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The Robot–Human Paradox: A Meta-Analysis of Customer Service by Robots Versus Humans on Customer Experience

Fernando de Oliveira Santini[1,2] | Weng Marc Lim[3,4,5] | Claudio Hoffmann Sampaio[6] | Tareq Rasul[7] | Wagner Junior Ladeira[1,2] | Park Thaichon[8] | Debdutta Choudhury[2]

[1]Universidade Do Vale Do Rio dos Sinos (UNISINOS), Porto Alegre, Brazil | [2]School of Business, Woxsen University, Hyderabad, India | [3]Sunway Business School, Sunway University, Sunway City, Selangor, Malaysia | [4]ASU-Cintana Alliance Global Partner Affiliate Faculty, Arizona State University, Tempe, Arizona, USA | [5]School of Business, Law and Entrepreneurship, Swinburne University of Technology, Hawthorn, Victoria, Australia | [6]School of Business, Pontifical Catholic University of Rio Grande Do Sul (PUCRS), Porto Alegre, Brazil | [7]College of Business Administration, Gulf University for Science and Technology (GUST), Kuwait | [8]School of Business, University of Southern Queensland, Springfield, Australia

Correspondence: Park Thaichon (park.thaichon@gmail.com)

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ABSTRACT

The integration of robots in customer service has attracted considerable interest from both academia and industry. While some studies highlight positive impacts on customer experience, others report neutral or negative outcomes. This meta-analysis synthesises findings from 25 articles comprising 62 independent studies, 147 effect sizes, and a cumulative sample of 19,668 participants. The results indicate that robot-provided services generally reduce customers' positive emotion and intention compared to human-provided services. However, upon closer scrutiny, we found that robots outperform humans in contexts involving embarrassment (vs. non-embarrassment) and in services with a utilitarian (vs. hedonic) orientation. Fur, robot use is more effective in low (vs. high) complexity service settings. Furthermore, humanoid robots with visual output capabilities are more effective than non-humanoid or text-based robots. Moreover, the negative effects of robots (vs. humans) on customers' satisfaction and intention are less pronounced in product-oriented industries or sectors like electronics and retail than in service-oriented ones like healthcare and hospitality. These findings underscore the conditions under which robots are suitable for customer service, thereby providing valuable insights for strategically optimizing their deployment to improve customer experience.

1 | Introduction

The service robotics market is projected to reach USD 60.16 billion in 2024 and grow to USD 146.79 billion by 2029, with a compound annual growth rate (CAGR) of 19.53% (Mordor Intelligence 2024). Sectors such as agriculture, hospitality, logistics, medical, and professional cleaning have predominantly embraced this transition (IFR 2021). Consequently, contemporary customers frequently encounter robotic interfaces, whether in domestic environments featuring voice-activated services, hospitality contexts with artificial intelligence (AI)-powered hotel chatbots and robotic room service delivery, or retail settings assisting with product queries or pricing. Prominent brands have also integrated these technologies: Little Caesars employs robots for pizza preparation, McDonald's features an automated drive-thru, and Starbucks harnesses AI for its coffee machines. The increased use of robots across various sectors is often driven by considerations of cost and operational efficiency. However, cautionary examples, such as Elon Musk's acknowledgement that "humans are underrated" following the Tesla

Model 3's over-reliance on automation, highlight the potential pitfalls of over-dependence on robots.

Academia has been responsive to these industry trends, striving to understand both the benefits and drawbacks of robotic implementation. Particularly within the scope of customer experience, a multitude of studies has explored various contexts and robot technologies (Nguyen, Quach, and Thaichon 2021; Rancati et al. 2023). For example, Sands et al. (2021) analysed different service scripts presented during chatbot service encounters, Singh, Olson, and Tsai (2021b) examined robots used for conference registration, and Wien and Peluso (2021) evaluated AI recommenders for headphone appraisal. These studies investigated diverse customer experience outcomes, such as emotion (Frank and Otterbring 2023; Ruan and Mezei 2022), satisfaction (Longoni and Cian 2022; Pozharliev et al. 2021), and intention (Longoni, Bonezzi, and Morewedge 2019; Mende et al. 2019), yielding, at times, conflicting results. For instance, while some studies assert positive influences of robotic interactions on behavioural intentions (Becker, Mahr, and Odekerken-Schröder 2023; Mende et al. 2019; Shi, Lu, and Zhou 2023), others report neutral (Wien and Peluso 2021) or even negative effects (Longoni, Bonezzi, and Morewedge 2019). These discrepancies therefore reflect a paradox.

The conflicting results may stem from the fragmented contexts explored in studies involving robot use, presenting challenges for researchers and practitioners in determining optimal decision-making strategies (Hunter and Schmidt 2004). Consequently, meta-analyses are invaluable for consolidating our understanding of phenomena such as the use of robots in service contexts (Borenstein et al. 2009). To address this need, we propose a model tested through a meta-analysis, accessing 62 independent studies with a cumulative sample size of 19,668 participants from 9 different countries across 4 continents. Our research aims to (1) systematise the body of knowledge on service robot use and its prominent consequences (customer positive emotion, satisfaction, and intention) and (2) examine the moderators that influence these direct effects. Following recommendations from prior research (Fern and Monroe 1996), our work methodically collates and interprets findings to enable both academics and industry professionals to better understand the holistic impact of robots on customer experience. Building on previous suggestions (Hulland and Houston 2020), we examine a range of moderators, encompassing diverse contexts (industry and service settings), features, and tasks (Belanche et al. 2020; Borau et al. 2021; Choi et al. 2020; Flavián and Casaló 2021; Lalicic and Weismayer 2021; Longoni and Cian 2022).

