similar manner, a positive relationship was reported between brand equity, brand love, and customers repurchase intentions, all of which led to word-of-mouth recommendation (Otero and Wilson 2018). Consumer attachment to service robots played a mediating role between the service robot's anthropomorphic warmth, competence, service quality and consumers' intentions to recommend (Chi et al. 2024; Choi et al. 2020).

Customers' participation in value co-creation is paramount in service improvement initiatives (Zhang et al 2022). In the value co-creation process, consumers form knowledge, skills, competencies, and attachment to the brand, which favorably contribute to brand equity (Rubio et al. 2020). Brand-related factors directly influenced customers' willingness to participate in brand value co-creation (Zhao et al. 2019). Despite an increase in research on the topic of value co-creation (Merz et al. 2018), limited efforts have been made to examine the factors that determine customers' participation in the value co-creation process in the setting of robotic hospitality services. To provide an insightful understanding into the impact of perceived brand equity on customers' behavioral intentions toward robot services, this study proposed the following hypotheses:

H4-1

The perceived brand equity of robot service positively and significantly influences customers' intention to pay more.

H4-2

The perceived brand equity of robot service positively and significantly influences customer loyalty.

H4-3

The perceived brand equity of robot service positively and significantly influences intention to recommend to others.

H4-4

The perceived brand equity of robot service positively and significantly influences customers' intention to participate in value co-creation.

2.6. Moderating effects of perceived risk

Consumers may perceive high risk when a product or service is unfamiliar, complex or high-tech (Ahmed et al. 2002). Further, consumer characteristics such as personality traits (Maritz et al. 2013), product knowledge (Laroche et al. 2010) and demographic factors (Mitchell and Boustani 2014) may also affect the level of perceived risk. Several studies have used perceived risk as a moderating factor in the service context to evaluate the negative effects of uncertainty on consumer behavior (Antioco and Kleijnen 2010; Tseng and Wang 2016). For instance, Lai-Ming Tam (2012) evidenced that perceived risk significantly moderates the relationship between perceived values and loyalty, and between satisfaction and loyalty. In the context of service robot adoption, perceived risk mediated the relationship between personal innovativeness and service revisit intention (Lin et al. 2021). These findings suggest that perceived risk affects the relationships between service robot consumption values and the outcome variables. Hence, the following hypothesis was proposed:

H5

Perceived risk moderates the relationships between RRSCVs and outcome variables in the structural model.

2.7. Moderating effect of human–robot interaction quality

Humans convey emotions through their facial expressions (Gendron et al. 2018). For example, Diners' emotions may include happiness, anger, sadness, and surprise after their dining experiences (Oh and Kim 2022). These emotions are not limited to interactions with other humans but can also be related to human-made objects or technological innovations, such as artificially intelligent robots (Chuah and Yu 2021). Service robots cannot flexibly act or respond to special circumstances that customers may encounter because robots and AI currently lack social intelligence (Moriuchi and Murdy 2024). Even though service robots are unlikely to be self-determined with authentic emotions in the immediate future, they may mimic emotions, which are not real emotions (Cha et al. 2020). Although recent innovations have enabled service robots to show apparent emotions and understand human impressions (Chuah and Yu 2022), there is a need to understand the role of human robot-interaction quality in robot assisted hospitality sectors. This led to the development of the following hypothesis:

H6

Human-robot interaction quality moderates the relationship between consumption values and outcome variables in the structural model.

3. Research Methodology

3.1. Measurement instrument

This study developed comprehensive and contextual measurement instruments for the antecedents of the present study to enhance the contextual understanding into robotic consumption values. Providing conceptual definition of the underlying factors is an essential step in the development of measurement instruments (Carpenter 2018; Churchill Jr. 1979; Hinkin 1995). Definitions were established for each domain following a comprehensive review of the related literature. The items for RRSCVs were initially sourced from the literature (Choe and Kim 2019; Chuah et al. 2022; Hong et al. 2023; Hur et al. 2012; Lin and Mattila 2021; Sheth et al. 1991; Sweeney and Soutar 2001; Zhang et al. 2022), and validated through the scale development process, which included expert interview, pre-tests, pilot tests and main surveys.

The validation process for these constructs involved expert interviews, pre-tests, and pilot tests. Interviews were conducted with 10 experts, including customers who had experienced robot services in restaurants, designers of service robots, and professors in the field of hospitality services, to assess content validity, conciseness, and clarity of the measurement items (Churchill, Jr. 1979; Hinkin 1995). During the interviews, the participants were provided with a list of items, and were asked to evaluate their clarity, content, and meaning. The researchers also posed additional questions to elicit more suggestions for modifying the existing items and generating alternative measurement scales. The interviews were audio-recorded and transcribed to facilitate subsequent modification of the measurement items. Based on the feedback obtained, items were modified, replaced, or removed. The initial pool of 81 items identified in the literature for the seven consumption values was reduced to 52 items.

A pre-test was then conducted to validate the clarity and relevance of the measurement instruments. The pre-test involved 10 university faculty members who had scale development background in the fields of tourism and hospitality, and economics. The experts evaluated the items and offered valuable suggestions, which helped in the selection of appropriate items for the pilot test. These items were formatted using Likert 7-point scales (1 = strongly disagree… 7 = strongly agree) and used in the pilot test.

The pilot test was conducted in late June 2023 to assess the final structure of the questionnaire before the main survey was launched. In total, 250 samples were collected from reputable research firms (Macromill Embrain and Invight Inc.). Subsequently, exploratory factory analysis was performed using principal component analysis with varimax rotation. The analysis identified seven underlying factors, each with eigenvalues greater than 1.0. The communalities of the items ranged from 0.50 to 0.88, implying that a substantial proportion of the variance in each indicator was accounted for by the corresponding factors. Each indicator's factor loadings represented 0.49 to 0.88 of the respective underlying factors. Thus, the observed ranges of communalities and loadings satisfied the minimum requirements established in the literature (Fabrigar Wegener 2011; Hair et al. 2010). The reliability coefficients of the seven consumption values ranged from 0.91 to 0.94, confirming high internal consistency among the indicators.

Items for dependent and moderating factors were adapted from extant literature. Attitude toward robot services was measured by items adapted from Choi et al. (2020) and Ivanov et al. (2018). The items of perceived brand equity were sourced from Thomsen (2020) and Shekhar et al. (2013). The outcome variables that included intention to pay more (Rahman and Reynolds 2016), loyalty to the company (Chiu et al. 2009), intention to recommend to others (Klaus and Maklan 2013), and intention to participate in value co-creation

(Yi and Gong 2013; Zhang et al. 2022) were also assessed using items derived from literature. Additionally, items were adapted for perceived risk (Seo and Lee 2021) and human-robot interaction quality (Song and Kim 2022; Zhang et al. 2022).

3.2. Sampling technique and data collection

This study translated an English version questionnaire into a Korean version through a back-translation process. The study population was customers who had experienced robot services in restaurants in Korea within the previous two years. Convenience sampling method was utilized to select respondents since implementing probability sampling techniques in the context of online population is challenging. Power analysis with the desired level of significance and effect size (Sarstedt et al. 2021) was conducted to determine sample size. Specifically, the study considered medium effect size of 0.15 and 5% significance level, and statistical power of 0.95 (Cohen 1988). Based on these parameters, the minimum sample size required for the current study is 153 participants. However, the main survey yielded 800 samples, exceeding the minimum requirement. After excluding 44 insincerely completed samples, a total of 756 valid responses were used for further analyses. Data was collected via online research firms in Korea because online panel surveys enable reduction of research costs, quick responses, avoidance of paper waste, and collection of targeted samples (Latkovikj & Popovska 2019).

3.3. Data analysis methods

This study utilized exploratory factor analysis (EFA), confirmatory factor analysis (CFA), structural equation modeling (SEM) and multi-group analysis to analyze the data. This study identified the appropriate items and corresponding factors based on the results of EFA, as shown in the result section. CFA was subsequently performed to assess validity and reliability of the data, as well as to evaluate the fit of the measurement model. SEM and multigroup invariance analyses were employed to test research hypotheses. The study utilized SPSS version 29 for factor extraction and preliminary screening, while AMOS version 29 was employed to test measurement model, structural equation analysis and group comparisons.

4. Results

4.1. Profile of the respondents

Regarding the demographic profile, respondents were under 29 years of age (23%), 30–39 (20.6%), 40–49 (26.3%), 50–59 (22.2%), and 60 or older (7.8%). They were predominantly female (52.8%) and married (57.7%). The largest share of the respondents was represented by college graduates (69.4%), followed by post-graduates (13.1%) and those with a high school education or below (12.4%). Regarding occupation, most of the respondents (48.7%) were company workers, followed by professionals (12.7%) and housewives (8.6%). Most of them (72.8%) earned an annual household income of US$28,500 or above, while the remaining 27.2% earned less than US$28,500.

4.2. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)

This study conducted exploratory factor analysis (EFA) to identify the dimensions of the RRSCVs. Seven domains were generated, with each domain containing three to eight items. The factor model explained 69.95% of the total variance in the RRSCVs. The results showed that communalities ranging from 0.54 to 0.86 exceeded the 0.5 threshold, indicating that the extracted factors explained 54% to 86% of each variable's variance, while the factor loadings of the items far exceeded the requirement (0.4) (Hair et al. 2010). The EFA results of the RRSCVs, the outcome variables and moderating variables, are outlined in Tables 1 and 2.

