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Navigating Employee Perceptions of Service Robots: Insights for Sustainable Technology Adoption in Hospitality

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Abstract: The widespread deployment of service robots in industries such as hospitality has significantly transformed service delivery, influencing not only customers but also employees. This study examines the multi-dimensional impact of service robots on hotel employees, focusing on their attitudes, emotional responses, and willingness to collaborate, as shaped by perceived benefits (service reliability, process efficiency, and job crafting) and risks (inefficiency, insufficient intelligence, and privacy concerns). Data were collected from 471 hotel employees in South Korea with experience working alongside service robots, and Hayes' Process Macro Model 4 was employed for hypothesis testing. The findings reveal that perceived benefits positively influence employees' attitudes, emotions, and willingness to collaborate, while perceived risks exert a negative impact. Furthermore, attitudes and emotional responses mediate these relationships. These findings provide theoretical and practical insights for managers, policymakers, and service robot manufacturers to address employee concerns, improve human–robot collaboration, and promote sustainable technological integration within the service industry.

Keywords: service robots; employee perception; attitudes; emotional responses; human–robot collaboration; sustainable development; hospitality industry; technology adoption; workplace innovation



Academic Editor: Lewis Ting
On Cheung

Received: 12 April 2025

Revised: 31 May 2025

Accepted: 10 June 2025

Published: 16 June 2025

Citation: Wu, Y., Park, M., & Chang, J. H. (2025). Navigating Employee Perceptions of Service Robots: Insights for Sustainable Technology Adoption in Hospitality. *Tourism and Hospitality*, 6(2), 113. <https://doi.org/10.3390/tourhosp6020113>

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1. Introduction

In an age of rapid technological advancements, automation and artificial intelligence (AI) are reshaping service delivery across industries (Dwivedi et al., 2021a). Among these innovations, service robots stand out as a transformative force, redefining operational practices and customer experiences in sectors such as hospitality, healthcare, retail, and logistics (Xiao & Kumar, 2021; Holland et al., 2021). These robots, equipped with capabilities ranging from performing routine tasks to engaging in complex customer interactions, have demonstrated their potential to enhance efficiency, ensure consistency, and improve service quality. For instance, in the hospitality industry, service robots address labor shortages and deliver round-the-clock assistance, while in healthcare, they support patient care and precision in medical procedures (Selesi-Aina et al., 2024; Wan et al., 2020). These applications underscore the competitive advantages of integrating robotic technologies into service operations (Sahoo et al., 2024).

Current research predominantly highlights how robots improve customer satisfaction, operational efficiency, and technological innovation (Ivanov et al., 2017; Tussyadiah &

Park, 2018). However, unlike customers, employees working with robots must adapt their workflows, redefine their roles, and address concerns such as job displacement, skill acquisition, and changes in workplace dynamics (Wirtz et al., 2018; Broadbent et al., 2009). These challenges often generate resistance, anxiety, and negative emotions, which can undermine organizational efficiency and hinder technological adoption (Hancock et al., 2011). Yet, research investigating how employees perceive the benefits and risks of service robots and how these perceptions influence their attitudes and behaviors remains limited. In particular, the potential perception among employees of being replaced by robots and the resulting anxiety or resistance this may cause has received insufficient attention. Given the transformative potential of service robots, understanding employees' concerns about job displacement and the perceived threat to their professional identity is crucial for successful technological adoption and sustainable collaboration.

This study aims to bridge this gap by focusing on the hospitality industry, which is a labor-intensive industry characterized by high service demands and significant human–robot interaction (Tuomi et al., 2021). The study examines employees' evaluations of service robots in terms of perceived benefits, such as reliability, efficiency, and opportunities for job crafting, alongside perceived risks, including inefficiency, insufficient intelligence, and privacy concerns. These evaluations are expected to shape employees' attitudes, emotional responses, and willingness to collaborate with robotics.

To analyze these complex interactions, this study integrates multiple theoretical frameworks. Cognitive Appraisal Theory (CAT) explains how employees assess the benefits and risks of service robots (Lazarus & Folkman, 1984), while Affective Events Theory (AET) highlights how these appraisals trigger emotional responses (Weiss & Cropanzano, 1996). The Technology Acceptance Model (TAM) addresses employees' acceptance of robots based on perceived usefulness and ease of use (Davis, 1989), and the Stimulus–Organism–Response (SOR) framework provides a comprehensive lens to explore how cognitive and emotional factors influence behavioral intentions (Mehrabian & Russell, 1974). Together, these frameworks enable a multidimensional understanding of employees' responses to service robots, accounting for both rational appraisals and affective reactions.

This study contributes to the expanding body of literature on human–robot interaction by offering a deeper understanding of employees' perspectives on technology adoption. It seeks to provide actionable insights for managers and policymakers to devise strategies that cultivate positive employee–robot relationships, minimize resistance, and enhance collaboration. By addressing employee concerns and facilitating the seamless integration of service robots, this study supports the sustainable evolution of the service industry. It ensures that technological advancements deliver mutual benefits for organizations and their workforce, promoting a harmonious and productive coexistence in the workplace. Furthermore, this study explicitly considers the concept of sustainability in technology adoption, which encompasses adopting technological solutions that generate long-term economic, environmental, and social benefits. We argue that understanding how service robots contribute to sustainability by enhancing operational efficiency, reducing environmental impacts, and promoting employee well-being is crucial for the sustainable integration of technology in hospitality. Thus, this study contributes to theoretical and practical discourses on sustainable technology practices within the hospitality context.