Through a meta-analytic review of service robot integration and its consequences, including under various moderators, we reconcile prior research findings and contribute granular insights to the body of knowledge. Specifically, we offer a meta-analytical model for service robot integration that addresses fragmentation in the field across consequences (Lu et al. 2020) under varying characteristics or scenarios (Borghi et al. 2023; Fern and Monroe 1996). Our research thus provides comprehensive insights into the moderators of service robot effects, offering a breadth and depth unattainable in any single independent study (Hulland and Houston 2020). Finally, we discuss the theoretical and practical implications of our findings, paving the way for future research at the intersection of customer experience and service robots.

In the subsequent sections, we first juxtapose robots and humans in terms of customer experience, leading to our hypotheses. We then outline the methodological procedure adopted, followed by a detailed discussion of our findings. Concluding remarks cover implications, limitations, and directions for future research.

2 | Conceptual Background and Hypothesis Development

According to Lanfranco et al. (2004), the term "robot" has evolved significantly, shifting from its early association with simple machines performing mundane, repetitive tasks to its modern representation as highly sophisticated anthropomorphic entities reminiscent of those depicted in popular culture. Further refining this concept, the International Federation of Robotics (2021) defines a "robot" as an entity capable of autonomous actions without human intervention. Over the years, robots have profoundly altered the nature of work, particularly as they have become increasingly capable (Edwards et al. 2019; Wang et al. 2025). Robots no longer perform merely mechanistic roles; rather, they are now displacing jobs that require cognitive, analytical, and intuitive abilities, facilitating complex human-robot interactions (Belanche et al. 2020; Huang and Rust 2021; Jörling, Böhm, and Paluch 2019). Service robots, in particular, are defined as system-based, autonomous, and adaptable interfaces that interact, communicate, and deliver services to an organisation's customers; they can make autonomous decisions, adapt to situations using data from various sensors and sources, and establish a degree of automated social presence during service encounters (Wirtz et al. 2018). Given the increasing prevalence of human-robot interactions in society today, it is imperative to understand how these interactions shape customer responses.

Many scholars have sought to explore and explain the growing presence of robots in everyday life. A pivotal review by Royakkers and van Est (2015) traced the development, ethical considerations, and regulatory challenges of deploying robots in diverse fields, including households, law enforcement agencies, and medical facilities. In 2018, four notable reviews were published. Honig and Oron-Gilad (2018) thoroughly analysed the extensive research on the limitations of human-robot synchronisation. Kaartemo and Helkkula (2018) examined the integration of AI and robotics in value co-creation. Savela, Turja, and Oksanen (2018) explored research on the determinants of robot acceptance while Vandemeulebroucke, de Casterlé, and Gastmans (2018) synthesised consumer reactions to socially capable robots. The following year, Ivanov et al. (2019) investigated the incorporation of robots within hospitality, leisure, and travel. More recently, Klaus and Zaichkowsky (2020) proposed a framework for studying AI voice bots in service marketing while Lu et al. (2020) and Kipnis et al. (2022) provided insights into the interplay between consumers, service employees, and service robots.

Other relevant studies have been conducted in recent years. For instance, Pitardi et al. (2021) employed a mixed-method

approach (qualitative and experimental studies) to examine the effectiveness of robots in handling embarrassing service encounters. Their findings indicated that customers feel more at ease in such contexts, as robots do not express emotion or judgement. This lack of emotion and opinion formation can enhance the customer service experience and perception. These results are corroborated by Holthower and van Doorn (2023), who conducted experiments in various embarrassing contexts (e.g., body weight, lack of restaurant reservations, sensitive product purchases), as well as by Pitardi et al. (2024), who demonstrated through five experiments in hospitality settings that service robots reduce customers' meta-perception (i.e., their perception of how others view them), thereby alleviating customer discomfort.

Another study by Borghi et al. (2023) examined significant moderators (customer review effort focused on the robot, device used to post reviews, online review experience, and rapport) that could influence the effect of service robots on customer satisfaction ratings in a hotel context. The authors found that strong rapport (i.e., robot empathy and affinity) positively moderated the main direct effects. Conversely, customer review effort focused on the robot reduced satisfaction. The authors also showed that using a mobile device to post evaluations led to higher satisfaction compared to other devices, and that prior online review experience further enhanced customer satisfaction.

Consumers typically assess robots based on their agency and emotional capabilities (Pitardi et al. 2021). Agency refers to a robot's ability to form opinions and make moral and social judgements while emotion is associated with feelings (Gray and Wegner 2012). However, most robots lack these features. Huang and Rust (2018) argue that four types of intelligence are necessary for service tasks: mechanical, analytical, intuitive, and empathetic. They posit that robots excel in tasks requiring mechanical and analytical intelligence, particularly in transactional rather than relational services.

Numerous factors could enhance or diminish the customer experience of using robots. To explore these dynamics, researchers have conducted various studies yielding different outcomes and have identified several moderators. In light of this, we propose a model based on the most prominent outcomes identified in our systematic review (i.e., customers' positive emotion, satisfaction, and intention). We also suggest several moderators that could potentially amplify or attenuate the direct relationships, as presented in Figure 1.

2.1 | The Impact of Customer Service by Robot Versus Human on Customer Experience

As identified in our systematic review, the most prominent outcomes of robot service use are customers' positive emotion, satisfaction, and intention. The effects on these outcomes can vary based on several factors, such as context or industry (e.g., Borghi et al. 2023), service type (e.g., Pitardi et al. 2021; Holthöwer and van Doorn 2023; Pitardi et al. 2024), and task complexity (e.g., Huang and Rust 2018). To examine the direct effects of robot service use on customer experience outcomes, we adopted a general context. Within this context, we anticipated that the use of robots might have negative impacts.