Table 1
EFA results of the RRCVs (*N* = 756)

Constructs and items	Communalities	Factor loadings	Mean
Functional value (quality and performance) (Eigenvalue = 17.95, Variance explained = 42.74%, Cronbach's α = 0.92, Grand mean = 5.15)			
were easy to use.	0.64	0.56	5.35
delivered products/services in a time-efficient way.	0.60	0.52	5.19
delivered reliable products/services.	0.65	0.59	5.36
delivered products/services with consistent performance.	0.68	0.72	5.24
reduced the effort required for order/delivery purposes.	0.68	0.73	5.17
fulfilled my intention to get fast service.	0.76	0.74	4.81
delivered what I needed/asked for using convenient methods.	0.70	0.70	5.02
offered me products/services at my expected time.	0.68	0.64	5.08
Epistemic value (Eigenvalue = 3.94, Variance explained = 9.38%, Cronbach's α = 0.92, Grand mean = 5.19)			
gave me a new experience.	0.66	0.74	5.43
increased my curiosity to try something new.	0.77	0.82	5.21
stimulated my curiosity about the latest technology trends.	0.78	0.83	5.28
made me learn about new industry trends.	0.75	0.81	5.17
enabled me to learn something new and fresh.	0.77	0.81	5.12
enhanced my ability to use new technology devices/applications.	0.66	0.71	4.91
Humanlike capability value (Eigenvalue = 2.46, Variance explained = 5.86%, Cronbach's α = 0.92, Grand mean = 4.86)			
were just as accurate as human service.	0.67	0.63	4.84
provided products/services just as promptly as human service.	0.72	0.67	4.79
achieved product/services delivery just as professionally as human service.	0.76	0.72	4.52
offered service that was as standardized as human service.	0.73	0.68	4.92
were just as convenient as human service.	0.74	0.69	4.85
were just as responsive as human service.	0.76	0.73	4.76
Safety and privacy value (Eigenvalue = 1.44, Variance explained = 3.43%, Cronbach's α = 0.86, Grand mean = 5.20)			
delivered products/services using hygienic devices and equipment.	0.67	0.71	5.23
delivered products/services with good cleanliness and disinfection processes.	0.70	0.77	5.08
delivered what I needed/asked using safe methods.	0.71	0.70	5.26
delivered what I needed/asked without disturbance while I was talking with other diners.	0.56	0.63	5.24
helped protect my privacy and personal space.	0.54	0.60	5.22
delivered hot food/containers (e.g., hot soup, hot bowl) safely.	0.63	0.61	5.19
Emotional value (Eigenvalue = 1.29, Variance explained = 3.08%, Cronbach's α = 0.92, Grand mean = 5.08)			
made me excited	0.73	0.68	5.07
were fun to interact with.	0.73	0.72	5.33
made me feel comfortable about the service provided.	0.77	0.73	5.21

Constructs and items	Communalities	Factor loadings	Mean
made me feel modern and fashionable.	0.69	0.59	4.92
created positive feelings.	0.67	0.63	4.88
attracted my attention.	0.73	0.67	4.91
created enjoyment.	0.68	0.72	5.22
Social value (Eigenvalue = 1.18, Variance explained = 2.83%, Cronbach's α = 0.91, Grand mean = 4.50)			
helped make my interpersonal relationships closer.	0.71	0.74	4.50
created a social and happy mood at my gathering.	0.74	0.72	4.64
helped me to build a better image that I am a new technology adopter.	0.71	0.68	4.59
facilitated my interactions with other dining companions.	0.68	0.86	4.38
Helped me to build friendship with other companions during dining.	0.86	0.83	4.36
Price value (Eigenvalue = 1.10, Variance explained = 2.63%, Cronbach's α = 0.82, Grand mean = 5.08)			
delivered products/services at a reasonable price.	0.68	0.62	4.89
enabled me to avoid payment of additional fees such as service charges or tips.	0.66	0.74	5.51
helped me get cost-effective products/services.	0.67	0.56	5.02

Table 2
EFA results for the outcome and the moderating factors (N = 756)

Domains and items	Communalities	Factor loadings	Mean
Attitude toward service robots (Eigenvalue = 4.28, Variance explained = 71.12%, Cronbach's α = 0.88, Grand mean = 4.98)			
I felt pleased with the robot services provided by this restaurant.	0.54	0.59	5.27
I felt positive about the robot services provided by this restaurant.	0.76	0.87	5.20
I felt happy with the robot services provided by this restaurant.	0.71	0.84	4.55
I felt favorable about the robot services provided by this restaurant.	0.80	0.90	5.03
I felt in a good mood with the robot services provided by this restaurant.	0.83	0.91	5.00
I felt great about the robot services provided by this restaurant.	0.82	0.91	4.83
Perceived brand equity (Eigenvalue = 5.17, Variance explained = 73.87%, Cronbach's α = 0.94, Grand mean = 4.80)			
I felt that this restaurant demonstrated good performance.	0.71	0.84	4.98
I felt that this restaurant had a trouble-free performance.	0.69	0.83	4.76
I felt that this restaurant's services fitted my tastes/preferences.	0.73	0.85	4.76
I felt that this restaurant's brand is reputable.	0.56	0.75	4.70
I felt that this restaurant provided me with reliable service.	0.76	0.87	4.79
I felt that this restaurant gave me competitive service.	0.73	0.86	4.88
I felt that this restaurant met my needs and expectations.	0.70	0.83	4.75
Intention to pay more (Eigenvalue = 2.46, Variance explained = 81.98%, Cronbach's α = 0.89, Grand mean = 4.65)			
I felt that I would be happy to pay more for this restaurant.	0.82	0.90	4.79
I felt that this restaurant was good value for money.	0.84	0.92	4.64
I felt that I was happy to pay an affordable price at this restaurant.	0.80	0.90	4.53
Loyalty to the restaurant (Eigenvalue = 2.99, Variance explained = 74.75%, Cronbach's α = 0.88, Grand mean = 4.23)			
I want to choose this restaurant next time.	0.47	0.68	4.90
I want to choose this restaurant because of its use of robot technology.	0.85	0.92	3.88
I want to patronize this restaurant because of the adopted service robot technology.	0.85	0.92	3.86
I felt that I could easily recognize this restaurant's brand value because of the adopted service robot technology.	0.82	0.91	4.16
Intention to recommend to others (Eigenvalue = 2.34, Variance explained = 78.13%, Cronbach's α = 0.86, Grand mean = 4.41)			
I would like to talk about the service robot technology in this restaurant to my friends.	0.80	0.89	4.62
I would like to spread the word about this restaurant to my acquaintances.	0.79	0.89	4.47
I would like to post my experience about this restaurant's robot service on social media.	0.76	0.87	4.13
Intention to participate in value co-creation (Eigenvalue = 4.28, Variance explained = 85.61%, Cronbach's α = 0.96, Grand mean = 3.90)			
I would like to share information about my experience with and opinions about this restaurant.	0.85	0.92	3.90
I would like to express my personal needs to this restaurant.	0.87	0.93	3.83
I would like to provide suggestions for improving this restaurant's products and services.	0.88	0.94	3.86

Domains and items	Communalities	Factor loadings	Mean
I feel that my suggestions could be valuable in helping this restaurant improve its service robot offerings.	0.83	0.91	4.07
I would like to help this restaurant generate new ideas.	0.85	0.92	3.86
Perceived risk (Eigenvalue = 4.09, Variance explained = 68.14%, Cronbach's α = 0.91, Grand mean = 4.00)			
I am afraid of using service robots because they could perform poorly.	0.71	0.84	3.85
I think using service robots has some uncertainties.	0.67	0.82	4.27
I think relying on the performance of service robots would be risky.	0.69	0.83	4.19
I think using service robots could lead to feelings of psychological loss.	0.69	0.83	4.13
I am afraid that it takes time to learn how to use service robots.	0.61	0.78	3.58
I think using service robots may not protect my personal privacy.	0.72	0.85	3.97
HRI quality (Eigenvalue = 3.89, Variance explained = 64.77%, Cronbach's α = 0.89, Grand mean = 4.35)			
I think service robots give me sympathetic care.	0.62	0.79	4.13
I think service robots provide me with friendly services.	0.64	0.80	4.56
I think service robots make me feel comfortable.	0.71	0.84	4.06
I think service robots provide me with pleasant service.	0.63	0.80	4.61
I think service robots have the knowledge to answer my questions.	0.58	0.76	4.44
I think I can interact with service robots smoothly.	0.69	0.83	4.32

[Tables 1 and 2]

As Tables 3 and 4 show, confirmatory factor analysis (CFA) was performed to confirm the dimensionality of the factor model developed for this study. The measurement model was examined using a maximum likelihood estimation method. Accordingly, the measurement model fits were acceptable: χ^2 = 4974.56 (df = 2160, p < .001), χ^2/df = 2.303, RMSEA = .042, NFI = 0.90, IFI = 0.94, TLI = 0.93, CFI = 0.94. The composite reliability (CR) values of the constructs were greater than the cut-off value (0.7), while the calculated AVE values to measure the amount of variance extracted were 0.5 or higher, thereby confirming convergent validity (Hair et al. 2010). Since the results of this study further showed that the square roots of the AVEs were greater than the inter-construct correlations, verifying discriminant validity.