2. Literature Review

2.1. Service Robots

In the modern information era, the increasing application of technology in the hotel industry has positioned service robots as a disruptive innovation, redefining customer interactions and operational processes. These robots handle repetitive tasks, enhance

service efficiency, and improve overall customer satisfaction (Dwivedi et al., 2021b; Chiang & Trimi, 2020). For instance, customers are more likely to accept service robots when they perceive them as reliable and consistently efficient, increasing their trust in robotic services (Jörling et al., 2019; Broadbent et al., 2009; Hancock et al., 2011). Furthermore, personalized assistance provided by service robots significantly improves customer experiences by reducing wait times and enhancing convenience (Gursoy et al., 2019; L. Lu et al., 2019; Song & Kim, 2022).

Nevertheless, customers frequently express concerns regarding robots' insufficient intelligence when dealing with complex requests, potentially compromising their expectations for high-quality services (Huang & Rust, 2021; Belanche et al., 2021). Inefficiencies or slow response times during high-demand periods also negatively affect customer confidence (Tung & Au, 2018; Muthuswamy & Ali, 2023). Additionally, privacy concerns persist as customers fear their data collected by robots could be misused or inadequately protected (Jia et al., 2024; Bouhia et al., 2022).

Although existing studies provide valuable insights into customer perceptions, employee perspectives remain notably underexplored. Unlike customers, employees engage with service robots as direct collaborators, requiring them to adapt workflows and re-define their roles. Therefore, examining employees' perceptions and their willingness to collaborate with service robots represents a critical research gap that this study aims to address.

2.2. Cognitive Appraisal of Service Robots by Employees

Cognitive Appraisal Theory (CAT) provides a theoretical foundation for understanding how individuals evaluate external stimuli based on perceived benefits and risks. These cognitive appraisals shape emotional and attitudinal responses, which, in turn, influence behavior (Munanura et al., 2023).

In studies involving customers, cognitive appraisals of service robots often center on benefits such as service efficiency, reliability, and convenience, as well as risks related to inefficiency, insufficient intelligence, or privacy concerns (Grabinski, 2023; Yoganathan et al., 2021). For example, customers tend to trust and adopt service robots when they perceive them as reliable and capable of efficiently fulfilling their needs (V. N. Lu et al., 2020). Conversely, when customers perceive service robots as having insufficient intelligence, they are more likely to feel dissatisfied and reduce their interactions with these technologies (Ma et al., 2023).

Extending this perspective to employees, their cognitive appraisals are influenced by similar benefits and risks but are also shaped by their roles as collaborators. Employees' perceptions of benefits, such as enhanced service reliability, increased process efficiency, and opportunities for job crafting, positively influence their trust in service robots and reduce anxiety about task execution (Li et al., 2024; Guo et al., 2024). On the other hand, concerns over inefficiency, insufficient intelligence, and privacy risks may trigger resistance or anxiety (Guo et al., 2024; Liu et al., 2024).

Despite these insights, systematic analysis of how employees' cognitive appraisals of service robots influence their attitudes remains scarce. Specifically, there is a lack of research on the dual impact of perceived benefits (e.g., service reliability, process efficiency, and job crafting) and perceived risks (e.g., inefficiency, insufficient intelligence, and privacy concerns). This study extends CAT to explore these relationships. Moreover, from the employees' perspective, perceptions of robots as potential replacements rather than merely collaborators may provoke heightened anxiety, fear of job loss, and resistance. This fear of replacement may significantly influence their cognitive appraisals and subsequent behavioral intentions. Therefore, exploring these human replacement concerns explicitly within

cognitive appraisal frameworks is essential to fully capture the complexity of employees' perceptions. Based on the above discussion, we propose the following research hypotheses:

Hypothesis 1 (H1): *Employees' perceived benefits (service reliability, process efficiency, and job crafting) of service robot deployment in hotels will positively influence their positive attitudes.*

Hypothesis 2 (H2): *Employees' perceived risks (inefficiency, insufficient intelligence, and privacy concerns) of service robot deployment in hotels will negatively influence their positive attitudes.*

Hypothesis 3 (H3): *Employees' positive attitudes towards service robots will enhance their willingness to collaborate.*

2.3. Emotional Dynamics in Service Robot Integration

Affective Events Theory (AET) highlights that workplace events trigger emotional responses, shaping employees' attitudes and subsequent behaviors (Ta & Rykkje, 2024). This framework has been widely applied to customer–robot interactions, focusing on how specific events evoke emotional reactions. For instance, seamless task completions and personalized attention by service robots often generate positive emotions, such as satisfaction, trust, and delight, which enhance customer loyalty and the likelihood of repeated interactions (Roy et al., 2024; Yao & Xi, 2024). Conversely, service errors or delays caused by robots elicit frustration and dissatisfaction, leading to reduced customer engagement with the technology (S. Choi et al., 2021).

Extending this perspective to employees, service robot deployment represents a novel workplace event to which employees may have different emotional responses depending on the perceived benefits and risks. Employees who experience positive outcomes (e.g., improved process efficiency or better job crafting opportunities) are likely to experience positive emotions, such as enthusiasm, trust, and satisfaction (Li et al., 2024; Guo et al., 2024). For example, studies have shown that employees who perceive service robots as reliable and efficient report higher levels of trust in the technology and exhibit greater enthusiasm for integrating robots into their workflows (Guo et al., 2024).

On the other hand, perceived risks associated with service robots can evoke negative emotions. Employees who perceive robots as having insufficient intelligence or being inefficient may experience frustration, particularly during peak operational times when delays are detrimental to customer satisfaction (Ma et al., 2023; Guo et al., 2024). Additionally, privacy concerns, such as fears of data misuse or surveillance, often lead to feelings of anxiety or dissatisfaction (Liu et al., 2024). These emotional responses significantly influence employees' overall engagement and readiness to adapt to technological changes.