For instance, positive emotions are associated with feelings of agreeableness, enthusiasm, and uninhibited expression, which generally lead to favourable outcomes (Pansari and Kumar 2017; Xiao and Kumar 2021). Positive emotions also relate to the concepts of arousal (Ruan and Mezei 2022) and pleasantness (Pozharliev et al. 2021). However, robots are typically perceived as less empathetic (Wirtz et al. 2018) and less emotional (Gray and Wegner 2012). They tend to deliver standardised and uniform experiences, making them better suited to tasks requiring mechanical and analytical intelligence, particularly

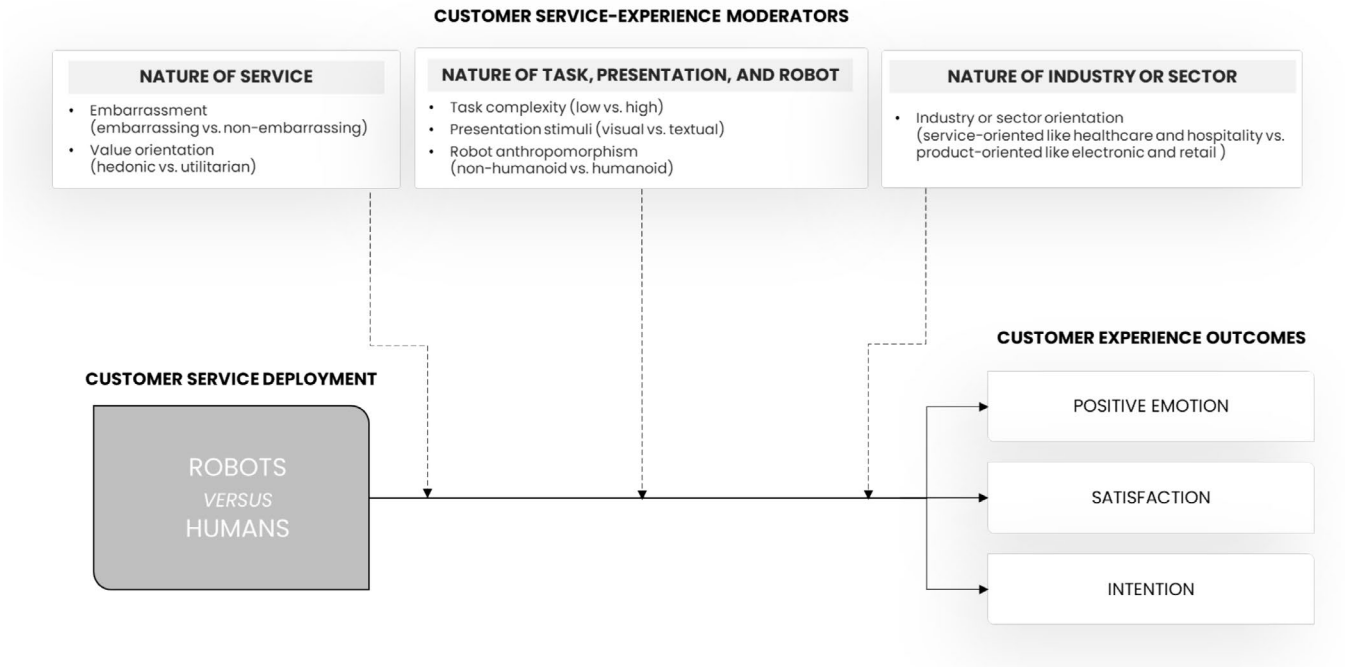

FIGURE 1 | Conceptual framework.

in transactional rather than relational services (Huang and Rust 2018). In other words, robots are more rational than emotional.

Regarding customer satisfaction and intention, numerous studies have investigated robot use across different contexts, often yielding contrasting results (e.g., Borghi et al. 2023). Generally, when comparing services provided by humans and robots, customers tend to report higher satisfaction and stronger intentions when interacting with humans. This preference can be attributed to the familiarity and comfort associated with human interactions, which elicit higher levels of satisfaction and intention (Pozharliev et al. 2021; Söderlund 2022). Social discomfort may also contribute to lower satisfaction and intention, as interactions with service robots could be perceived as violating social norms (Borau et al. 2021). Consequently, customers expect to maintain a comfortable social distance when engaging with unfamiliar service robots (Castelo, Schmitt, and Sarvary 2019). Moreover, customers generally perceive machines as efficient for routine tasks (Haslam 2006). However, cognitive dissonance arises when there is a discrepancy between the expected anthropomorphic attributes of a robot and its distinctly non-human characteristics (Mori, MacDorman, and Kageki 2012). Based on these insights, we propose the following hypothesis concerning robot service use and its effects on customer experience outcomes.

Hypothesis 1. *Customers experience lower (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans.*

2.2 | Moderating the Impact of Customer Service by Robot Versus Human on Customer Experience

As previously noted, the main effects of robot use can vary depending on several factors. In this meta-analysis, we incorporated the most prominent future research suggestions to analyse relevant factors that could enhance or diminish the effects of robot use on customers' positive emotion, satisfaction, and intention. We categorised these moderators into three main groups: (a) nature of service, (b) nature of task, presentation, and robot, and (c) nature of industry or sector.

2.2.1 | Nature of Service

In relation to the type of service, we investigated two potential moderators: (a) embarrassing versus non-embarrassing services and (b) hedonic versus utilitarian services. The use of robots in contexts involving embarrassing situations, such as purchasing condoms or seeking medical treatment for erectile dysfunction, has gained significant attention (e.g., Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024) because robots are perceived as effective in these situations. The positive predisposition customers exhibit towards interacting with robots in embarrassing situations can be attributed to the fact that robots do not display emotion or judgement (Pitardi et al. 2021, 2024). This insight is crucial, as embarrassing situations often evoke discomfort in consumers (Pitardi et al. 2024), which can lead to avoiding such purchases or services (Grace 2007). Social judgement is a major concern in customer decision-making in embarrassing situations (Dahl, Manchanda, and Argo 2001), but robot interaction can alleviate this concern (Holthöwer and van Doorn 2023). Accordingly, we propose:

Hypothesis 2a. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans in embarrassing situations compared to non-embarrassing situations.*