Table 3
CFA results of measurement model ($N = 756$)

Constructs	Codes	Estimate	S.E.	C.R.	P-value	Standardized loadings	AVE	CR
Functional value (performance and quality)	FVPQ1	.713	.038	18.81	***	0.65	0.60	0.83
	FVPQ2	.786	.039	20.23	***	0.69		
	FVPQ3	.785	.036	22.07	***	0.74		
	FVPQ4	.885	.037	23.70	***	0.77		
	FVPQ5	.945	.041	22.99	***	0.76		
	FVPQ6	1.018	.042	24.34	***	0.80		
	FVPQ7	.913	.038	24.33	***	0.79		
	FVPQ8	1.000				0.81		
Safety and privacy value	SPV1	.872	.043	20.45	***	0.72	0.60	0.82
	SPV2	.885	.044	19.98	***	0.71		
	SPV3	1.004	.042	23.64	***	0.81		
	SPV4	.927	.048	19.48	***	0.69		
	SPV5	.839	.045	18.70	***	0.67		
	SPV6	1.000				0.79		
Price value	PV1	.872	.035	24.70	***	0.80	0.58	0.80
	PV2	.729	.044	16.58	***	0.59		
	PV3	1.000				0.86		
Humanlike capability value	HLCV1	1.327	.079	16.70	***	0.77	0.67	0.93
	HLCV2	1.475	.086	17.07	***	0.80		
	HLCV3	1.572	.089	17.67	***	0.84		
	HLCV4	1.378	.078	17.64	***	0.84		
	HLCV5	1.475	.083	17.69	***	0.84		
	HLCV6	1.463	.083	17.57	***	0.83		
Social value	SV1	.855	.028	30.74	***	0.82	0.73	0.92
	SV2	.872	.030	28.74	***	0.78		
	SV3	.831	.030	27.73	***	0.77		
	SV4	.998	.025	39.82	***	0.92		
	SV5	1.000				0.91		
Epistemic value	EPV1	.806	.040	20.35	***	0.71	0.68	0.91
	EPV2	.967	.041	23.42	***	0.80		
	EPV3	1.020	.041	24.80	***	0.84		
	EPV4	1.069	.042	25.44	***	0.86		
	EPV5	1.050	.041	25.70	***	0.86		
	EPV6	1.000				0.77		
Emotional value	EMV1	1.012	.047	21.67	***	0.79	0.71	0.92

Constructs	Codes	Estimate	S.E.	C.R.	P-value	Standardized loadings	AVE	CR
	EMV2	.850	.043	19.81	***	0.73		
	EMV3	1.064	.047	22.52	***	0.82		
	EMV4	1.093	.049	22.10	***	0.80		
	EMV5	.998	.047	21.14	***	0.77		
	EMV6	1.074	.047	22.71	***	0.83		
	EMV7	1.000				0.74		
Attitude toward robot services	ATT1	1.000				0.51	0.67	0.83
	ATT2	.905	.062	14.54	***	0.85		
	ATT3	1.026	.072	14.20	***	0.81		
	ATT4	.933	.063	14.70	***	0.87		
	ATT5	.953	.064	14.88	***	0.90		
	ATT6	1.018	.069	14.84	***	0.90		
Perceived brand equity	PBE1	1.000				0.86	0.69	0.94
	PBE2	.977	.029	33.63	***	0.83		
	PBE3	1.021	.034	30.10	***	0.84		
	PBE4	.939	.039	24.05	***	0.73		
	PBE5	1.040	.033	31.52	***	0.86		
	PBE6	1.024	.035	29.61	***	0.83		
	PBE7	1.059	.033	32.15	***	0.86		
Intention to pay more	PM1	1.000				0.86	0.73	0.89
	PM2	1.052	.034	30.79	***	0.87		
	PM3	1.080	.038	28.39	***	0.83		
Loyalty to restaurant	LOY1	1.000				0.76	0.81	0.95
	LOY2	1.641	.088	18.75	***	0.93		
	LOY3	1.684	.089	18.88	***	0.94		
	LOY4	1.645	.083	19.79	***	0.97		
Intention to recommend to others	IRE1	1.000				0.80	0.67	0.86
	IRE2	1.006	.038	26.28	***	0.84		
	IRE3	1.090	.043	25.10	***	0.81		
Intention to participate in value co-creation	IPVC1	1.000				0.88	0.81	0.96
	IPVC2	1.015	.022	46.62	***	0.89		
	IPVC3	1.068	.027	39.38	***	0.93		
	IPVC4	.991	.028	35.49	***	0.89		
	IPVC5	1.026	.028	36.99	***	0.91		

Table 4
Correlation, AVE, mean and standard deviation (N = 756)

Factors	FVPQ	SPV	PV	HLCV	SV	EPV	EMV	ATT	PBE	PM	LOY	IRE	IPVCC
FVPQ	**0.774**												
SPV	.760**	**0.774**											
PV	.753**	.770**	**0.762**										
HLCV	.727**	.720**	.733**	**0.819**									
SV	.454**	.455**	.491**	.581**	**0.854**								
EPV	.446**	.511**	.517**	.491**	.542**	**0.826**							
EMV	.551**	.581**	.614**	.621**	.690**	.775**	**0.787**						
ATT	.608**	.607**	.652**	.655**	.662**	.695**	.755**	**0.819**					
PBE	.519**	.533**	.575**	.592**	.632**	.625**	.730**	.734**	**0.831**				
PM	.482**	.496**	.556**	.519**	.535**	.524**	.594**	.607**	.776**	**0.854**			
LOY	.461**	.452**	.479**	.548**	.642**	.503**	.613**	.627**	.770**	.720**	**0.900**		
IRE	.394**	.420**	.440**	.478**	.609**	.552**	.646**	.639**	.757**	.667**	.802**	**0.819**	
IPVCC	.244**	.244**	.237**	.338**	.547**	.361**	.411**	.379**	.551**	.467**	.695**	.686**	**0.900**
Mean	5.1508	5.153	5.146	4.858	4.493	5.269	5.058	4.970	4.619	4.653	4.200	4.405	3.901
Std. Dev.	.897	.909	.963	1.072	1.1791	.997	1.013	1.082	1.046	1.059	1.206	1.221	1.382

*Note: **. Correlation is significant at the 0.01 level (2-tailed).*

The bold numbers in the diagonals are square root of AVEs.

FVPQ: functional value of performance and quality, SPV: safety and privacy value, PV: price value, HLCV: human like capability value, SV: social value, EPV: epistemic value, EMV: emotional value, AAT: attitude, PBE: perceived brand equity, PM: intention to pay more, LOY: loyalty, IRE: intention to recommend to others, IPVCC: intention to participate in value co-creation

[Tables 3 and 4]

4.3. Results of the structural equation modeling

The overall structural model reveals as follows: χ^2 = 4480.635 (df = 1929, p < .001), χ^2/df = 2.32, RMSEA = .042, NFI = .90, IFI = .94; TLI = .94, CFI = .94. The results confirmed that the model fitted the data. The results showed that many of the structural paths were positive and statistically significant (Table 5). The functional value of performance and quality (β = 0.11, t = 2.33, p < 0.05) positively and significantly influenced attitude toward robot services, supporting H1-1. However, since price value (β = 0.07, t = 1.58, p > 0.05) and safety and privacy value (β=-0.04, t=-0.68, p > 0.05) did not affect attitude, H1-2 and H1-3 were not supported. Furthermore, humanlike capability value (β = 0.09, t = 1.82, p < 0.05), social value (β = 0.08, t = 2.46, p < 0.05), epistemic value (β = 0.08, t = 2.67, p < 0.01), and emotional value (β = 0.61, t = 12.27, p < 0.001) positively and significantly influenced attitude toward robot services, supporting H1-4, H1-5, H1-6, and H1-7. Attitude toward robot services (β = 0.30, t = 5.04, p < 0.001) also positively and significantly influenced perceived brand equity, supporting H2-1.