Despite existing insights into customer-focused emotional dynamics, the application of AET to employees' emotional responses to service robots remains limited. This study employs AET to examine how perceived benefits and risks of service robots shape employees' emotional responses and, subsequently, their willingness to collaborate with the technology. Based on the above discussion, we propose the following research hypotheses:

Hypothesis 4 (H4): *Employees' perceived benefits (service reliability, process efficiency, and job crafting) of service robot deployment in hotels will positively influence their positive emotions.*

Hypothesis 5 (H5): *Employees' perceived risks (inefficiency, insufficient intelligence, and privacy concerns) of service robot deployment in hotels will negatively influence their positive emotions.*

Hypothesis 6 (H6): *Employees' positive emotions towards service robots will enhance their willingness to collaborate.*

2.4. Technology Acceptance: Bridging Perceptions and Collaboration

The Technology Acceptance Model (TAM) identifies perceived usefulness (PU) and perceived ease of use (PEOU) as key determinants of technology adoption. PU refers to the belief that a technology improves performance, while PEOU captures the extent to which the technology is perceived as easy to operate (Lee et al., 2018). In customer-facing contexts, the TAM has been widely used to explain technology adoption behaviors. For instance, customers are more likely to use service robots when they perceive them as providing substantial benefits, such as improved service quality, convenience, and operational efficiency (Y. Choi et al., 2020; Kim & Lee, 2014). However, risks such as unintuitive interfaces or a lack of competence in handling complex requests can undermine their ease of use, deterring adoption (Xiao & Kumar, 2021).

When applying the TAM to the employee context, perceived usefulness (PU) can be conceptualized as the perceived benefits of service robots, including enhancements in process efficiency, reliability, and opportunities for job crafting. These perceived benefits play a crucial role in shaping employees' perceptions of how service robots can improve their performance and streamline workflows. Empirical studies have shown that employees are more likely to accept and collaborate with technologies when they perceive technologies as reducing repetitive tasks, enhancing operational efficiency, and contributing to desirable work outcomes (Liu et al., 2024). Similarly, perceived ease of use (PEOU) reflects the level of simplicity and intuitiveness employees associate with interacting with service robots, which significantly influences their willingness to engage with these technologies. In other words, when service robots are perceived as having insufficient intelligence, being inefficient, or requiring substantial intervention, these perceptions of risk undermine employees' willingness to collaborate with them (Guo et al., 2024). Moreover, privacy concerns, such as fears of data misuse or surveillance, further weaken employees' trust and sense of control, thereby intensifying their resistance to adopting and collaborating with these technologies (Malik et al., 2024).

Building on the TAM, this study investigates the direct relationship between the perceived benefits and risks of service robots and employees' willingness to collaborate. Based on the above discussion, the following research hypotheses are proposed:

Hypothesis 7 (H7): *Employees' perceived benefits (service reliability, process efficiency, and job crafting) of service robots enhance their willingness to collaborate.*

Hypothesis 8 (H8): *Employees' perceived risks (inefficiency, insufficient intelligence, and privacy concerns) of service robots reduce their willingness to collaborate.*

2.5. SOR Framework: Connecting Stimuli to Behavioral Responses

The Stimulus–Organism–Response (SOR) framework provides a comprehensive model for analyzing how external stimuli influence internal psychological states, which subsequently drive behavior (Malik et al., 2024).

SOR-based research in the hotel industry demonstrates that stimuli, such as personalized recommendations, enhance trust and satisfaction (organism), leading to increased repeat purchase intentions (response) (S. Choi et al., 2021; Zhu et al., 2020). Conversely, negative stimuli, such as service failures or inefficiencies, evoke dissatisfaction and withdrawal behaviors (Leo & Huh, 2020).

Applying the SOR framework to employees, service robots serve as external stimuli characterized by perceived benefits (e.g., service reliability, process efficiency, and job crafting) and risks (e.g., inefficiency, insufficient intelligence, and privacy concerns). These stimuli shape employees' psychological responses, including attitudes and emotions, which

mediate their willingness to collaborate with the robots. Positive appraisals of service robots as reliable and efficient stimulate trust and cooperation, fostering a collaborative work environment (Guo et al., 2024; Liu et al., 2024). On the contrary, risks such as inefficiency or privacy issues act as negative stimuli (Guo et al., 2024; Liu et al., 2024). This study extends the SOR framework to analyze how perceived benefits and risks influence employees' willingness to collaborate through the mediating effects of attitudes and emotions. Based on the above discussion, we propose the following research hypotheses:

Hypothesis 9 (H9): *Employees' positive attitudes towards service robots will mediate the relationship between their perceived benefits (service reliability, process efficiency, and job crafting) and willingness to collaborate.*

Hypothesis 10 (H10): *Employees' positive attitudes towards service robots will mediate the relationship between their perceived risks (inefficiency, insufficient intelligence, and privacy concerns) and willingness to collaborate.*

Hypothesis 11 (H11): *Employees' positive emotions towards service robots will mediate the relationship between their perceived benefits (service reliability, process efficiency, and job crafting) and willingness to collaborate.*

Hypothesis 12 (H12): *Employees' positive emotions towards service robots will mediate the relationship between their perceived risks (inefficiency, insufficient intelligence, and privacy concerns) and willingness to collaborate.*

2.6. Summary of Theoretical Framework

This study integrates CAT, AET, TAM, and SOR theories to construct a comprehensive framework for understanding how perceived benefits and perceived risks influence employees' willingness to collaborate through attitudes and emotions. The conceptual model is summarized in Figure 1.