Recent studies also suggest further investigation into the efficiency of robot use in hedonic versus utilitarian contexts (e.g., Longoni and Cian 2022; So et al. 2023). Following these suggestions, we propose examining this distinction within a broad range of studies. The prevailing understanding is that robots are more useful in utilitarian contexts (e.g., Castelo, Schmitt, and Sarvary 2019; So et al. 2023) due to their cognitive rather than emotional orientation (Babin, Darden, and Griffin 1994). Utilitarian contexts typically demand more objective tasks and involve low-level construal (So et al. 2023). Based on this, we propose:

Hypothesis 2b. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans in utilitarian-oriented services compared to hedonic-oriented services.*

2.2.2 | Nature of Task, Presentation, and Robot

Regarding task, presentation, and robot characteristics, we investigated three potential moderators: (a) task complexity (high versus low), (b) presentation stimuli (textual versus visual), and (c) robot anthropomorphism (humanoid versus non-humanoid). Several previous studies call for more research on task complexity (e.g., Huang and Rust 2018; So et al. 2023). Goodhue and Thompson's (1995) task-technology fit theory offers valuable insights on this topic, suggesting that consumers are indifferent to whether humans or robots are used for low-complexity tasks. However, when a task is perceived as highly complex, customers typically prefer human providers due to the increased risk of errors. Similar findings were observed in experiments conducted by So et al. (2023). Their study found that task complexity significantly moderated the effects of functional perceptions (e.g., perceived ease of use, perceived usefulness) on consumer responses to service robots. Specifically, customers preferred humanoid robots over non-humanoid robots for complex tasks, whereas the moderator effect was not significant for low-complexity tasks. Based on these insights, we propose:

Hypothesis 3a. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans for low-complexity tasks compared to high-complexity tasks.*

In terms of presentation stimuli, we explored the potential influence of how outputs are presented (textual versus visual), as recommended by previous research (e.g., Longoni and Cian 2022; Pitardi et al. 2021; Ryoo, Jeon, and Kim 2024). Most studies examining the impact of robots versus humans on customer responses manipulate scenarios using textual (e.g., chat interfaces)

or visual (e.g., robot demonstrations) elements. Visual stimuli, known for their richness and entertainment value, have been found to enhance social interaction and, consequently, customer experience (Huang et al. 2021; McColl-Kennedy et al. 2019; Ordenes et al. 2014). Hence, we propose:

Hypothesis 3b. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans using visual presentations compared to textual presentations.*

Finally, we investigated the potential influence of robot anthropomorphism (humanoid versus non-humanoid), an area identified as crucial for further investigation (e.g., Borghi et al. 2023; Pitardi et al. 2021, 2024; So et al. 2023). Humanoid robots, with their anthropomorphic traits, are considered more effective at mitigating adverse outcomes—as indicated in numerous studies that underscore the pivotal role of anthropomorphism in shaping customer intentions (Lin, Chi, and Gursoy 2020; Shi et al. 2021). In this regard, we propose:

Hypothesis 3c. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans when robots are humanoid compared to non-humanoid.*

2.2.3 | Nature of Industry or Sector

A frequently suggested area for future research involves exploring the impact of robot use across different industries or sectors (e.g., Borghi et al. 2023; Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024). This is particularly important because most primary studies focus on specific industries or sectors, such as healthcare (Longoni, Bonezzi, and Morewedge 2019) or hospitality (Belanche et al. 2020). One major advantage of meta-analyses is the ability to analyse a broad range of industries or sectors simultaneously, which is often not feasible in any single independent study (Hulland and Houston 2020). In this study, we examined data from various industries or sectors, including hospitality, healthcare, electronics, and retail. Industries or sectors such as electronics and retail frequently involve robot interactions, indicating higher customer familiarity with robots (Nomura, Syrdal, and Dautenhahn 2015). One possible explanation is that these industries or sectors are more product-oriented than service-oriented, making them more transactional than relational (Huang and Rust 2018). Indeed, it has been noted that robot use is more accepted in transactional than in relational situations (Huang and Rust 2018). Given this logic, we propose:

Hypothesis 4. *Customers experience higher (a) positive emotion, (b) satisfaction, and (c) intention when receiving services from robots compared to humans in product-oriented industries or sectors like electronic and retail compared to service-oriented industries or sectors like healthcare and hospitality.*

3 | Methodology

This meta-analytic research conducts a comprehensive investigation and integration of findings from prior studies, focusing on discerning the implications of deploying robots over humans in customer service and their influence on customer experience outcomes. To achieve this, we adhere to Moher et al.'s (2009) Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol, encompassing the phases of identification, screening, eligibility, and inclusion (Supporting Information: Appendix A). The widespread adoption of this protocol in numerous marketing-centred systematic literature reviews and meta-analytic inquiries (Bergmann et al. 2023; Kraus et al. 2022; Lim and Rasul 2022; Lim et al. 2022) strengthens the robustness and trustworthiness of the present inquiry.

In the initial identification phase, we brainstormed and collectively agreed on salient keywords to align all relevant studies in the literature with the present study's goals and scope. This endeavour was supported by a search of extant literature. We searched three primary databases, Scopus, Web of Science, and Google Scholar—guided by an array of keywords, including "service robots", "intelligent physical devices", "robot-assisted services", and "autonomous robots". This exploration included literature up to April 30, 2024, employing multiple search strings using the Boolean operators "OR" and "AND". Carefully focusing on business-centric articles, the initial search identified 458 articles. However, after removing duplicates and non-English articles, this list was refined to a corpus of 388 articles.

The next stages involved the application of screening, eligibility, and inclusion criteria. We considered experimental studies where robot use for customer service was manipulated (vs. human) and tested against customer experience outcomes (positive emotion, satisfaction, intention) as dependent variables. The studies were also required to report the mean and standard deviation for both the experimental (robot) and control (human) groups. If studies did not report the necessary information for our coding (mean and standard deviation for experimental and control groups) (e.g., Pitardi et al. 2021), we contacted the authors to obtain this data in order to include the study in our meta-analysis. Applying these criteria, 25 valid articles involving 62 experiments and a cumulative sample of 19,668 were included in this meta-analysis. The valid articles are presented in Supporting Information: Appendix B.