Table 5
Structural equation model results ($N = 756$)

Hypotheses	Paths	Standard Coefficients	*t*-value	*p*-value	Decision
H1-1	Functional value of performance and quality " attitude toward robot services	0.11	2.33*	0.020	Supported
H1-2	Price value " attitude toward robot services	0.07	1.58	0.115	Not supported
H1-3	Safety and privacy value " attitude toward robot services	-0.04	-0.70	0.486	Not supported
H1-4	Humanlike capability value" attitude toward robot services	0.09	1.82*	0.050	supported
H1-5	Social value" attitude toward robot services	0.08	2.46*	0.014	Supported
H1-6	Epistemic value" attitude toward robot service	0.08	2.67**	0.008	Supported
H1-7	Emotional value" attitude toward robot services	0.61	12.27***	0.000	Supported
H2-1	Attitude toward robot service-perceived brand equity	0.30	5.04***	0.000	Supported
H3-1	Functional value of performance and quality " perceived brand equity	0.00	-0.08	0.991	Not supported
H3-2	Price value " perceived brand equity	0.07	1.38	0.129	Not supported
H3-3	Safety and privacy value " perceived brand equity	-0.02	-0.27	.843	Not supported
H3-4	Humanlike capability value" perceived brand equity	0.10	1.94*	.048	Supported
H3-5	Social value" perceived brand equity	0.25	6.65***	0.000	Supported
H3-6	Epistemic value" perceived brand equity	0.14	4.16***	0.000	Supported
H3-7	Emotional value" perceived brand equity	0.13	2.04*	.029	Supported
H4-1	Perceived brand equity" intention to pay more	0.86	24.04***	0.000	Supported
H4-2	Perceived brand equity" loyalty to the company	0.82	15.33***	0.000	Supported
H4-3	Perceived brand equity" intention to recommend to others	0.89	23.53***	0.000	Supported
H4-4	Perceived brand equity" intention to participate in value co-creation	0.63	17.97***	0.000	Supported

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

In the relationships between consumption values and perceived brand equity, the functional value of performance and quality (β=-0.00, t=-0.08, $p > 0.05$), price value (β = 0.07, t = 1.38, $p > 0.05$), and safety and privacy value (β=-0.02, t=-0.27, $p > 0.05$) did not significantly affect perceived brand equity. Therefore, H3-1, H3-2, and H3-3 were not supported. On the other hand, humanlike capability value (β = 0.10, t = 1.94, $p < 0.05$), social value (β = 0.25, t = 6.65, $p < 0.001$), epistemic value (β = 0.14, t = 4.16, $p < 0.001$), and emotional value (β = 0.13, t = 2.04, $p < 0.05$) positively and significantly affected perceived brand equity, supporting H3-4, H3-5, H3-6, and H3-7. Brand equity, in turn, had a positive and significant effect on the intention to pay more (β = 0.86, t = 24.04, $p < 0.001$), loyalty to the company (β = 0.82, t = 15.33, $p < 0.001$), intention to recommend to others (β = 0.89, t = 23.53, $p < 0.001$), and intention to participate in value co-creation (β = 0.63, t = 17.97, $p < 0.001$), supporting H4-1, H4-2, H4-3, and H4-4. Figure 1 and Table 5 report the details of the structural model and the paths of the model.

[Figure 1 **and** Table 5]

4.4. Moderating effect of perceived risk

To test the moderating effect of perceived risk, this study conducted measurement invariance by evaluating the chi-square difference between the unrestricted model and the full metric invariance model. The outcome showed the difference between the chi-squares of the baseline model and fully nested model was not significant, implying that full metric invariance was supported [$\Delta\chi^2$ (df) = 66.20 < $\chi^2_{.01}$ (58) = 85.95]. This indicates that some of the loadings of the paths were invariant across low and high perceived risk groups. Having established measurement model invariance, the study tested the structural invariance model across the two groups. Testing structural invariance requires calculating the chi-square difference between baseline model and the full path invariance model (Hair et al. 2010). The difference between the metrices was significant, suggesting that structural invariance was not supported [$\Delta\chi^2$ (df) = 133.51 > $\chi^2_{.01}$ (77) = 108.8]. The results show that some of the paths across the groups were non-invariant.

The cross-group invariance tests revealed that six out of 19 paths were significantly different across the groups. The relationship between epistemic value and attitude toward robot services was significant only for the low perceived risk group, while the path between emotional value and attitude was stronger for the high (vs. low) perceived risk group. The path between humanlike capability value and perceived brand equity was also significant only for high perceived risk, whereas the relationship between emotional value and perceived brand equity was significant only for low perceived risk. In addition, the positive relationships between perceived brand equity and loyalty, and between perceived brand equity and intention to participate in value co-creation were stronger for high (vs. low) perceived risk. Thus, hypothesis H_5 of the structural model was partially supported. The results are illustrated in Tables 6, 7, and 8

Table 6
Measurement invariance of low perceived risk (*n* = 352) and high perceived risk (*n* = 404) **Note**: Chi-square difference test: $\Delta\chi^2$ (df) = 66.20 < $\chi^2_{.01}$ (58) = 85.95; thus, the full metric invariance model was supported. This implies that at least some of the factor loadings of the paths were invariant across the two groups.

Models	Low perceived risk vs High perceived risk		
	χ^2/df	$\Delta\chi^2$ /df	CFI (RMSEA)
Unconstrained invariance model	8703.93/4602	-	.916(0.034)
Full metric invariance model	8770.13/4660	66.20/58	.916(0.034)

Table 7
Structural invariance of low perceived risk (*n* = 352) and high perceived risk (*n* = 404)

Groups	Models	χ^2	df	$\Delta\chi^2$ /df	CFI	TLI	RMSEA
Low and high perceived risk	Full metric invariance model	9457.98	4702	-	0.90	0.90	0.037
	Full path invariance model	9591.49	4779	133.51/77	0.90	0.90	0.037

Note: Chi-square difference test: $\Delta\chi^2$ (df) >$\chi^2_{.01}$ (77) = 108.8, therefore, full structural invariance was not supported. Thus, at least some relations across groups are not equal.

Table 8
Results of paths for the low perceived risk (*n* = 352) and high perceived risk (*n* = 404)

Hypothesis				Low PR (n = 352)		High PR (n = 404)		Baseline model	Nested model	$\Delta\chi^2(1)$	p-value	Decision
				β	*t*-values	β	*t*-values					
H1a	FVPQ	→	ATT	0.13	1.85	0.01	0.16	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9459.085	1.102	.294	Not supported
H1b	PV	→	ATT	0.13	1.69	0.005	0.05	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9459.025	1.042	.307	Not supported
H1c	SPV	→	ATT	-0.04	-0.51	0.05	0.55	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9458.530	.547	.460	Not supported
H1d	HLCV	→	ATT	0.14	1.56	0.13	1.12	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9457.987	.004	.951	Not supported
H1e	SV	→	ATT	0.11	2.75	0.04	0.81	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9459.389	1.406	.236	Not supported
H1f	EPV	→	ATT	**0.17**	3.45***	-0.05	-0.72	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9465.153	7.169**	.007	Supported
H1g	EMV	→	ATT	**0**.57	8.03***	**1.14**	9.44***	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9476.210	18.227***	.000	Supported
H2a	ATT	→	PBE	0.26	3.90***	0.42	3.60***	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9459.433	1.450	.229	Not supported
H3a	FVPQ	→	PBE	0.01	0.07	0.00	-0.01	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9457.985	.002	.962	Not supported
H3b	PV	→	PBE	0.11	1.43	0.07	0.76	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9458.097	.114	.736	Not supported
H3c	SPV	→	PBE	-0.02	-0.26	-0.02	-0.18	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9457.985	.002	.963	Not supported
H3d	HLCV	→	PBE	-0.02	-0.22	0.41	3.47***	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9466.589	8.606**	.003	Supported
H3e	SV	→	PBE	0.14	3.45***	.16	3.64***	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9458.104	.121	.728	Not supported
H3f	EPV	→	PBE	0.19	3.64***	0.13	2.05*	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9458.379	.395	.529	Not supported
H3g	EMV	→	PBE	0.25	3.10**	-0.17	-0.91	$X^2(4702)$ = 9457.983	$X^2(4703)$ = 9457.985	4.394*	.036	Supported
H4a	PBE	→	PM	0.78	17.46***	0.85	16.87***	$X^2(4702)$ =	$X^2(4703)$ =	1.036	.309	Not supported

Hypothesis				Low PR (n = 352)		High PR (n = 404)		Baseline model	Nested model	$\Delta\chi^2(1)$	p-value	Decision
				β	*t*-values	β	*t*-values					
								9457.983	9459.019			
H4b	PBE	→	LOY	0.63	13.49***	0.82	15.93***	$X^2(4702) = 9457.983$	$X^2(4703) = 9464.960$	6.977**	.008	Supported
H4c	PBE	→	IRE	0.95	16.80***	0.92	15.34***	$X^2(4702) = 9457.983$	$X^2(4703) = 9458.101$	.118	.731	Not supported
H4d	PBE	→	IPVCC	0.67	11.26***	0.86	11.95***	$X^2(4702) = 9457.983$	$X^2(4703) = 9461.832$	3.849*	.050	Supported

[Tables 6, 7 and 8]

4.5. Moderating effect of human-robot interaction quality

This study evaluated the measurement invariance by determining the difference between the chi-squares of the unconstrained invariance model and the full metric invariance model. Accordingly, full metric invariance was supported [$\Delta\chi^2$ (df) = 77.20 < $\chi^2_{.01}$ (58) = 85.95]. This indicates that the paths across the groups were invariant. To determine whether the relationships between the paths remained consistent across low and high groups, a structural invariance analysis was also conducted. The analysis showed a significant chi-square difference between the full metric invariance model and the full path invariance model. Thus, structural invariances between the two groups were not supported [$\Delta\chi^2$ (df) = 153.37 > $\chi^2_{.01}$ (77) = 108.8], indicating the presence of non-invariant paths across the groups.

In the presence of the moderating factor, nine out of 19 paths were significant, but only three relationships were significantly different across the groups. The relationship between epistemic value and attitude toward robot service was significantly different only for the high group. Additionally, the analysis showed that strong relationships between perceived brand equity and intention to pay more, as well as between perceived brand equity and intention to participate in value co-creation, were stronger for the high groups. Thus, human robot interaction quality partially influenced the proposed structural model. Thus, hypothesis H_6 was partially supported. The results are illustrated in Tables 9, 10, and 11.