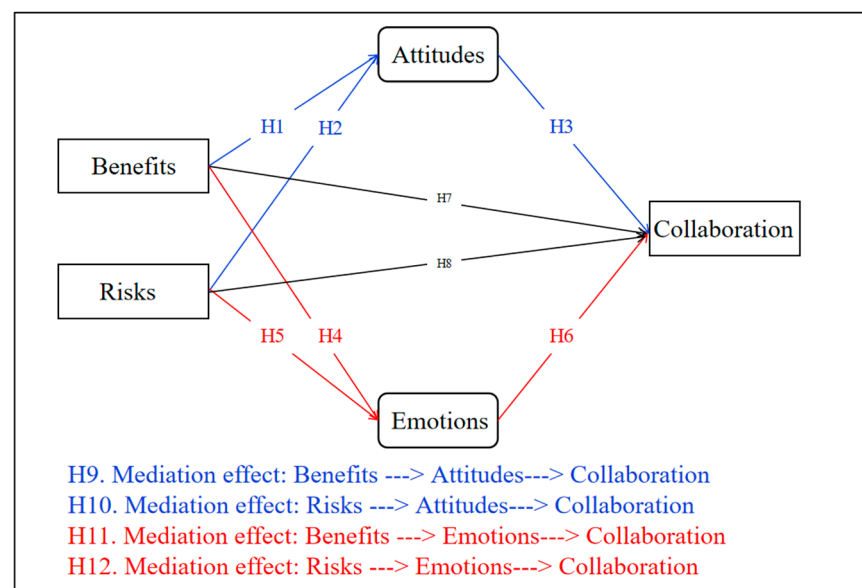


Figure 1. The proposed model.

3. Method

3.1. Measurement Methods

In this study, we adopted measurement scales and definitions from previous validated studies. The key constructs and example measurement items, along with their relevant references, are concisely summarized in Table 1.

Table 1. Operational definitions, example items, and references for constructs.

Construct	Operational Definition	Example Measurement Items	References
Service Reliability (SR)	Employees' perception of consistent and accurate service delivery by robots	"Service robots provide consistent and reliable services to customers."	Chiang and Trimi (2020) ; Li et al. (2024)
Process Efficiency (PE)	Employees' perception of robots enhancing operational efficiency	"Service robots improve efficiency because they do not require rest."	Chowdhury et al. (2022) ; Li et al. (2024)
Job Crafting (JC)	Employees' perception of skill enhancement through robot collaboration	"Working with service robots provides opportunities to develop professional skills."	Guo et al. (2024)
Inefficiency (IE)	Employees' perception of robots not meeting expected efficiency	"Working with service robots is not as efficient as I expected."	Liu et al. (2024)
Insufficient Intelligence (II)	Employees' perception of robots lacking sufficient intelligence	"Service robots are not intelligent enough, which makes my work more passive."	Ma et al. (2023)
Privacy Concerns (PCs)	Employees' concerns about surveillance and data collection by robots	"Service robots' data collection makes me feel uncomfortable about being monitored."	Jia et al. (2024) ; Gan et al. (2019)
Attitude (AT)	Employees' overall evaluation of service robots	"I feel positive towards working with service robots."	Gursoy et al. (2019) ; L. Lu et al. (2019)
Emotional Reaction (EM)	Employees' emotional experiences triggered by robots	"I feel enthusiastic about the presence of service robots."	Roy et al. (2024) ; Weiss and Cropanzano (1996)
Willingness to Collaborate (WTC)	Employees' subjective readiness to collaborate with robots	"I am willing to collaborate closely with service robots."	L. Lu et al. (2019) ; Lee et al. (2018)

To ensure the accuracy and reliability of the study, we used an online survey method based on structured questionnaires adapted from validated scales in previous studies. To mitigate potential bias and sampling errors, rigorous methodological protocols were followed. Specifically, a pre-test was conducted with 20 hospitality employees in December 2022. The pre-test helped identify and correct ambiguous wording and any potential misinterpretation of items. Subsequently, minor modifications were incorporated to enhance clarity and validity. Additionally, random sampling from multiple hospitality venues was employed to ensure representativeness and reduce sampling errors.

3.2. Data Collection

We selected hotel employees in South Korea as the study sample because the hospitality sector represents one of the most intensive adopters of service robots, characterized by frequent and diverse human–robot interactions. South Korea is at the forefront of technological adoption, providing an ideal context to investigate real-world employee perceptions in an environment where service robots are widely integrated into daily operations. Prior studies in hospitality (Tuomi et al., 2021), catering (Roy et al., 2024), and retail sectors (Leo & Huh, 2020) informed this sampling strategy, further validating our decision to focus specifically on hotel employees.

In January 2023, questionnaires were distributed to hotel employees who had experience working alongside service robots, resulting in 500 collected responses. After rigorous data cleaning and the removal of incomplete responses, 471 valid responses remained for analysis. The final sample size ($N = 471$) was deemed sufficient based on established recommendations from the hospitality and robotics literature, which typically suggest a minimum sample of 300–400 for robust statistical analyses (Ivanov et al., 2017; Tuomi et al., 2021). Furthermore, considering the use of multiple regression and Hayes' Process Macro Model 4 mediation analyses, this sample size significantly exceeds recommended thresholds, typically requiring at least 10–15 respondents per predictor variable to ensure statistical power and generalizability (Hair et al., 2019).

Ethical approval was obtained from the Institutional Review Board (IRB) at Sejong University (SUIRB-HR-2022-010, approved on 16 November 2022). Participants were fully informed about the study's purpose and assured of confidentiality and anonymity. Participation was voluntary, and informed consent was obtained from all respondents prior to their participation. No identifiable personal information was collected, minimizing potential risks associated with confidentiality.