After identifying the valid studies, the meta-analysis proceeded with the coding process. This involved two independent researchers who coded the experiments based on direct relationships and moderators. In this step, we followed the guidelines provided by Rust and Cooil (1994). The coders achieved a high agreement level (91%) and resolved any disagreements through discussion, following established practices (Palmatier et al. 2006; Santini et al. 2023).

Finally, we conducted the meta-analytical calculations. We applied Cohen's (1988) *d* to calculate the effect size of direct effects. This measure represents the difference between two means (i.e., experimental condition vs. control condition) divided by the combined standard deviation (Chernev, Böckenholt, and Goodman 2015; Santini et al. 2023). We employed random effects models for all analyses (Hunter and Schmidt 2004). We also investigated potential publication bias in the direct effects using Egger's test and funnel plot analysis. This analysis determined whether our data distribution was

representative of the studies reviewed or if it exhibited asymmetry (Egger et al. 1997; Sterne and Egger 2005; Thornton and Lee 2000). The Egger regression measures the degree of funnel plot asymmetry by using the intercept from the regression of standard normal deviations against precision (Egger et al. 1997). Hierarchical linear meta-analysis was applied to investigate the potential moderators proposed in this study. The raw effect sizes from primary studies were used as dependent variables in the multivariate regression analysis, with all moderators included in the same analysis. We conducted all analyses using the metafor package in the R software (Viechtbauer 2010).

4 | Findings

We examined the direct effects of robot (vs. human) customer service on salient customer experience outcomes, namely, customers' positive emotion, satisfaction, and intention. We also explored the moderators influencing these direct relationships.

4.1 | Direct Effects of Customer Service by Robot Versus Human on Customer Experience

First, we tested the hypothesis related to customer service and experience outcomes. Hypothesis 1 predicted that customers experience lower positive emotion (Hypothesis 1a), satisfaction (Hypothesis 1b), and intention (Hypothesis 1c) when receiving services from robots compared to humans. Two of the three hypotheses were supported. Based on 16 effect sizes, there was a significant negative effect of robot use (vs. human use) on positive emotion ($d = -0.35$; 95% CI [−0.66, −0.04], $Z = -2.23$; $p < 0.05$). Thus, Hypothesis 1a was supported. To test Hypothesis 1b, we analysed 63 effect sizes encompassing over 16,000 respondents. The effect of robot use on customer satisfaction was about neutral ($d = -0.06$; 95% CI [−0.18, 0.05], $Z = -1.06$; $p = 0.28$). As the effect was not significant, Hypothesis 1b was not supported. Finally, we investigated the effect of robot use (vs. human use) on customer intention using 68 effect sizes with more than 12,000 respondents. The results indicated a significant negative effect ($d = -0.17$; 95% CI [−0.28, −0.05], $Z = -2.92$; $p < 0.05$). Thus, Hypothesis 1c was supported.

As part of our analysis, we evaluated potential publication bias using Egger's test and funnel plot analysis (Egger et al. 1997; Sterne and Egger 2005; Thornton and Lee 2000). The results suggest that publication bias did not affect our findings. The Egger's test was not significant for customers' positive emotion ($t = 1.18$; $p = 0.253$), satisfaction ($t = 1.76$; $p = 0.08$), or intention ($t = 1.18$; $p = 0.09$). All funnel plots are available in Supporting Information: Appendix C.

Our empirical findings provide robust and generalisable evidence of the direct impacts of customer service deployment on customer experience outcomes. Specifically, robot (vs. human) engagement significantly diminishes customers' positive emotion and intention. However, closer inspection of the results reveals substantial heterogeneity, with I^2 values ranging between 90% and 96%. This high degree of heterogeneity suggests that further moderation analysis is necessary to identify the specific conditions under which robot (vs. human) customer service influences customer experience outcomes.

4.2 | Moderating Effects on Customer Service by Robot Versus Human and Customer Experience

We conducted a moderation analysis to explore how robot use (vs. human use) in customer service influences customer experience outcomes. Table 1 presents the detailed results of this analysis.

4.2.1 | Nature of Service

This study examined the possible influence of embarrassment and value orientation on the relationship between customer service deployment and customer experience outcomes, revealing several significant findings.

Regarding embarrassment, the results indicated that embarrassing situations reduced the negative effects of robot use (vs. human use) only on customers' positive emotion ($\beta = -1.78$; $p < 0.01$) and intention ($\beta = -0.54$; $p < 0.01$). When examining only studies involving robot use, the results revealed that the negative effects were less pronounced in embarrassing situations ($d_{\text{positive emotion}}$: −0.13; CI [−0.36, 0.09]; $p = 0.23$; $d_{\text{intention}}$: −0.01; CI [−0.11, 0.08]; $p = 0.33$) than in non-embarrassing situations ($d_{\text{positive emotion}}$: −0.88; CI [−0.96, −0.26]; $p < 0.01$; $d_{\text{intention}}$: −0.55; CI [−0.76, −0.33]; $p < 0.01$). Thus, Hypothesis 2a was partially supported.

Regarding value orientation, the significant effects were observed only for customer intention ($\beta = 0.26$; $p < 0.05$), wherein services with a utilitarian orientation were less detrimental to customer intention than hedonic services ($d_{\text{utilitarian}}$: −0.00; CI [−0.14, 0.12]; $p = 0.08$; d_{hedonic}: −0.26; CI [−0.41, −0.10]; $p < 0.05$). Thus, Hypothesis 2b was partially supported.

