Determinants of customer acceptance of frontline service robots in a retail context

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Abstract

Purpose – The core purpose of this study is to gain an understanding of the functional and socio-emotional factors that shape customer acceptance of frontline service robots (FSRs) in a retail setting. In particular, it focuses not only on the antecedents but also the mediating roles of perceived value and psychological comfort and the moderating effects of self-efficacy and technology anxiety.

Design/methodology/approach – Using a mixed-method research design grounded in the theory of consumption value and the technology acceptance model, this study surveyed 388 customers with recent experience engaging with an FSR in a telecommunications retail context. This research identifies key mediators and moderators influencing customer acceptance.

Findings – Results reveal that customer perceived value, encompassing both hedonic and utilitarian dimensions, along with psychological comfort, mediates the impact of functional and socio-emotional elements on customer acceptance. Furthermore, self-efficacy and technology anxiety act as significant moderators, shaping the acceptance process.

Research limitations/implications – As the importance of robots in services becomes more prominent, this study moves beyond conceptual or scenario-based studies to provide empirical insights into the drivers of customer acceptance of FSRs. It highlights practical implications for the design and deployment of FSRs in retail and other service settings, suggesting that managers should focus on enhancing customer perceived utilitarian value and psychological comfort, and to lesser extent hedonic value to drive acceptance.

Originality/value – To the best of the authors' knowledge, this research is among the first to survey customers with actual FSR experiences, addressing a gap in the literature on emerging artificial intelligence technologies. It offers actionable guidance for managers aiming to integrate FSRs effectively in frontline service environments.

Keywords Frontline service robot, Customer acceptance, Perceived value, Psychological comfort, Technology anxiety, Self-efficacy

Paper type Research paper

Introduction

The adoption of artificial intelligence (AI)-powered robots for service tasks in many industries has emerged as a strategic imperative to improve operational efficiency and quality of service, representing a significant innovation, particularly in delivering automated in-store customer services (Song and Kim, 2022; Haenlein and Kaplan, 2021; Amelia *et al.*, 2022). However, questions persist regarding the perceived innovation and practical utility of frontline service robots (FSRs), with deployment inconsistencies often leading to perceptions of these technologies as superficial novelties or gimmicks rather than meaningful advancements in service delivery (Mende *et al.*, 2019; Subero-Navarro *et al.*, 2022). In real-world settings like retail stores, FSRs with voice interfaces often struggle to recognize input accurately in noisy environments, leading to user frustration and reduced perceived usefulness (Luger and Sellen, 2016; Porcheron *et al.*, 2018). At Japan's Hen-na Hotel, many robots were eventually removed after frequent failures to understand guests' commands, especially in the presence of background noise (Knight, 2019). Addressing such challenges requires further research. Hence the overarching aim of the current study is to gain an understanding of experiential, psychological and contextual factors shaping consumer acceptance of FSRs.

FSRs are designed to replicate interactions typical of frontline human staff by using adaptive interfaces that deliver

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services while facilitating effective communication (Gursoy *et al.*, 2019; Wirtz *et al.*, 2018). Unlike traditional self-service technologies, FSRs incorporate autonomous and adaptable systems that provide social presence during service encounters, shaping customer expectations across functional, social and emotional dimensions (Lu *et al.*, 2019; Van Doorn *et al.*, 2017). Studies underscore the importance of deploying FSRs with context-specific strategies. Tussyadiah and Park (2018) found that customers generally respond positively to FSRs, particularly when they deliver timely, efficient and accurate services. However, Belanche *et al.* (2020) highlight that replicating the nuanced aspects of human interaction remains a persistent challenge. These insights point to the need for a balanced approach that maximizes the utilitarian strengths of FSRs while enhancing their social interaction capabilities to address customer concerns and meet diverse expectations effectively.