Data were collected in January 2023, which remain highly relevant and timely given the rapid post-pandemic acceleration of technology adoption, especially in the hospitality industry. The widespread and intensive use of service robots became particularly salient after COVID-19, significantly altering operational dynamics and employee interactions. Thus, data from 2023 accurately captures contemporary employee perceptions during a critical transition period, providing hospitality managers with valuable insights for ongoing and future technological implementations.

3.3. Data Analysis

This study aims to explore the impact of service robots on hotel employees' cognition, which involves complex relationships among multiple variables. We used SPSS 27 to conduct statistical analyses (McCormick & Salcedo, 2017; George & Mallery, 2024). Firstly, frequency analysis was carried out to identify the demographic characteristics of the participants. Secondly, confirmatory factor analysis (CFA) was performed to verify the validity of the variable set in this study, and reliability was verified using Cronbach's alpha values (Chiang & Trimi, 2020). In addition, Pearson's correlation coefficients were employed to analyze the correlations between perceived benefit (PB), perceived risk (PR), attitude (AT), emotional reaction (EM), and willingness to collaborate (WTC). Finally, multiple regression analysis and Hayes' Process Macro Model 4 were utilized for hypothesis testing. In the first stage of hypothesis testing, multiple regression analysis was used to test the effects of PB and PR on AT and EM, and regression analysis was used to test the effects of AT and EM on WTC. In the next stage, Hayes' Process Macro Model 4 was employed to examine the mediating effect of AT and EM on the relationship between PB, PR, and WTC (McCormick & Salcedo, 2017).

The process macro model is a powerful tool for analyzing mediation effects and can comprehensively and systematically examine the relationships among variables (McCormick & Salcedo, 2017). In our research model, there exist potential mediation effect relationships among variables such as PB, PR, EM, AT, and WTC. For instance, perceived benefit and perceived risk may affect willingness to collaborate by influencing employees' attitudes and emotional reactions. Whether there is a mediating effect of attitude and emotional reactions in this process is one of the focuses of our research. The process macro model can accurately capture these complex relationships and provide strong support for us to deeply understand the interaction mechanism between service robots and employees. Therefore, we used Model 4 of the process macro model to test our research hypotheses one by one.

4. Results

4.1. Sample Demographics

This study collected a total of 471 valid questionnaires, with the sample covering employees of different ages, genders, and educational backgrounds. Specifically, male employees accounted for 45.4%, while female employees accounted for 54.6%; the age distribution was mainly concentrated between 19 and 39 years old, accounting for 74.1% (38.9% for 19–29 years old and 35.2% for 30–39 years old) of the total sample; and in terms of educational background, those with a bachelor's degree or above (university graduate and graduate school graduate) accounted for 60.5% (54.1% for university graduate and 6.4% for graduate school graduate). The sample has a certain representativeness in terms of gender, age, and educational background, which can better reflect employees' general perception of the introduction of service robots. The sample demographics are presented in Table 2.

Table 2. Sample demographics.

Category	Specific Category	Frequency (%)
Gender	Male	214 (45.4%)
	Female	257 (54.6%)
Age	19–29 years old	183 (38.9%)
	30–39 years old	166 (35.2%)
	40–49 years old	75 (15.9%)
	50–59 years old	33 (7.0%)
	60 years old and above	14 (3.0%)
Current workplace	Hotel	151 (32.1%)
	Resort	20 (4.2%)
	Fine dining restaurant	45 (9.6%)
	Family restaurant (e.g., Outback, VIPS, etc.)	216 (45.9%)
	Catering business with more than 5 people	39 (8.3%)
Education level	High school graduate	78 (16.6%)
	Junior college graduate	108 (22.9%)
	University graduate	255 (54.1%)
	Graduate school graduate	30 (6.4%)

Table 2. Cont.

Category	Specific Category	Frequency (%)
Location of workplace	Seoul	222 (47.1%)
	Busan	40 (8.5%)
	Daegu	42 (8.9%)
	Incheon	13 (2.8%)
	Gwangju	12 (2.5%)
	Daejeon	2 (0.4%)
	Ulsan	9 (1.9%)
	Gyeonggi Province	75 (15.9%)
	Gangwon Province	16 (3.4%)
	South Jeolla Province	7 (1.5%)
	South Gyeongsang Province	28 (5.9%)
	Jeju Island	5 (1.1%)
Monthly average income (KRW)	Less than 2 million	56 (11.9%)
	2 million or more–less than 4 million	328 (69.6%)
	4 million or more–less than 6 million	84 (17.8%)
	6 million or more	3 (0.6%)

4.2. Reliability and Validity Analysis and Correlation Analysis

The descriptive statistical results show that the mean and standard deviation of each variable are within a reasonable range. The reliability analysis results show that Cronbach's Alpha coefficients range from 0.763 to 0.891, indicating good internal consistency of the scale. The analysis of structural validity and criterion validity verifies the effectiveness and accuracy of the measurement tool. The results of the factor analysis validate the rationality of the scale structure in the questionnaire and confirm the dimension division of each variable. The factors extracted through the maximum variance rotation method were consistent with the theoretical expectations, and the factor loadings of each factor were greater than 0.710, indicating that the scale has high structural validity. The validity analysis results range from 0.710 to 0.853, further confirming the soundness of the measurement instrument.