4.2.2 | Nature of Task, Presentation, and Robot

We also explored task complexity as a moderator, finding partial support for Hypothesis 3a ($\beta_{\text{positive emotion}} = -0.96$; $p < 0.05$; $\beta_{\text{intention}} = -0.27$; $p < 0.05$). When tasks were low in complexity, the negative effects of robot use (vs. human use) on customers' positive emotion and intention were less pronounced ($d_{\text{positive emotion}}$: −0.28; CI [−0.59, 0.02]; $p = 0.52$; $d_{\text{intention}}$: −0.06; CI [−0.16, 0.04]; $p = 0.45$) than when tasks were high in complexity ($d_{\text{positive emotion}}$: −0.51; CI [−0.91, −0.07]; $p < 0.05$; $d_{\text{intention}}$: −0.32; CI [−0.55, −0.10]; $p < 0.05$).

The results also highlighted the importance of presentation stimuli ($\beta_{\text{positive emotion}} = -0.75$; $p < 0.01$; $\beta_{\text{satisfaction}} = -0.25$; $p < 0.01$). Text-based messages elicited negative experiences in terms of both customers' positive emotion and satisfaction ($d_{\text{positive emotion}}$: −0.73; CI [−0.81, −0.28]; $p < 0.05$; $d_{\text{satisfaction}}$: −0.16; CI [−0.30, −0.03]; $p < 0.05$), but visual presentation did not ($d_{\text{positive emotion}}$: 0.02; CI [−0.20, 0.25]; $p = 0.33$; $d_{\text{satisfaction}}$: 0.09; CI [−0.14, 0.33]; $p = 0.72$). Consequently, our results partially supported Hypothesis 3b.

TABLE 1 | Moderation results.

Effect	Estimate	Standard error	*z*	*p*
Customer service using robot (vs. human) on customer positive emotion				
Intercept	0.31	0.49	0.63	0.005
Nature of service				
Embarrassment (embarrassing vs. non-embarrassing)	−1.78	0.13	−4.55	0.001
Value orientation (hedonic vs. utilitarian)	−0.22	0.32	0.68	0.49
Nature of task, presentation, and robot				
Task complexity (low vs. high)	−0.96	0.41	−1.78	0.021
Presentation stimuli (visual vs. textual)	−0.75	0.26	−2.89	0.003
Robot anthropomorphism (non-humanoid vs. humanoid)	0.99	0.41	2.37	0.017
Nature of industry or sector				
Context (service-oriented vs. product-oriented)	0.46	0.37	1.23	0.218
Customer service using robot (vs. human) on customer satisfaction				
Intercept	0.17	0.08	2.09	0.034
Nature of service				
Embarrassing (embarrassing vs. non-embarrassing)	−0.65	0.06	−1.41	0.157
Value orientation (hedonic vs. utilitarian)	0.14	0.12	1.10	0.267
Nature of task, presentation, and robot				
Task complexity (low vs. high)	0.06	0.41	0.41	0.675
Presentation stimuli (visual vs. textual)	−0.25	0.12	2.01	0.007
Robot anthropomorphism (non-humanoid vs. humanoid)	0.11	0.17	0.65	0.515
Nature of industry or sector				
Context (service-oriented vs. product-oriented)	0.28	0.13	2.14	0.032
Customer service using robot (vs. human) on customer intention				
Intercept	0.45	0.16	−2.66	0.007
Nature of service				
Embarrassing (embarrassing vs. non-embarrassing)	−0.54	0.10	−5.17	0.001
Value orientation (hedonic vs. utilitarian)	0.26	0.12	2.19	0.027
Nature of task, presentation, and robot				
Task complexity (low vs. high)	−0.27	0.11	−2.42	0.015
Presentation stimuli (visual vs. textual)	0.19	0.11	1.61	0.105
Robot anthropomorphism (non-humanoid vs. humanoid)	0.26	0.12	2.12	0.020
Nature of industry or sector				
Context (service-oriented vs. product-oriented)	0.31	0.10	2.86	0.004

Similarly, robot anthropomorphism moderated the effects (Hypothesis 3c). Humanoid robots mitigated the negative effects on customers' positive emotion ($\beta = 0.99$; $p < 0.05$) and intention ($\beta = 0.26$; $p < 0.05$). Noteworthily, the negative effects were less pronounced when humanoid robots were used ($d_{\text{positive emotion}}$: −0.01; CI [−0.21, 0.01]; $p = 0.21$; $d_{\text{intention}}$: −0.01; CI [−0.13, 0.16]; $p = 0.74$), instead of non-humanoid robots ($d_{\text{positive emotion}}$: −0.17; CI [−0.48, −0.14]; $p < 0.05$; $d_{\text{intention}}$: −0.24; CI [−0.39, −0.10]; $p < 0.05$). Thus, Hypothesis 3c was partially supported.

4.2.3 | Nature of Industry or Sector

We further investigated the potential influence of different industries or sectors on the relationship between robot use (vs.

human use) in customer service and customer experience outcomes. The analysis revealed positive moderation effects of robot use on both customers' satisfaction ($\beta = 0.28$; $p < 0.05$) and intention ($\beta = 0.31$; $p < 0.01$). The results indicated that delivering customer service through robots in product-oriented industries or sectors (e.g., electronics and retail) were better for customer experience compared to service-oriented ones (e.g., hospitality and healthcare). For customer satisfaction, the negative effects were more pronounced in service-oriented industries or sectors (d: −0.15; CI [−0.29, −0.01]; $p < 0.05$) than in product-oriented ones (d: 0.13; CI [−0.11, 0.38]; $p = 0.43$). Similarly, for customer intention, the negative effects were more prominent in service-oriented industries or sectors (d: −0.33; CI [−0.52, −0.14]; $p < 0.05$) than in product-oriented ones (d: −0.02; CI [−0.13, 0.08]; $p = 0.12$). Therefore, Hypothesis 4 is partially supported.