Previous research on customer acceptance of service robots has often relied on conceptual models or laboratory experiments, which may not fully capture the complexities of real-world interactions (Odekerken-Schröder *et al.*, 2021; Söderlund, 2021). While these controlled settings offer valuable insights, they often introduce biases and lack ecological validity, meaning the findings may not always apply to real-world environments (Whelan *et al.*, 2018; Savela *et al.*, 2018; Šabanović, 2010). Understanding human–robot interaction and technology adoption necessitates the consideration of contextual factors, which are often overlooked in experimental research designs (Venkatesh *et al.*, 2012; Dautenhahn, 2007). Moreover, research on service robot acceptance has used various terminologies, including repatronage (Odekerken-Schröder *et al.*, 2021; Lin, 2022), adoption (Xiao and Kumar, 2019) and intention to use (Ivanov and Webster, 2019a), reflecting the diverse conceptualizations and measurement approaches within the field. In this study, we focus on customer acceptance for its broad relevance and clear applicability, as recommended by Wirtz *et al.* (2018). One influential framework in this area is the Service Robot Acceptance Model (sRAM), which suggests that acceptance depends on both functional dimensions (e.g. perceived usefulness and autonomy) and socio-emotional dimensions (e.g. social presence and humanness). Additionally, the theory of consumption value (TCV) (Sheth *et al.*, 1991) outlines two key predictors of acceptance: utilitarian value (practical benefits) and hedonic value (emotional enjoyment) which map onto sRAMS functional needs and socio-emotional needs, respectively.

Building on these models, this study advances the current understanding by positioning psychological comfort as a critical mediating factor. Psychological comfort, characterized by reduced anxiety, feelings of security and being worry free (Lloyd and Luk, 2011), has been identified as a key determinant of customer satisfaction (i.e. positive emotions such as happiness concerning the service experience) and long-term commitment within service contexts (Spake *et al.*, 2003). In the domain of FSRs, psychological comfort is shaped by both functional attributes (e.g. perceived usefulness and autonomy) and socio-emotional attributes (e.g. social presence and humanness). Given its influence on consumer perceptions, psychological comfort is expected to play a pivotal role in fostering customer acceptance of FSRs.

This study formulates four overarching research questions to define the conceptual scope of FSR acceptance. While these questions explore broad theoretical dimensions, the hypotheses (*H1–H9*) specify testable paths within the structural model:

- How do functional dimensions (perceived usefulness and perceived autonomy) influence utilitarian value and customer acceptance of FSR?
- What is the impact of socio-emotional dimensions (social presence and perceived humanness) on hedonic value and customer acceptance of FSR?
- What role does psychological comfort play in mediating the relationship between functional and socio-emotional dimensions and customer acceptance of FSR?
- How do self-efficacy and technology anxiety moderate the relationship between functional dimensions and utilitarian value, and between socio-emotional dimensions and hedonic value?

To address this gap in the literature, we conducted empirical research involving customers with real-world experience interacting with FSRs in retail environments. Building on Gursoy *et al.*'s (2019) call for more comprehensive AI acceptance models, we propose a multi-step framework. This framework suggests that customers' perceptions of both hedonic and utilitarian value, along with psychological comfort, mediate the relationship between key antecedents and FSR acceptance. Furthermore, we introduce technology anxiety and self-efficacy as moderators to better understand the conditions under which these relationships hold true, offering deeper insights into the mechanisms driving FSR acceptance (Ivanov and Webster, 2019b; Lu *et al.*, 2019). This research makes a significant contribution to the field of robot acceptance by offering a more robust model examined in a real-world environment that integrates both functional and socio-emotional dimensions, introduces psychological comfort as a mediator and explores how factors like self-efficacy and technology anxiety moderate these relationships. The findings provide practical insights that can inform the design and implementation of service robots, particularly in retail contexts, where robots are increasingly integrated into frontline service operations.

Literature review and conceptual model

In prior research on customer acceptance of FSRs, several terms have been used interchangeably, including repatronage (Odekerken-Schröder *et al.*, 2021), acceptance (Amelia *et al.*, 2022), adoption (Xiao and Kumar, 2019), intention to use (Ivanov and Webster, 2019a) and willingness to use (Lu *et al.*, 2019). For the sake of clarity and broader applicability, we align with the term "customer acceptance", as adopted by Wirtz *et al.* (2018), due to its general intuitiveness and relevance across various technological settings.

Several conceptual models, including the sRAM (Wirtz *et al.*, 2018; Wong and Wong, 2024) and the Degree of Robotics Adoption Model (Xiao and Kumar, 2019), have guided research in this area. The sRAM posits that customer acceptance and adoption of FSRs are influenced by how well the robots meet both functional and socio-emotional needs.

Functional needs are related to the usefulness and autonomy of the robot, while socio-emotional needs focus on the robot's social presence and humanness. When these needs are aligned with customer expectations, role congruency is achieved, which in turn increases customer acceptance. In line with this, we focus on both functional and socio-emotional dimensions as antecedent factors that influence customer acceptance.