Table 9
Measurement invariance of low human-robot interaction quality (*n* = 291) and high human-robot interaction quality (*n* = 465)

Models	Low HRIQ vs High HRIQ		
	χ^2/df	$\Delta\chi^2$ /df	CFI (RMSEA)
Unconstrained invariance model	8360.91/4574	-	.915(0.033)
Full metric invariance model	8438.10/4632	77.20/58	.915(0.033)

Note: Chi-square difference test: $\Delta\chi^2$ (df) = 77.20 < $\chi^2_{.01}$ (58) = 85.95; therefore, the full metric invariance model was supported, indicating at least some of the paths across the groups were invariant.

Table 10
Structural invariance for low human-robot interaction quality (*n* = 291) and high human-robot interaction quality (*n* = 465)

Groups	Models	χ^2	df	$\Delta\chi^2$ /df	CFI	TLI	RMSEA
Low and high HRIQ	Full metric invariance model	9138.707	4684	-	0.90	0.90	0.036
	Full path invariance model	9294.077	4761	155.37/77	0.90	0.90	0.036

Note: Chi-square difference test: $\Delta\chi^2$ (df) > $\chi^2_{.01}$ (77) = 108.8, therefore full structural invariance was not supported. Thus, at least some relations across groups are not equal.

Table 11
Results of paths for low human-robot interaction quality (n = 291) and high human-robot interaction quality (n = 465)

Hypothesis				Low HRIQ (n = 291)		High HRIQ (n = 465)		Baseline model	Nested model	Δχ2(1)	*p*-value	Decision
				β	*t*-values	β	*t*-values					
H1a	FVPQ	→	ATT	0.00	− .053	0.16	2.686**	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9141.633	2.926	.227	Not supported
H1b	PV	→	ATT	0.14	1.766	0.02	.294	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9140.165	1.458	.147	Not supported
H1c	SPV	→	ATT	0.05	.543	-0.11	-1.752	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9140.815	2.107	.756	Not supported
H1d	HLCV	→	ATT	0.08	1.116	0.12	1.887	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9138.804	.097**	.002	Supported
H1e	SV	→	ATT	0.15	2.892**	-0.07	-1.506	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9148.561	9.853	.723	Not supported
H1f	EPV	→	ATT	0.14	2.261	0.09	2.743**	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9138.833	.126***	.000	Supported
H1g	EMV	→	ATT	0.47	5.789***	0.79	11.417***	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9152.338	13.631	.087	Not supported
H2a	ATT	→	PBE	0.35	3.922***	0.21	1.697	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9139.962	1.255	.263	Not supported
H3a	FVPQ	→	PBE	-0.03	− .409	0.06	.748	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9139.332	.624	.429	Not supported
H3b	PV	→	PBE	0.04	.453	0.19	2.581*	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9140.285	1.578	.209	Not supported
H3c	SPV	→	PBE	-0.12	-1.280	0.10	1.310	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9141.944	3.237	.072	Not supported
H3d	HLCV	→	PBE	0.12	1.561	-0.02	− .283	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9140.611	1.904	.168	Not supported
H3e	SV	→	PBE	0.15	2.598**	0.20	3.680***	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9139.013	.305	.581	Not supported
H3f	EPV	→	PBE	0.22	3.237**	0.08	1.815	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9141.396	2.689	.101	Not supported
H3g	EMV	→	PBE	0.17	1.769	0.15	1.152	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9138.713	.006	.939	Not supported
H4a	PBE	→	PM	0.76	11.758***	0.88	18.043***	$X^2(4684)$ = 9138.707	$X^2(4685)$ = 9145.636	6.929**	.008	Supported

Hypothesis				Low HRIQ (n = 291)		High HRIQ (n = 465)		Baseline model	Nested model	Δχ2(1)	*p*-value	Decision
				β	*t*-values	β	*t*-values					
H4b	PBE	→	LOY	0.67	9.601***	0.78	14.469***	$X^2(4684) = 9138.707$	$X^2(4685) = 9140.427$	1.720	.190	Not supported
H4c	PBE	→	IRE	0.82	11.374***	0.84	16.154***	$X^2(4684) = 9138.707$	$X^2(4685) = 9140.521$	1.814	.178	Not supported
H4d	PBE	→	IPVCC	0.39	6.488***	0.57	11.829***	$X^2(4684) = 9138.707$	$X^2(4685) = 9146.276$	7.568**	.006	Supported

[Tables 9, 10, 11]

5. Discussion and implications

5.1. Discussion

This study conceptualized the relationship between the RRSCVs and customers' behavioral intentions toward robot services in the restaurant management context. First, the results showed that performance and quality value, and humanlike capability value, positively and significantly influenced attitudes toward robot services. The outcomes support previous findings, which ascertained a positive relationship between consumption values and attitude toward service robots (Chuah et al. 2022; Hur et al. 2012; Lin and Mattila 2021). Additionally, social, epistemic, and emotional values positively and significantly influenced attitudes toward robot services. These results align with the findings of past studies (Chuah et al. 2022; Hong et al. 2023), which demonstrated positive relationships between these values and attitude toward restaurant robot services.

Second, the results of this study further indicated that the effect of safety and privacy on attitude was not significant, which did not support previous studies which demonstrated that the adoption of service robots had a negative effect on users' concerns about safety and privacy (Leo and Huh 2020; Lin et al. 2021). Similarly, price value was not a significant predictor of customers' attitudes, even though the value was a crucial factor influencing consumers' intentions to adopt new technology, as suggested in literature (Hong et al. 2023; Venkatesh et al. 2012).

Third, the relationship between consumption values and brand equity was assessed. The results demonstrated that humanlike capability value significantly impacted perceived brand equity, indicating that service robots are as capable as human staff. This finding challenges the previous research which asserted that service robots did not yet reach the desired level of development for integration into the hospitality industry (Rosete et al. 2020). Additionally, social, epistemic and emotional values significantly affected perceived brand equity. Prior studies also found that the social benefits of service robots influenced consumers' choice and overall hotel experience (Ivanov and Webster 2021), while brand emotional value positively predicted brand loyalty, a key component of brand equity (Matthews et al. 2014). The results of the current study further showed that the influence of perceived brand equity positively and significantly impacted intention to pay more, loyalty, intention to recommend to others and intention to participate in value co-creation, supporting the existent literature (Taylor et al. 2004; Zhao et al. 2019).

Fourth, however, performance and quality value, safety and privacy value and price values did not emerge as significant predictors of brand equity, contrary to most prior findings (Hong et al. 2023; Leo and Huh 2020; Tussyadiah and Park 2018; Taylor et al. 2004). Nevertheless, the present results are consistent with some previous findings. For example, Hamid et al. (2023) reported that the integration of robots as both core and facilitating products is unlikely to improve consumers' perceived performance and brand reputation. Concerning price value, Moriuchi and Murdy (2024) posited that customers may anticipate service robots to provide food delivery in cost-effective and efficient manner. These results underscore the need for further empirical investigation into the relationship between these consumption values and perceived brand equity.

Fifth, this study tested the moderating effects of perceived risk in the structural model. The relationship between epistemic value and attitude toward robot service, and the influence of emotional value on perceived brand equity were positive and significant only for the

low (vs. high) perceived risk group. The findings were consistent with those of prior studies, which found that trust in robots (Kim et al. 2013; Seo and Lee 2021) and human-robot interactions (Tay et al. 2014) were improved when perceived risk was low.

Sixth, the significant effect of emotional value on attitude toward robot services, as well as humanlike capability value on perceived brand equity was positive and significant only for the high (vs. low) perceived risk group. Likewise, the moderating effect of perceived risk on the relationship between perceived brand equity and both loyalty to the company and intention to participate in value co-creation were positive and greater for the high (vs. low) perceived risk group, standing in contrast to prior studies that reported perceived risk had a negative interaction effect on the relationship between intention to use and adoption of technology (Seo and Lee 2021). Consequently, the moderating effect was stronger among respondents having high perceived risk than low perceived risk. This suggests that the level risk experienced was lower than what was expected by participants with a high-perceived risk, and this unexpectedly fostered their positive perception of robotic services.

Seventh, in the proposed structural model, HRI quality significantly affected the paths from epistemic value to attitude toward robot services, from perceived brand equity to both intentions to pay more and intention to participate in value co-creation. All the paths were stronger for the high (vs. low) HRI quality group. The results align with the previous studies, emphasizing the importance of interaction quality of service robots in enhancing customer experiences (Song and Kim 2022: Zhang et al. 2025). Overall, the findings suggest improving the quality of interaction between guests and service robots can help organizations elevate their service quality and enhance customer satisfaction.

5.2. Theoretical Implications

This study has the following theoretical contributions. First, the study identified seven multidimensional consumption values and showed that many of the RRSCVs including performance and quality, humanlike capability, social, emotional and epistemic values effectively predicted attitude toward robot services. Whereas price value and safety and privacy value did not. Thus, the empirical evidence of this study obtained from real users of robot services enriches the extant literature that has focused on potential users of robotic restaurants (Chuah et al. 2022; Hwang et al. 2020). Additionally, this study extends the consumption value theory by incorporating price value, safety and privacy value and humanlike capability value which are often overlooked by previous studies within the context of robotic restaurant services (Chuah et al. 2022; Hur et al. 2012; Kwak et al. 2021).