5 | Conclusion

5.1 | General Discussion

The use of robots in customer service has recently become a trending topic among both academics and managers. Many benefits can justify the adoption of robots in customer-facing roles, such as greater operational consistency and efficiency as well as lower operational costs. However, from a different perspective, robot use may also lead to negative outcomes for firms, including diminished positive emotion, satisfaction, and intention among customers, as it is challenging for robots to replicate certain human qualities, such as empathy and emotion. This paradox of robot use (vs. human use) is reflected in scientific research as well. In response, we provide a meta-analytical study that consolidates the existing knowledge on the impact of robot use (vs. human use) on customer experience, focusing on positive emotion, satisfaction, and intention. Our analysis synthesises data from 25 articles covering 62 independent studies and 147 effect sizes. Table 2 summarises the key findings of this study.

Our findings reconcile previously conflicting results in the literature by offering a better understanding of the moderators that influence the impact of robots on customer experience. Prior studies reported varying outcomes, with some highlighting the positive effects of robotic interactions on customer behaviour (Becker, Mahr, and Odekerken-Schröder 2023; Shi, Lu, and Zhou 2023; Mende et al. 2019), while others documented neutral or negative outcomes (Longoni, Bonezzi, and Morewedge 2019; Wien and Peluso 2021). Through closer scrutiny of a diverse range of industries or sectors—such as electronics, retail, healthcare, and hospitality—our meta-analysis clarifies that concerns about the negative effects of robot use in customer service on customers' satisfaction and intention are mitigated in product-oriented industries or sectors like electronics and retail, where customers tend to be more familiar with robotic interfaces. Our analysis also shows that robots perform particularly well in embarrassing service situations, corroborating the findings of Holthöwer and van Doorn (2023) and Pitardi et al. (2021, 2024). In addition, our results highlight the importance of task simplicity and robot anthropomorphism in shaping customer responses. This helps explain why some studies reported negative outcomes when robots were used for complex tasks without human-like features (Goodhue and Thompson 1995; Lin, Chi, and Gursoy 2020). Integrating these diverse findings, our study offers a comprehensive framework that identifies the conditions under which robots can enhance or diminish customer experience. This framework provides valuable insights for both academic inquiry and practical application, presenting a clearer path forward for firms seeking to balance operational consistency, efficiency, and cost with customer experience.

5.2 | Theoretical Contributions

From a theoretical perspective, our study offers several important contributions. First and foremost, as is common in meta-analytic studies (Hunter and Schmidt 2004), our study has systematised the knowledge on robot use (vs. human use) within the domain of customer experience. This analysis allowed us to identify that the most frequently tested constructs in this context were: (1) customer intention (68 effect sizes), (2) customer satisfaction (63 effect sizes), and (3) customer positive emotion (16 effect sizes).

Besides that, our meta-analysis resolves previous conflicting findings (Fern and Monroe 1996). We observed that the effects of robot use (vs. human use) on customers' positive emotion and intention are both significant and negative. These findings help to address the paradox of robot use, given that past research has reported positive, neutral, and negative effects, especially regarding customers' positive emotion and intention.

In addition, the moderation analyses yield several valuable insights. In this meta-analysis, we were able to test a wide range of moderators, which would have been difficult to manage in a single independent study (Hulland and Houston 2020). Following recommendations from prior research, we examined moderators related to nature of service, nature of task, presentation, and robot, and nature of industry or sector.

In relation to service type, this study offers noteworthy insights. Our broad-scope analysis of robot use (vs. human use) in embarrassing situations consolidates the findings of prior studies (e.g., Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024), demonstrating that robots do not negatively influence customers' positive emotion or intention in these scenarios. Furthermore, our findings show that in utilitarian services, robot use does not have a detrimental effect on customer intention. This reinforces the idea that utilitarian services typically involve cognitive and objective tasks (Castelo, Schmitt, and Sarvary 2019; So et al. 2023), making them more compatible with robot involvement.

We also conducted several analyses related to task, presentation, and robot characteristics. The findings reveal that low-complexity tasks and humanoid robots do not negatively affect customers' positive emotion or intention. In terms of task complexity, our findings align with Goodhue and Thompson's (1995) proposition that consumers are indifferent to whether humans or robots perform low-complexity tasks. Regarding robot characteristics, our findings support the notion that anthropomorphic traits enhance customer experiences (Lin, Chi, and Gursoy 2020; Shi et al. 2021). Moreover, the results show that visual outputs are more effective than textual outputs in reducing

TABLE 2 | Summary of the meta-analytic study.

Expectations	Findings	Contributions
Customer service using robot (vs. human) negatively impacts customers' positive emotion, satisfaction, and intention.	Customer service using robot (vs. human) negatively impacts customers' positive emotion and intention. The strongest effect is on customer positive emotion ($d = -0.35$), followed by customer intention ($d = -0.17$).	Our findings offer a harmonised perspective that reconciles previously inconsistent results regarding the effects of robot (vs. human) service deployment. Our results support the general effects reported in previous studies (e.g., Belanche et al. 2020; Fernandes and Oliveira 2021).
Different types of service encounter moderate the effects of using robot (vs. human) in customer service on customers' positive emotion, satisfaction, and intention.	Customer service using robot (vs. human) in embarrassing situations did not negatively impact customers' positive emotion and intention. In non-embarrassing contexts, negative effects were observed. Customer service using robot (vs. human) in utilitarian services did not negatively impact on customer intention, whereas in hedonic services, negative effects were present.	The results support the assumption that robot use can be beneficial in embarrassing situations (Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024) and utilitarian services (e. g., Castelo, Schmitt, and Sarvary 2019; So et al. 2023). This finding provides strong evidence to support studies on embarrassment that have grown in recent years (Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024) and efforts to compare hedonic and utilitarian contexts (Pitardi et al. 2021; Holthöwer and van Doorn 2023).
Different types of task, presentation, and robot moderate the effects of using robot (vs. human) in customer service on customers' positive emotion, satisfaction, intention.	High task complexity and non-humanoid robots negatively impact use of robot (vs. human) in customer service on customers' positive emotion and intention. Customer service using robots (vs. humans) with visual presentation did not negatively impact customers' positive emotion and satisfaction, though negative effects were observed with text presentation.	These findings support past research on robot use in high-complexity tasks (e.g., So et al. 2023), visual stimuli (e.g., Huang et al. 2021) and humanoid robot use (e.g., Shi et al. 2021). These results make a valuable contribution by addressing this debate in prior research (e.g., Huang and Rust 2018; Longoni and Cian 2022; Pitardi et al. 2021; So et al. 2023).
Different types of industry or sector moderate the effects of using robot (vs. human) in customer service on customers' positive emotion, satisfaction, and intention.	Customer service using robots (vs. human) did not negatively impact customers' satisfaction and intention in product-oriented industries and sectors like electronic and retail, though negative effects were observed in service-oriented industries and sectors like healthcare and hospitality.	These findings suggest that consumers in industries or sectors related to products like electronic and retail are more familiar with technology (Nomura, Syrdal, and Dautenhahn 2015). These results support similar claims or suspicions in past research (e.g., Borghi et al. 2023; Holthöwer and van Doorn 2023; Pitardi et al. 2021, 2024).