The results of the correlation analysis conducted in this study show that employees' perceived benefits of service robots are significantly positively correlated with positive emotions, attitudes, and willingness to cooperate. For example, the correlation coefficient between variable SR and AT is (0.659 **, $p < 0.01$), the correlation coefficient between SR and EM is (0.557 **, $p < 0.01$), and the correlation coefficient between SR and WTC is (0.768 **, $p < 0.01$). However, employees' perceived risks of service robots are significantly negatively correlated with positive emotions, attitudes, and willingness to cooperate. For example, the correlation coefficient between IE and AT is (−0.388 **, $p < 0.01$), the correlation coefficient between IE and EM is (−0.252 **, $p < 0.01$), and the correlation coefficient between IE and WTC is (−0.237 **, $p < 0.01$). In addition, there is a significant positive correlation between employees' positive emotions, attitudes, and willingness to cooperate. For example, the correlation coefficient between EM and WTC is (0.586 **, $p < 0.01$). The correlation analysis results are presented in Table 3.

Next, Table 5 shows the multiple regression analysis results for perceived benefits and risks on emotional responses (EMs). Service reliability (SR: $\beta = 0.158, p = 0.005$), process efficiency (TE: $\beta = 0.357, p < 0.001$), and job crafting (JC: $\beta = 0.113, p = 0.011$) have significant positive effects on positive emotional responses (EMs), supporting hypotheses H4a, H4b, and H4c. From the perceived risks, inefficiency (IE: $\beta = -0.091, p = 0.038$) and insufficient intelligence (II: $\beta = -0.208, p < 0.001$) have significant negative effects on positive emotional responses (EMs), supporting hypotheses H5a and H5b. Privacy concerns (PCs: $\beta = -0.131, p = 0.006$) also have a significant negative effect on positive emotional responses, supporting hypothesis H5c.

Table 5. Regression analysis of perceived benefits and risks on emotion.

Variables	B	SE	β	t-Value	p-Value	VIF
Constant	2.267	0.352		6.430	0.000	
SR	0.171	0.061	0.158	2.826	0.005	2.501
PE	0.350	0.050	0.357	7.026	<0.001	2.078
JC	0.104	0.041	0.113	2.557	0.011	1.569
IE	−0.105	0.051	−0.091	−2.077	0.038	1.558
II	−0.193	0.049	−0.208	−3.923	<0.001	2.249
PCs	−0.111	0.040	−0.131	−2.766	0.006	1.807
$R^2 = 0.423$, Adjusted $R^2 = 0.415$, $F = 56.603$, $p < 0.001$						

Table 6 shows the regression analysis results for attitude (AT) and emotion (EM) on willingness to cooperate (WTC). The results indicate that attitudes (ATs: $\beta = 0.560, p < 0.001$) and emotion (EM: $\beta = 0.586, p < 0.001$) both have significant positive effects on willingness to cooperate (WTC), supporting hypotheses H3 and H6.

Table 6. Regression analysis of attitude and emotion on willingness to cooperate.

Variables	B	SE	β	t-Value	p-Value	R^2	Adjusted R^2	F-Value	p-Value
Constant	1.470	0.143		10.249	0.000				
AT	0.615	0.042	0.560	14.644	<0.001	0.314	0.312	214.437	<0.001
EM	0.640	0.041	0.586	15.648	<0.001	0.343	0.342	244.846	<0.001

4.3.2. Mediation Analysis

To examine the mediating roles of positive attitudes (ATs) and positive emotional responses (EMs) between perceived benefits (SR, TE, and JC), perceived risks (IE, II, and PCs), and willingness to cooperate (WTC), we conducted a mediation analysis using Hayes' Process Macro Model 4. For clarity, the key results are summarized in Table 7.

Table 7. Summary table of the mediation analysis.

Predictor	Mediator	Direct Effect (c')	Indirect Effect (ab)	Total Effect (c)	Sig
SR	AT	0.8355	0.0743	0.9099	$p < 0.05$
	EM	0.7588	0.1511	0.9099	$p < 0.05$
PE	AT	0.4335	0.2000	0.6335	$p < 0.05$
	EM	0.4082	0.2253	0.6335	$p < 0.05$

Table 7. Cont.

Predictor	Mediator	Direct Effect (c')	Indirect Effect (ab)	Total Effect (c)	Sig
JC	AT	0.3174	0.1674	0.4849	$p < 0.05$
	EM	0.3013	0.1835	0.4849	$p < 0.05$
IE	AT	−0.0294	−0.2680	−0.2974	$p < 0.05$
	EM	−0.1199	−0.1775	−0.2974	$p < 0.05$
II	AT	−0.3637	−0.1732	−0.5369	$p < 0.05$
	EM	−0.3579	−0.1790	−0.5369	$p < 0.05$
PCs	AT	−0.2903	−0.0648	−0.3551	$p < 0.05$
	EM	−0.2793	−0.0758	−0.3551	$p < 0.05$

Key Findings

The results indicate that both attitudes (ATs) and emotional responses (EMs) significantly mediate the relationships between perceived benefits/risks and willingness to cooperate (WTC).

For perceived benefits, service reliability (SR) positively influences WTC via partial mediation of AT ($abAT = 0.0743$, $p < 0.05$) and EM ($abEM = 0.1511$, $p < 0.05$), with a significant total effect ($c = 0.9099$, $p < 0.05$). Similarly, process efficiency (PE) enhances WTC through AT ($abAT = 0.2000$, $p < 0.05$) and EM ($abEM = 0.2253$, $p < 0.05$), with a significant total effect ($c = 0.6335$, $p < 0.05$). Job crafting (JC) also positively affects WTC via AT ($abAT = 0.1674$, $p < 0.05$) and EM ($abEM = 0.1835$, $p < 0.05$), with a significant total effect ($c = 0.4849$, $p < 0.05$).