Second, the results also showed that humanlike capability, social, epistemic, and emotional values contributed to improving the brand equity of robot service restaurants. This offers new insights into how consumers associate perceived brand equity with service values. This extends the existing literature by addressing the previously unexplored relationship within the context of robotic restaurant services. However, performance and quality, price, as well as safety and privacy values did not influence brand equity, highlighting the need for further research to examine the effects of these antecedents.

Third, the results illustrated that consumption values of robotic restaurant services enhanced the outcomes including intention to pay more, loyalty, intention to recommend, and intention to participate in value co-creation through perceived brand equity. Notably, brand equity more strongly predicted four of the abovementioned outcomes. These findings provide comprehensive understanding of how consumption values influence behavioral intentions that ultimately benefit the service providers (Sirgy 2012).

Fourth, this study also examined the moderating roles of perceived risk and HRI quality and showed that these factors partially influenced the relationships in the structural equation model. Specifically, the role of perceived risk was found to be much greater for the high (vs. low) perceived risk group, contradicting the previous findings (Abayomi et al. 2020; Kim et al. 2013). The findings highlight the need for further investigation of consumer's perceived risk associated with adoption of service robots. HRI quality significantly moderated some paths in the structural model, revealing that the relationships were stronger for the high HRI quality group. The results supported the findings of previous studies, ascertaining that service quality arising from interactions with robot services determines value perception and future intentions (Choi et al. 2020; Song and Kim 2022). Overall, these moderation analyses imply the need to consider the importance of attributes of robot technologies when assessing customers' behavioral intentions.

5.3. Managerial implications

First, the findings suggest restaurant managers nurture performance and quality values, humanlike capability value, social value, emotional value and epistemic value to enhance customers' attitude and perceived brand equity, which help sustain positive customer

intentions. Furthermore, based on the findings, the restaurant managers should address safety and privacy issues and consider price adjustments to boost foster customer experience. The findings of this study also indicated that service robots possess service delivery capabilities comparable to human staff. Thus, managers can consider deploying robots to assume some responsibilities carried out by human staff, thereby leveraging their comparative advantages in operational efficiency and cost reduction (Moriuchi and Murdy 2024) and potentially enhance their brand reputation and competitiveness. These findings also provide valuable information for robot designers and developers to develop robots that meet the customers' needs. Customers' feedback can be leveraged to develop robots featuring customer-friendly interfaces, and that can provide quality, innovative, and engaging services, while maintaining affordability and minimizing safety and privacy concerns.

Second, the results of this study indicated that the perceived brand equity of robotic restaurants significantly enhanced customers' behavioral intentions including intention to pay more, loyalty, intention to recommend to others, and intention to participate in value co-creation. These positive behavioral intentions are pivotal for improving service providers' performance (Chuah et al. 2022; Koschate-Fischer et al. 2012; Ramanathan et al. 2017). Consequently, the results suggest that adoption of robotic services can elevate restaurants' business viability by positively shaping customers' behavior. Previous studies (Lin et al. 2024; Zhang et al 2022) affirmed that customers' participation in value co-creation helps technology service providers to meet the specific needs of customers, provide important marketing information, and enable customers to create value for themselves and for the company.

Third, the results about the moderating effect of HRI quality aligned with the findings of previous studies (Choi et al. 2020; Kim et al. 2013; Lin et al. 2024; Moriuchi and Murdy 2024). HRI quality offers a unique lens for assessing how the nature of robot technology affects the dynamics between perceived values and outcomes. In contrast, although low perceived risk was expected to enhance service robot adoption, high perceived risk more effectively influenced relationships in the structural model. Thus, restaurant managers who have implemented or are considering the adoption of robot technologies should carefully assess perceived risks and service robots' ability to interact with guests and human staff.

Fourth, government and regulatory bodies need to develop policies and regulations to ensure the ethical and safe use of robots in hospitality industries, and address privacy and safety issues. They can support initiatives from robot developers and suppliers to create advanced robot technologies that meet the evolving demands of future generations.

5.4. Limitations and suggestions for future studies

This study has some limitations. First, since this study gathered data only in Korea, this limits the generalizability of the findings. Future research needs to test the research model in other countries or regions to extensively examine the role of consumption values of robotic hospitality services. Second, the study focused on consumer perspectives and thus there is a need to assess consumption values from the viewpoints of other stakeholders such as restaurant employees or robot manufacturers. Third, this study considered only two moderating factors that customers' behavioral intentions. Therefore, future studies need to investigate other meaningful consumer psychological factors, such as sense of humor (Zhang et al. 2021), sensation seeking, or technology adoption level (Zeng et al. 2020) to better understand their impact on the relationships between technology consumption values and customers' outcomes. Lastly, this study used a survey and quantitative analysis. Therefore, future studies need to adopt qualitative research methods such as in-depth interviews or use big data analysis of customers' responses in their social media communities.

Declarations

Author Contribution

Dr. Tadesse Bekele Hailu: Conceptualization, data collection, analysis, discussion, reviewPorfessor Seongseop (Sam) Kim: Conceptualization, data collection, supervision, reviewDr. Chen (Jason) Zhang: Conceptualization, Review

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References

1. Abayomi OJ, Zhang X, Peng X, Zhao S (2020) How do institutional pressures and behavioral intentions affect mobile services adoption? The moderating role of perceived risk. ACM SIGMIS Database 51(2):82–100
2. Ahmed SA, d'Astous A, Eljabri J (2002) The impact of technological complexity on consumers' perceptions of products made in highly and newly industrialized countries. Int Mark Rev 19(4):387–407. https:// doi: 10.1108/02651330210435681
3. Antioco M, Kleijnen M (2010) Consumer adoption of technological innovations: effects of psychological and functional barriers in a lack of content versus a presence of content situation. Eur J Mark 44(11/12):1700–1724. https:// doi 10.1108/03090561011079846
4. Assarut R, Eiamkanchanalai S (2015) Consumption values, personal characteristics and behavioral intentions in mobile shopping adoption. Market-Tržište 27(1):21–41
5. Candan B, Yıldırım S (2013) Investigating the relationship between consumption values and personal values of green product buyers. Int J Econ Manag Sci 2(12):29–40
6. Carpenter S (2018) Ten steps in scale development and reporting: A guide for researchers. Commun Methods Meas 12(1):25–44. https://doi.org/10.1080/19312458.2017.1396583
7. Cha SS (2020) Customers' intention to use robot-serviced restaurants in Korea: relationship of coolness and MCI factors. Int J Contemp Hosp Manag 32(9):2947–2968. https:// doi: 10.1108/IJCHM-01-2020-0046
8. Chang HH, Hsu CH, Chung SH (2008) The antecedents and consequences of brand equity in service markets. Asia Pac Manag Rev 13(3):601–624
9. Chi R, Zhang J, Pan M (2024) The effect of anthropomorphic competence-warmth congruence of service robots on recommendation intention. Curr Psychol 43(7):6570–6583. https://doi.org/10.1007/s12144-023-04825-5
10. Chiu CM, Lin HY, Sun SY, Hsu MH (2009) Understanding customers' loyalty intentions towards online shopping: an integration of technology acceptance model and fairness theory. Behav Inf Technol 28(4):347–360. https://doi.org/10.1080/01449290801892492
11. Choe J, Kim S (2019) Development and validation of a multidimensional tourist's local food consumption value (TLFCV) scale. Int J Hosp Manag 77:245–259. https://doi: 10.1016/j.ijhm.2018.07.004
12. Choi Y, Choi M, Oh M, Kim S (2020) Service robots in hotels: understanding the service quality perceptions of human-robot interaction. J Hosp Mark Manag 29(6):613–635. https://doi.org/10.1080/19368623.2020.1703871
13. Choi Y, Oh M, Choi M, Kim S (2021) Exploring the influence of culture on tourist experiences with robots in service delivery environment. Curr Issues Tour 24(5):717–733. https://doi.org/10.1080/13683500.2020.1735318
14. Chuah SHW, Aw ECX, Cheng CF (2022) A silver lining in the COVID-19 clouds: examining customers' value perceptions, willingness to use and pay more for robotic restaurants. J Hosp Mark Manag 31(1):49–76. https://doi.org/10.1080/19368623.2021.1926038
15. Churchill Jr GA (1979) A paradigm for developing better measures of marketing constructs. J Mark Res 16(1):64–73.
16. Degeratu AM, Rangaswamy A, Wu J (2000) Consumer choice behavior in online and traditional supermarkets: the effects of brand name, price, and other search attributes. Int J Res Mark 17(1):55–78
17. Fabrigar LR, Wegener DT (2011) Exploratory factor analysis: theory and application. Exploratory Factor Analysis. Oxford Univ Press
18. Fishbein M, Ajzen I (1977) Belief, attitude, intention, and behavior: An introduction to theory and research. Philos Rhetor 10(2):130–132
19. Fuentes-Moraleda L, Díaz-Pérez P, Orea-Giner A, Muñoz-Mazón A, Villacé-Molinero T (2020) Interaction between hotel service robots and humans: A hotel-specific Service Robot Acceptance Model (sRAM). Tour Manag Perspect 36:100751.
20. García D, Barber R, Salichs MA (2014) Design and development of a wireless emergency start and stop system for robots. In: 2014 11th International Conference on Informatics in Control, Automation and Robotics (ICINCO), vol 2, pp 223–230. IEEE
21. Gendron M, Crivelli C, Barrett LF (2018) Universality reconsidered: diversity in making meaning of facial expressions. Curr Dir Psychol Sci 27(4):211–219. https://doi.org/10.1177/0963721417746
22. Gonçalves HM, Lourenço TF, Silva GM (2016) Green buying behavior and the theory of consumption values: A fuzzy-set approach. J Bus Res 69(4):1484–1491.
23. Grazzini L, Viglia G, Nunan D (2023) Dashed expectations in service experiences: Effects of robots' human-likeness on customers' responses. Eur J Mark 57(4):957–986.
24. Hair JF, Black WC, Babin BJ, Anderson RE (2010) Multivariate data analysis. 7th ed. Pearson, New York