While much of the existing literature has primarily examined the direct effects on customer acceptance, relatively few studies have investigated the indirect mechanisms underlying this process. Notable exceptions include comprehensive theoretical frameworks that delineate the psychological pathways through which customers develop acceptance of FSRs (Gursoy *et al.*, 2019; van Pinxteren *et al.*, 2019; Odekerken-Schröder *et al.*, 2021). These frameworks highlight that perceived value, encompassing both utilitarian and hedonic dimensions, alongside psychological comfort, serves as critical mediators in explaining the relationship between functional and socio-emotional antecedents and the eventual acceptance of FSRs.

Functional constructs are essential in shaping the evaluation and acceptance of new technologies, including FSRs (Wirtz *et al.*, 2018). In the context of this study, perceived usefulness is defined as the extent to which customers perceive that an FSR performs effectively during service encounters. Prior research indicates that customers are more inclined to accept FSRs when they perceive them as proficient in fulfilling functional roles, such as delivering accurate information or facilitating service completion (Wirtz *et al.*, 2018; Tojib *et al.*, 2022). This underscores the significance of functional performance in fostering customer acceptance.

Building on this premise, it is posited that when FSRs provide functional benefits – such as accurate responses, helpful recommendations or clear directions – customers are likely to experience positive emotions, including a sense of security, reassurance, ease and relief from mental distress. These emotional responses collectively contribute to psychological comfort, which is defined as a reduction in anxiety and an overall sense of emotional well-being during the service encounter (Lloyd and Luk, 2011; Spake *et al.*, 2003). Thus, we hypothesize:

H1. Perceived usefulness is positively associated with (a) perceived utilitarian value and (b) perceived psychological comfort.

In addition, perceived autonomy (i.e. from users' perspective) is a critical psychological need that affects users' emotional and cognitive responses during technology use (Kim *et al.*, 2016). According to self-determination theory, individuals experience satisfaction and ease when they feel in control of their actions and decisions (White, 1959). In the context of FSRs, users who perceive autonomy – such as the ability to control the robot through verbal commands or touch – are likely to experience more positive evaluations. This perception of autonomy contributes to utilitarian value and psychological comfort, as it reduces the cognitive effort required for interaction and increases the user's confidence in the technology (Nikou and Economides, 2017; Dabholkar and Bagozzi, 2002). Therefore, we anticipate:

H2. Perceived autonomy is positively associated with (a) utilitarian value and (b) psychological comfort.

Technology infusions are transforming customers' experiences. Van Doorn *et al.* (2017) note, customer experiences of the future will be to a large extent determined by the manner in which technology engages customers on a social level. In the context of FSR interactions, social presence refers to customers experience of perceiving the robot as a social entity, capable of engaging in interactive and relational behaviours. It interacts with humans by following social behaviours and rules attached to its role. When interacting with an agent that exhibits human-like qualities, there is a sense that you are interacting with another human being. FSR infused with social intelligence are capable of demonstrating human-like mind in service interactions. Such human characteristics lead people to personify FSR and even perceive them as in-group members (Chi *et al.*, 2025). Hence it is not surprising that social presence is strongly linked to emotional and hedonic benefits, such as enjoyment and fun (Van Doorn *et al.*, 2017). Robots that exhibit social presence, through friendly gestures, eye contact or responsive communication, are more likely to create a positive emotional experience, enhancing perceived hedonic value. In line with social cognition theory and psychological ownership perspectives (Van Doorn *et al.*, 2017), we also hypothesize that social presence also contributes to psychological comfort by making users feel more connected and less anxious during the interaction with an FSR. Thus:

H3. Social presence is positively associated with (a) perceived hedonic value and (b) psychological comfort.

Another important socio-emotional dimension is perceived humanness, which refers to the robot's appearance and behaviour that resemble human traits, such as having a face, voice and gestures (Broadbent *et al.*, 2013). The degree of human-likeness often influences the user's confidence in the FSRs' abilities and their emotional attachment (Latikka *et al.*, 2019). However, as uncanny valley theory (Mori *et al.*, 2012) suggests, excessive human-likeness can induce discomfort and negative emotions. Moderate human-like features, such as friendly faces and empathetic language, have been shown to positively affect customer engagement and satisfaction (Schuetzler *et al.*, 2018). We hypothesize that perceived humanness influences both hedonic value and psychological comfort. Therefore, we propose:

H4. Perceived humanness is positively associated with (a) perceived hedonic value and (b) psychological comfort.