For perceived risks, inefficiency (IE) negatively impacts WTC, fully mediated by AT ($abAT = -0.2680$, $p < 0.05$) and partially mediated by EM ($abEM = -0.1775$, $p < 0.05$), with no significant direct effect ($c' = -0.0294$, $p > 0.05$). Insufficient intelligence (II) negatively affects WTC through partial mediation of AT ($abAT = -0.1732$, $p < 0.05$) and EM ($abEM = -0.1790$, $p < 0.05$), with a significant total effect ($c = -0.5369$, $p < 0.05$). Lastly, privacy concerns (PC) negatively influence WTC via AT ($abAT = -0.0648$, $p < 0.05$) and EM ($abEM = -0.0758$, $p < 0.05$), with a significant total effect ($c = -0.3551$, $p < 0.05$). These findings underscore the critical mediating roles of AT and EM in shaping WTC.

A summary of the mediation analysis results is provided in Table 7. This table integrates the direct, indirect, and total effects across all predictors and mediators for a concise overview.

5. Conclusions

5.1. Discussion

The findings of this study highlight significant implications for sustainability in technology adoption within hospitality. Specifically, integrating service robots aligns closely with sustainability goals, encompassing economic sustainability through increased efficiency and reduced labor costs; environmental sustainability via optimized resource use and reduced waste; and social sustainability by alleviating employees' repetitive workloads, enhancing employee skills, and reducing burnout risks. For instance, service robots handling delivery and cleaning tasks significantly decrease resource consumption and environmental footprints, while robots performing front-desk tasks enable employees to focus more effectively on personalized customer interactions and professional skill development.

This study provides a comprehensive examination of the influence of service robots on employees in the hotel industry, with a particular focus on their cognitive appraisals,

attitudes, emotional responses, and willingness to collaborate. Through the integration of multiple theoretical frameworks and employing empirical research methods, this study offers nuanced insights into how employees perceive the benefits and risks associated with robotic technologies.

The findings confirm that perceived benefits (service reliability, process efficiency, and job crafting opportunities) and perceived risks (inefficiency, insufficient intelligence, and privacy concerns) significantly influence employees' cognitive appraisals and emotional responses, ultimately affecting their willingness to collaborate. These empirical results substantiate and extend the theoretical propositions derived from the integrated frameworks (CAT, AET, TAM, and SOR) adopted in this study.

Specifically, Cognitive Appraisal Theory (CAT) is reinforced by demonstrating how employees' cognitive evaluations of perceived robot benefits and risks distinctly shape their attitudes, aligning closely with Lazarus and Folkman's (1984) assertion that appraisal processes significantly dictate subsequent emotional and behavioral outcomes. Furthermore, Affective Events Theory (AET) is extended through the explicit identification of perceived robot attributes as critical workplace events capable of evoking either positive or negative emotional reactions, thereby influencing collaboration intentions.

Our findings also refine the Technology Acceptance Model (TAM) by highlighting how specific robot attributes (e.g., process efficiency and reliability) translate into perceived usefulness, while concerns (e.g., insufficient intelligence and privacy risks) hinder perceived ease of use, collectively influencing employees' acceptance and collaboration willingness. Lastly, the Stimulus–Organism–Response (SOR) framework is strengthened by confirming attitudes and emotions as significant internal mechanisms (organism responses) mediating the relationship between external stimuli (robot characteristics) and employee behaviors (collaboration intentions).

Thus, by empirically validating these interrelationships, our research not only supports but also enriches these theoretical models, offering a refined understanding of human–robot interaction dynamics in the workplace context.

Employees' positive evaluations of service robots stem from their perception of reliability and consistent performance (Chiang & Trimi, 2020). This underscores the importance of regular maintenance, enhanced monitoring systems, and effective feedback mechanisms to ensure service reliability. Similarly, improving process efficiency through optimized algorithms and targeted employee training fosters trust and collaboration (Chowdhury et al., 2022). Job crafting opportunities, which allow employees to redefine their roles and focus on creative, high-value tasks, also play a crucial role in enhancing their acceptance of robots. Promoting open communication and encouraging employees to share their experiences further alleviates anxieties about role redundancy, fostering a sense of empowerment.

Mitigating perceived risks is equally essential. Addressing inefficiency concerns requires continuous performance optimization and responsiveness improvements, while advancing robots' capabilities in handling complex tasks can alleviate fears of insufficient intelligence. Privacy concerns, a critical issue among employees (Gan et al., 2019), demand robust data protection mechanisms, such as advanced encryption and transparent communication about data usage policies. These measures collectively enhance employees' trust and reduce resistance to collaboration with robots.

Interestingly, although privacy concerns were found to negatively influence employee attitudes and collaboration willingness, the magnitude of their effects was smaller than initially anticipated. This somewhat contradictory finding might stem from the practical reality of the hospitality industry, where employees often perceive data collection as necessary or unavoidable for operational efficiency and personalized customer service. Additionally, given South Korea's generally high acceptance and familiarity with technology integration

and data-driven services, employees might perceive privacy risks as relatively manageable compared to inefficiencies or insufficient robot intelligence, which directly impact their workload and operational outcomes. This nuanced result suggests future research should further investigate contextual conditions, such as organizational transparency and communication effectiveness, that might moderate privacy-related concerns.

5.2. Theoretical and Practical Implications

This study contributes significantly to the growing literature on human–robot interaction by offering a multi-theoretical approach to understanding employees' perceptions of service robots. The integration of CAT, AET, TAM, and SOR frameworks facilitates a comprehensive exploration of how perceived benefits and risks shape employees' cognitive and emotional responses and, subsequently, their willingness to collaborate. By identifying the mediating roles of attitudes and emotions, the study advances theoretical understanding of the mechanisms driving employee behavior in the context of workplace automation.