25. Hamid R, Fadzil FRM, Ong MHA, Azdel AA (2023) Robotic concepts: study of perceived brand reputation and customers' perceived performance in a restaurant. Glob Bus Finance Rev 28(5):13. https://doi.org/10.17549/gbfr.2023.28.5.13
26. Hinkin TR (1998) A brief tutorial on the development of measures for use in survey questionnaires. Organ Res Methods 1(1):104–121
27. Holt DB (2002) Why do brands cause trouble? A dialectical theory of consumer culture and branding. J Consum Res 29(1):70–90. https://doi: 10.1086/339922
28. Hong C, Choi EK, Joung HW, Kim HS (2023) The impact of customer perceived value on customer satisfaction and loyalty toward the food delivery robot service. J Hosp Tour Technol 14(5):908–924. https://doi: 10.1108/JHTT-11-2022-0305
29. Huang D, Chen Q, Huang J, Kong S, Li Z (2021) Customer-robot interactions: understanding customer experience with service robots. Int J Hosp Manag 99:103078. https://doi: 10.1016/j.ijhm.2021.103078
30. Huang YC (2024) The roles of social media and mutual relationships between travel attitudes and brand equity. Asia Pac J Mark Logist 36(2):390–407. https:// doi 10.1108/APJML-02-2023-0108
31. Hur WM, Yoo JJ, Chung TL (2012) Consumption values and consumer innovativeness on convergence products. Ind Manag Data Syst 112(5):688–706. https://doi 10.1108/02635571211232271
32. Hwang J, Lee KW, Kim D, Kim I (2020) Robotic restaurant marketing strategies in the era of the fourth industrial revolution: focusing on perceived innovativeness. Sustainability 12(21):9165. https://doi.org/10.3390/su12219165
33. Ivanov S, Webster C (2021) Willingness-to-pay for robot-delivered tourism and hospitality services–an exploratory study. Int J Contemp Hosp Manag 33(11):3926–3955. https://doi 10.1108/IJCHM-09-2020-1078
34. Ivanov S, Webster C, Garenko A (2018) Young Russian adults' attitudes towards the potential use of robots in hotels. Technol Soc 55:24–32. https://doi.org/10.1016/j.techsoc.2018.06.004
35. Kaldewei M, Stummer C (2019) How product intelligence and brand affect consumption value and intended usage: Evidence from a smart washing machine. In: Proceedings of the European Marketing Academy, vol 48, p 9749
36. Kim KJ, Park E, Sundar SS (2013) Caregiving role in human–robot interaction: a study of the mediating effects of perceived benefit and social presence. Comput Human Behav 29(4):1799–1806. http://dx.doi.org/10.1016/j.chb.2013.02.009
37. Klaus PP, Maklan S (2013) Towards a better measure of customer experience. Int J Market Res 55(2):227–246. http://doi: 10.2501/IJMR-2013-021
38. Koschate-Fischer N, Diamantopoulos A, Oldenkotte K (2012) Are consumers really willing to pay more for a favorable country image? A study of country-of-origin effects on the willingness to pay. J Int Mark 20(1):19–41
39. Kwak MK, Lee J, Cha SS (2021) Senior consumer motivations and perceived value of robot service restaurants in Korea. Sustainability 13(5):2755. . https://doi.org/ 10.3390/su13052755
40. Lai-Ming Tam J (2012) The moderating role of perceived risk in loyalty intentions: an investigation in a service context. Mark Intell Plan 30(1):33–52. https://doi: 10.1108/02634501211193903
41. Laroche M, Vinhal Nepomuceno M, Richard MO (2010) How do involvement and product knowledge affect the relationship between intangibility and perceived risk for brands and product categories? J Consum Mark 27(3):197–210.
42. Latkovikj MT, Popovska MB (2019) Online research about online research: advantages and disadvantages. E-methodology 6(6):44–56
43. Leo X, Huh YE (2020) Who gets the blame for service failures? Attribution of responsibility toward robot versus human service providers and service firms. Comput Human Behav 113:106520. https://doi: 10.1016/j.chb.2020.106520
44. Li Q, Liu Y, Jin Z (2025) Navigating perceived value and risk in hotel robotic services: dual drivers of consumer adoption intentions. J Qual Assur Hosp Tour 1–32. https://doi.org/10.1080/1528008X.2025.2511835
45. Lin B, Lee W, Yang R, Lim E (2025) Examining the effects of values and risks on outdoor food delivery robot adoption using mixed methods: different stakeholders' perspectives. Inf Technol Tour 27(1):157–188. https://doi.org/10.1007/s40558-025-00313-7
46. Lin IY, Mattila AS (2021) The value of service robots from the hotel guest's perspective: a mixed-method approach. Int J Hosp Manag 94:102876. https://doi: 10.1016/j.ijhm.2021.102876
47. Lin Y, Zhou X, Fan W (2021) How do customers respond to robotic service? A scenario-based study from the perspective of uncertainty reduction theory. Int J Hosp Manag 92:102726. https://hdl.handle.net/10125/70681 978-0-9981331-4-0
48. Lin VS, Zhang X, Ren Y, Huang WJ, Xiao H (2024) Tourists' value co-creation with service robots: antecedents and mechanisms. J Hosp Tour Res 48(6):949–963. https://doi.org/10.1177/10963480231197091

49. Lu L, Zhang P, Zhang TC (2021) Leveraging “humanlike” of robotic service at restaurants. Int J Hosp Manag 94:102823. https://doi: 10.1016/j.ijhm.2020.102823
50. Maleki C, Sheikhesmaeili S (2016) Pattern of structural relationships of the effects of consumption values on product perceived value and purchase intention of chain stores customers. Int J Med Res Health Sci 5(11):386–392
51. Mamman M, Ogunbado AF, Abu-Bakr AS (2016) Factors influencing customer’s behavioral intention to adopt Islamic banking in Northern Nigeria: a proposed framework. IOSR J Econ Finan 7(1):51–55
52. Manning L (2007) Food safety and brand equity. Br Food J 109(7):496–510. https://doi 10.1108/00070700710761491
53. Maritz A, Yeh S, Shieh C (2013) Effects of personality trait on perceived risk and travel intention in tourism industry. Actual Probl Econ 2(3):103–109
54. Matthews DR, Son J, Watchravesringkan K (2014) An exploration of brand equity antecedents concerning brand loyalty: a cognitive, affective, and conative perspective. J Bus Retail Manag Res 9(1):25–39
55. Merz MA, Zarantonello L, Grappi S (2018) How valuable are your customers in the brand value co-creation process? The development of a Customer Co-Creation Value (CCCV) scale. J Bus Res 82:79–89. http://dx.doi.org/10.1016/j.jbusres.2017.08.018
56. Mitchell VW, Boustani P (2014) The effects of demographic variables on measuring perceived risk. In: Proceedings of the 1993 Academy of Marketing Science (AMS) Annual Conference, Cham: Springer Int Publ, pp. 663–669. http://doi: 10.1007/978-3-319-13159-7_14
57. Moriuchi E, Murdy S (2024) The role of robots in the service industry: factors affecting human-robot interactions. Int J Hosp Manag 118:103682. http://doi: 10.1016/j.ijhm.2023.103682
58. Naeini AB, Azali PR, Tamaddoni KS (2015) Impact of brand equity on purchase intention and development, brand preference and customer willingness to pay higher prices. Manag Adm Sci Rev 4(3):616–626
59. Oh M, Kim S (2022) Role of emotions in fine dining restaurant online reviews: the applications of semantic network analysis and a machine learning algorithm. Int J Hosp Tour Adm 23(5):875–903. https://doi.org/10.1080/15256480.2021.1881938
60. Okada K, Inaba M, Inoue H (2005, April) Real-time and precise self collision detection system for humanoid robots. In: Proceedings of the 2005 IEEE International Conference on Robotics and Automation, pp 1060–1065. IEEE
61. Oliver RL (2010) Satisfaction: a behavioral perspective on the consumer. 2nd ed. Routledge, Armonk, NY
62. Otero C, Wilson GP (2018) Effects of brand love and brand equity on repurchase intentions of young consumers. Int Rev Manag Mark 8(4):7
63. Rahman I, Reynolds D (2016) Predicting green hotel behavioral intentions using a theory of environmental commitment and sacrifice for the environment. Int J Hosp Manag 52:107–116. https://doi.org/10.1016/j.ijhm.2015.09.007
64. Ramanathan U, Subramanian N, Yu W, Vijaygopal R (2017) Impact of customer loyalty and service operations on customer behaviour and firm performance: empirical evidence from UK retail sector. Prod Plan Control 28(6-8):478–488. https://doi.org/10.1080/09537287.2017.1309707
65. Rizkalla N, Setiadi DD (2020) Appraising the influence of theory of consumption values on environmentally friendly product purchase intention in Indonesia. Manag Mark J 18(1):8–25
66. Rosete A, Soares B, Salvadorinho J, Reis J, Amorim M (2020) Service robots in the hospitality industry: An exploratory literature review. In: International Conference on Exploring Services Science, Cham: Springer International Publishing, pp 174–186. https://doi.org/10.1007/978-3-030-38724-2_13
67. Rubio N, Villaseñor N, Yagüe MJ (2020) Value co-creation in third-party managed virtual communities and brand equity. Front Psychol 11:927. http://doi: 10.3389/fpsyg.2020.00927
68. Sarstedt M, Ringle CM, Hair JF (2021) Partial least squares structural equation modeling. In: Handbook of market research, Springer, pp. 587–632. https://doi.org/10.1057/s41270-023-00279-7
69. Seo KH, Lee JH (2021) The emergence of service robots at restaurants: integrating trust, perceived risk, and satisfaction. Sustainability 13(8):4431. https://doi.org/10.3390/su13084431
70. Shekhar Kumar R, Dash S, Chandra Purwar P (2013) The nature and antecedents of brand equity and its dimensions. Mark Intell Plan 31(2):141–159. https://doi 10.1108/02634501311312044
71. Sheth JN, Newman BI, Gross BL (1991) Why we buy what we buy: a theory of consumption values. J Bus Res 22(2):159–170
72. Sirgy MJ (2012) The psychology of quality of life: Hedonic well-being, life satisfaction, and eudaimonia. Vol 50. Springer Science & Business Media.