the negative impact on positive emotion and satisfaction. This aligns with the argument that visual stimuli play a strategic role in fostering better social interaction (Huang et al. 2021).

Last but not least, in terms of contextual features, we were able to access studies from four different industries or sectors, that is, electronics, retail, healthcare, and hospitality, which enabled us to make a comparison between product-oriented versus service-orientated industries or sectors. This cross-industry or sector analysis addresses a gap identified in previous research, which has largely focused on a single industry or sector (e.g., Borghi et al. 2023; Pitardi et al. 2021, 2024). Our findings indicate that in product-oriented industries or sectors like electronics and retail, robot use does not have a negative impact on customers' satisfaction or intention. This supports previous research suggesting that consumers are more familiar with robots in these sectors and are therefore less likely to feel discomfort during their interactions (Nomura, Syrdal, and Dautenhahn 2015).

5.3 | Managerial Contributions

The findings from this study offer several valuable insights for managerial practice. The first relates to the paradox discussed in this article. Our results suggest that managers should exercise caution when replacing human employees with robots in customer-facing roles. The findings support the theory that negative outcomes can arise from robot use (Mori, MacDorman, and Kageki 2012; Snyder and Fromkin 1980). However, the moderators identified in this study offer useful strategies to mitigate these negative effects.

Our analysis shows that in the product-oriented industries or sectors like electronics and retail, robot use does not negatively impact customers' positive emotion or satisfaction. Nevertheless, managers should be cautious when deploying robots in service-oriented industries or sectors like healthcare and hospitality. For these, managers may consider using robots for low-complexity, utilitarian tasks, in line with the results from our moderator analysis. In healthcare (e.g., Pitardi et al. 2021) and hospitality (e.g., Pitardi et al. 2024), embarrassing service situations are relatively common. In such scenarios, robot use is not harmful, according to our findings. This suggests that robots can be effective in services where social discomfort might otherwise arise.

Another key insight is that humanoid robots help neutralise the negative effects of robot use on customers' positive emotion and intention. A notable example is the Pepper robot, developed by SoftBank Robotics for use in classrooms and healthcare settings. These robots can recognise faces and track human emotions. During the COVID-19 pandemic, the Fukuoka SoftBank Hawks, a professional baseball team in Japan, employed Pepper robots as robotic fans to maintain engagement during matches without spectators.

5.4 | Current Limitations and Future Directions

Every scientific endeavour, while illuminating certain aspects of its domain, inevitably leaves others in the shadows, inviting further exploration. Our study is no exception. Below, we outline several limitations that also present opportunities for future research.

First and foremost, we limited our analysis to outcomes with at least three effect sizes, following Hunter and Schmidt's (2004) guidelines. As a result, we primarily focused on the relationship between robot (vs. human) service and customer experience outcomes—specifically, customers' positive emotion, satisfaction, and intention. Future research could expand this scope by investigating other outcomes, such as customer loyalty and advocacy, which remain underexplored and offer promising areas for further study.

Furthermore, our meta-analysis, while expansive, focused solely on experimental studies yielding Cohen's *d* effects. An intriguing avenue for subsequent research would be to contrast these findings with those from correlational studies, such as surveys. This comparative approach could unveil complex dynamics between effect sizes as produced by correlations vis-à-vis Cohen's *d*. Moreover, our exclusive focus on quantitative data inadvertently excludes the potential benefits of qualitative robot studies. A systematic review dedicated to unpacking qualitative studies could provide deep, narrative-rich insights into the human-robot interaction phenomenon.

Next, the cultural and economic contexts in which human-robot interactions occur likely shape customer responses in significant ways. While some scholars (Lu et al. 2020) have called for cross-cultural and cross-economic studies (e.g., comparing developed and developing economies), our analysis, which primarily draws on U.S.-based studies, was unable to address these dimensions. Future research could explore these dynamics to better understand how cultural and economic differences influence the effectiveness of robots in customer service.

Last but not least, technological advances continue to provide researchers with innovative tools and methodologies. To deepen our understanding of robot (vs. human) interactions in customer service, future studies could incorporate cutting-edge tools that capture real-time emotional responses. Technologies such as electroencephalograms (EEGs), facial emotion recognition systems, and eye-tracking devices offer valuable opportunities for mapping visual attention and gauging instantaneous customer reactions (Lim 2018). Leveraging these tools could generate more comprehensive insights into customer engagement, enhancing both academic inquiry and practical application.

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Ethics Statement

During the preparation of this work, the authors used Grammarly and Microsoft Editor to improve clarity and language. Following the use of these tools, the authors thoroughly reviewed and revised the content as necessary and take full responsibility for the final version of the publication.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data can be made available upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.