Practically, the findings provide actionable insights for managers, policymakers, and service robot manufacturers. For managers, prioritizing the enhancement of service reliability and process efficiency is crucial to fostering employees' trust in robotic technologies. Specifically, managers should implement detailed maintenance schedules and regular performance audits to consistently ensure robot reliability. Additionally, providing structured opportunities for job crafting, such as assigning employees roles in overseeing robot-assisted processes or participating in robot improvement committees, can enhance their sense of empowerment and reduce fears of redundancy.

Managers should also develop targeted training programs, including hands-on technical workshops that enable employees to directly interact with service robots, scenario-based simulation training to practice problem-solving and troubleshooting skills, and skill-building sessions focused on human–robot collaboration techniques. Clear and frequent communication explicitly outlining how robots complement rather than replace human employees, including transparent policy updates and open forums for employee feedback, will further alleviate fears about job displacement and support smoother technology integration.

Furthermore, managers should explicitly address employees' fears about job displacement by clearly communicating how service robots are intended to support rather than replace human roles. Providing transparent communication about future role adjustments, reskilling opportunities, and career development pathways can alleviate replacement fears and foster a more positive environment for sustainable technology adoption.

Policymakers should establish comprehensive and clear regulatory guidelines to ensure data privacy and security in workplaces employing service robots. These regulations should mandate robust data encryption standards, explicit user consent protocols, and regular compliance audits of robot-related data collection practices. Furthermore, policymakers could incentivize hospitality businesses by offering certifications or financial incentives for adherence to exemplary privacy and security practices. Initiatives supporting industry-wide training and certification programs aimed at enhancing employees' capabilities in managing and collaborating with service robots would further facilitate sustainable and beneficial technology adoption.

For service robot manufacturers, aligning robot functionalities with specific employee needs is critical. Efforts should include enhancing robot intelligence, responsiveness, and task adaptability based on direct feedback from frontline employees. Manufacturers should incorporate advanced data protection technologies, clearly communicate their privacy policies, and ensure transparency regarding the nature and scope of data collection. Providing

comprehensive training materials and ongoing technical support to client organizations will also help ensure effective robot integration and increased employee acceptance.

Overall, this study emphasizes the necessity of a coordinated and proactive approach among managers, policymakers, and robot manufacturers. By addressing employee concerns through targeted, transparent, and actionable measures, stakeholders can collaboratively ensure the harmonious and sustainable integration of robotic technologies within hospitality workplaces.

5.3. Limitations and Future Research

Despite its contributions, this study has limitations. First, it focuses on the hotel industry in South Korea, which may limit the generalizability of the findings to other sectors or cultural contexts. Specifically, Korea's hospitality industry is characterized by high technological readiness, intense competition, and a cultural emphasis on efficiency and innovation. These contextual factors might positively bias employees' openness and adaptability towards robotic technologies. Additionally, cultural dimensions, such as hierarchical organizational structures, strong collectivism, and relatively high power distance, might influence employee perceptions, attitudes, and responses to the integration of robots differently compared to Western or other Asian contexts. Therefore, future studies could conduct cross-cultural comparisons to explore how distinct national or organizational cultures influence employees' cognitive and emotional responses to service robot integration, further enriching our understanding of technology adoption dynamics.

Second, reliance on self-reported survey data introduces subjectivity and potential biases. Additionally, the cross-sectional design of this study limits the ability to establish definitive causal relationships among perceived benefits, risks, and employee responses. Employee attitudes and emotional reactions to service robots may evolve significantly over time, especially as employees become more familiar with robotic technologies or as their roles change. Therefore, future research should adopt a longitudinal design to rigorously track how employee perceptions, attitudes, emotional reactions, and collaboration willingness evolve over extended periods, providing stronger evidence of causal relationships and capturing dynamic changes resulting from prolonged human–robot interactions.

Third, although demographic characteristics, such as age, education, and work experience, were reported, their potential moderating effects were not explicitly analyzed. For example, younger employees might exhibit more favorable attitudes towards service robots due to greater familiarity with emerging technologies, while education levels may influence employees' openness to technological changes and skill acquisition. Future research could explicitly investigate how these demographic variables moderate the relationship between employees' perceptions of robots and their attitudes, emotional reactions, and willingness to collaborate, thus providing further practical implications for targeted managerial strategies.

Finally, future research can investigate the impact of different robot types on employees' perceptions and behaviors to identify the most effective solutions for specific tasks. Understanding the role of individual differences, such as personality traits, experience, and educational background, can provide tailored insights for workforce management. Furthermore, training programs aimed at improving employees' acceptance of and collaboration with robots warrant deeper exploration. Finally, the influence of emerging trends, such as increased robot intelligence and personalization, on employee–robot interaction and organizational outcomes should be explored.

By building on these findings, future research can advance both theoretical and practical understanding of service robots' integration into the workplace, ensuring that technological advancements benefit employees and organizations alike in a sustainable manner.

Author Contributions: Conceptualization, Y.W., M.P. and J.H.C.; methodology, Y.W., M.P. and J.H.C.; validation, J.H.C.; formal analysis, Y.W. and J.H.C.; investigation, Y.W. and J.H.C.; data curation, Y.W., M.P. and J.H.C.; writing—original draft preparation, Y.W.; writing—review and editing, M.P. and J.H.C.; visualization, Y.W. and J.H.C.; funding acquisition, J.H.C. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5A2A03054930).

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Sejong University (SUIRB-HR-2022-010 and 16 November 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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