73. Song CS, Kim YK (2022) The role of human-robot interaction in consumers' acceptance of humanoid retail service robots. J Bus Res 146:489–503. https://doi.org/10.1016/j.jbusres.2022.03.087
74. Song X, Gu H, Li Y, Leung XY, Ling X (2024) The influence of robot anthropomorphism and perceived intelligence on hotel guests' continuance usage intention. Inf Technol Tour 26(1):89–117. https://doi.org/10.1007/s40558-023-00275-8
75. Sweeney J, Soutar G (2001) Consumer perceived value: the development of a multiple item scale. J Retail 77(2):203–220
76. Taylor SA, Celuch K, Goodwin S (2004) The importance of brand equity to customer loyalty. J Prod Brand Manag 13(4):217–227
77. Thomsen C (2020) The impact of hotel service robot appearance and service attributes on customer experience. Univ South Carolina.
78. Tran TP, Mai ES, Taylor EC (2021) Enhancing brand equity of branded mobile apps via motivations: a service-dominant logic perspective. J Bus Res 125:239–251. http://doi: 10.1016/j.jbusres.2020.12.029
79. Tseng SY, Wang CN (2016) Perceived risk influence on dual-route information adoption processes on travel websites. J Bus Res 69(6):2289–2296. http://doi: 10.1016/j.jbusres.2015.12.044
80. Tussyadiah IP, Park S (2018) Consumer evaluation of hotel service robots. In: Information and communication technologies in tourism 2018, Springer, pp. 308–320. http://doi: 10.1007/978-3-319-72923-7_24
81. Venkatesh V, Thong JY, Xu X (2012) Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q 36(1):157–178
82. Wu L, Fan A, Yang Y, He Z (2021) Robotic involvement in the service encounter: a value-centric experience framework and empirical validation. J Serv Manag 32(5):783–812. https://doi: 10.1108/JOSM-12-2020-0448
83. Wu TJ, Zhang RX (2024) Exploring the impacts of intention towards human-robot collaboration on frontline hotel employees' positive behavior: an integrative model. Int J Hosp Manag 123:103912. http://doi: 10.1016/j.ijhm.2024.103912
84. Yan B (2019) Research on the influence of customer perceived value on brand equity. Am J Ind Bus Manag 9(3):609–626
85. Yang J, Chew E (2021) A systematic review for service humanoid robotics model in hospitality. Int J Soc Robot 13(6):1397–1410. https://doi.org/10.1007/s12369-020-00724-y
86. Yi Y, Gong T (2013) Customer value co-creation behavior: scale development and validation. J Bus Res 66(9):1279–1284
87. Zailani S, Iranmanesh M, Sean Hyun S, Ali MH (2019) Applying the theory of consumption values to explain drivers' willingness to pay for biofuels. Sustainability 11(3):668. https://doi.org/10.3390/su11030668
88. Zeng Z, Chen PJ, Lew AA (2020) From high-touch to high-tech: COVID-19 drives robotics adoption. Tour Geogr 22(3):724–734. https://doi.org/10.1080/14616688.2020.1762118
89. Zhang M, Gursoy D, Zhu Z, Shi S (2021) Impact of anthropomorphic features of artificially intelligent service robots on consumer acceptance: moderating role of sense of humor. Int J Contemp Hosp Manag 33(11):3883–3905. http://doi 10.1108/IJCHM-11-2020-1256
90. Zhang X, Balaji MS, Jiang Y (2022) Robots at your service: value facilitation and value co-creation in restaurants. Int J Contemp Hosp Manag 34(5):2004–2025. https://doi.org/10.1108/IJCHM-10-2021-1262
91. Zhao Y, Chen Y, Zhou R, Ci Y (2019) Factors influencing customers' willingness to participate in virtual brand community's value co-creation: the moderating effect of customer involvement. Online Inf Rev 43(3):440–461. http://doi: 10.1108/OIR-08-2017-0232

Figures

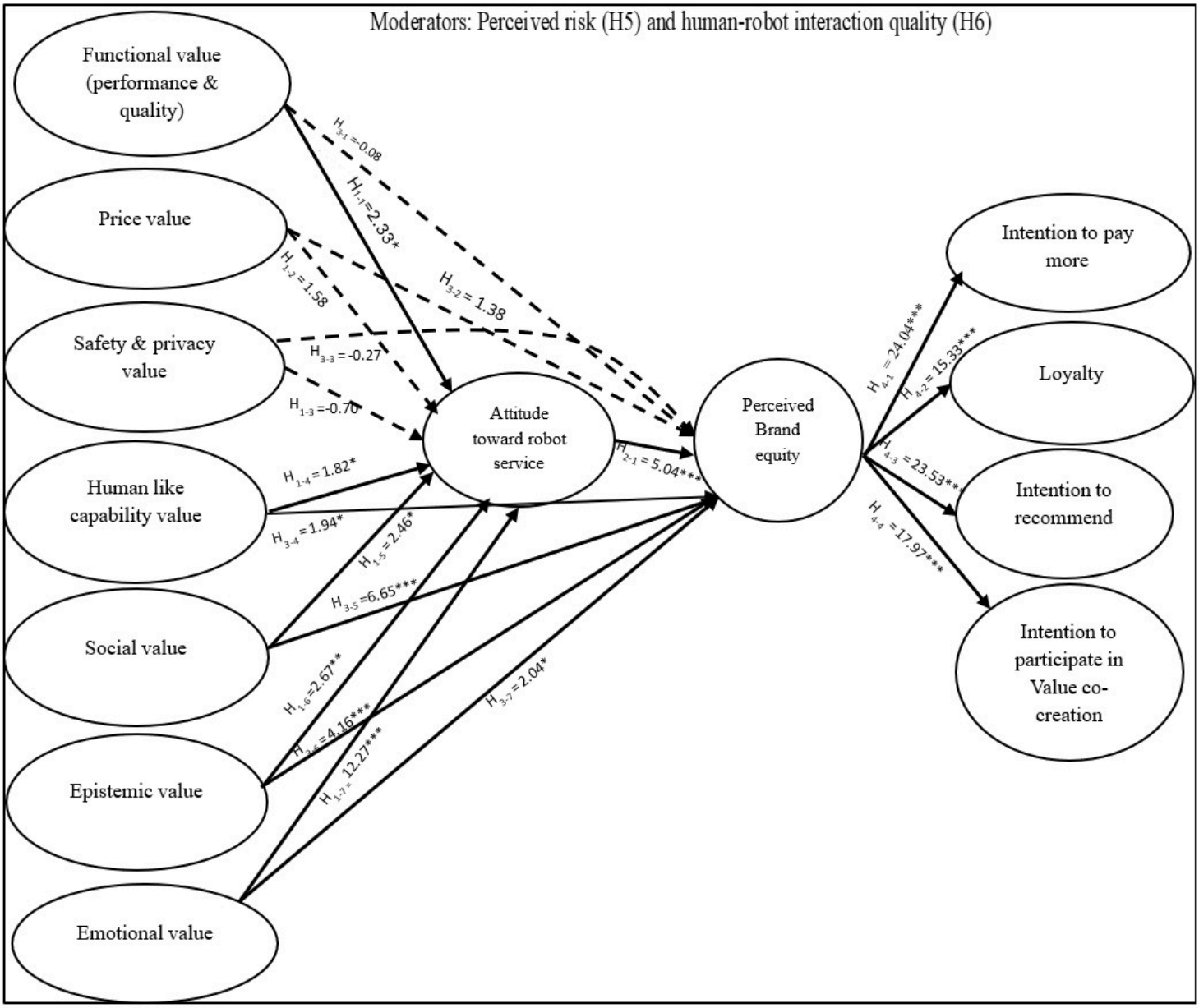


Figure 1

A conceptual model of the RRSCVs