Mediators

The TCV (Sheth *et al.*, 1991) provides a useful framework for understanding how consumers evaluate products based on both utilitarian and hedonic values. In the context of FSRs, utilitarian value reflects the functional benefits, such as improved task performance, quicker service or more accurate information (Leiño Calleja *et al.*, 2023). This closely aligns with the concept of perceived usefulness in the TAM (Davis, 1989) and UTAUT2 (Venkatesh *et al.*, 2012), which consistently highlight functional benefits as key predictors of adoption.

Conversely, hedonic value relates to the positive emotional feeling derived from interacting with the robot, including enjoyment and pleasure from the robot's appearance and social interaction (Babin *et al.*, 1994; Venkatesh *et al.*, 2012). This parallels the notion of hedonic motivation introduced in UTAUT2 as a driver of technology use, especially in non-utilitarian settings. Prior studies have shown that while both utilitarian and hedonic values influence user behaviour, utilitarian benefits often exert stronger effects in early adoption stages (Venkatesh and Davis, 2000). Utilitarian and hedonic values are also established predictors of continued usage in service contexts (Odekerken-Schröder *et al.*, 2021).

In addition, psychological comfort serves as a critical mediator, reflecting customers' emotional responses to the robot. According to Spake *et al.* (2003), comfort reduces uncertainty and fosters positive emotions during service encounters, directly influencing engagement. This construct is particularly relevant in human–robot interactions, where emotional ease and reduced anxiety promote willingness to continue using the service. Recent research supports its mediating role in AI-based service adoption (Roongruangsee and Patterson, 2024). Therefore, we hypothesize:

H5. Utilitarian value is positively associated with customers' FSR acceptance.

H6. Hedonic value is positively associated with customers' FSR acceptance.

H7. Psychological comfort is positively associated with customers' FSR acceptance.

Moderating effects

We explore two significant moderating effects in our model: self-efficacy and technology anxiety. Self-efficacy refers to an individual's belief in their ability to successfully interact with technology (Bandura, 1977). Customers with high self-efficacy are more likely to engage with FSRs confidently, leading them to perceive perceived usefulness and perceived autonomy more positively. These individuals are more likely to derive utilitarian value from the robot. Therefore, we hypothesize:

H8. Under conditions of higher self-efficacy, (a) perceived usefulness and (b) perceived autonomy have stronger associations with utilitarian value.

Technology anxiety, defined as a feeling of discomfort or even fear when interacting with technology (Hsu *et al.*, 2019), can hinder the utilitarian and socio-emotional benefits of FSRs. This anxiety may be due to individuals' personality traits, being technology averse, an FSR sceptic, or may come about due to the uncanny theory (Mori et al., 2012), i.e. when the FSR is perceived too human-like customers get a eerie feeling, inducing heightened anxiety. Customers with high technology anxiety are more likely to focus on their discomfort rather than the functional benefits of the robot, which weakens their perception of its usefulness and emotional value. As such, we hypothesize:

H9. Under conditions of higher technology anxiety, (a) perceived usefulness and (b) perceived autonomy have weaker influences on utilitarian value, and (c) social presence and (d) perceived humanness have weaker influences on hedonic value.

Control variables

To control for external factors that may influence FSR acceptance, we include experience with robots, gender, age and education as covariates. Research has shown that these demographic factors can significantly influence technology adoption behaviour (Henager and Cude, 2016). By controlling for these factors, we ensure a more robust and accurate analysis of the relationships between functional and socio-emotional dimensions, psychological comfort and FSR acceptance.

The conceptual model is shown in Figure 1.

Method

We used a two-stage approach: in-depth interviews (Stage 1) followed by a questionnaire survey (Stage 2). The study was conducted in collaboration with a leading telecommunications company in Thailand, where the frontline service robot, named "Linda", was deployed to engage customers in their retail stores. Linda's primary functions included greeting customers, providing product information and assisting with general inquiries. In instances where customer queries were more complex, Linda referred them to human staff for further assistance.

Qualitative study

In Stage 1, we conducted in-depth interviews with 30 customers who had interacted with the FSR to validate variables identified in prior literature and uncover additional insights into acceptance. Each interview lasted 15–20 min, was audio-recorded with participant consent and transcribed *verbatim* for analysis. The interview protocol was developed based on the sRAM (Wirtz *et al.*, 2018), and covered three key dimensions: functional, social-emotional and relational.

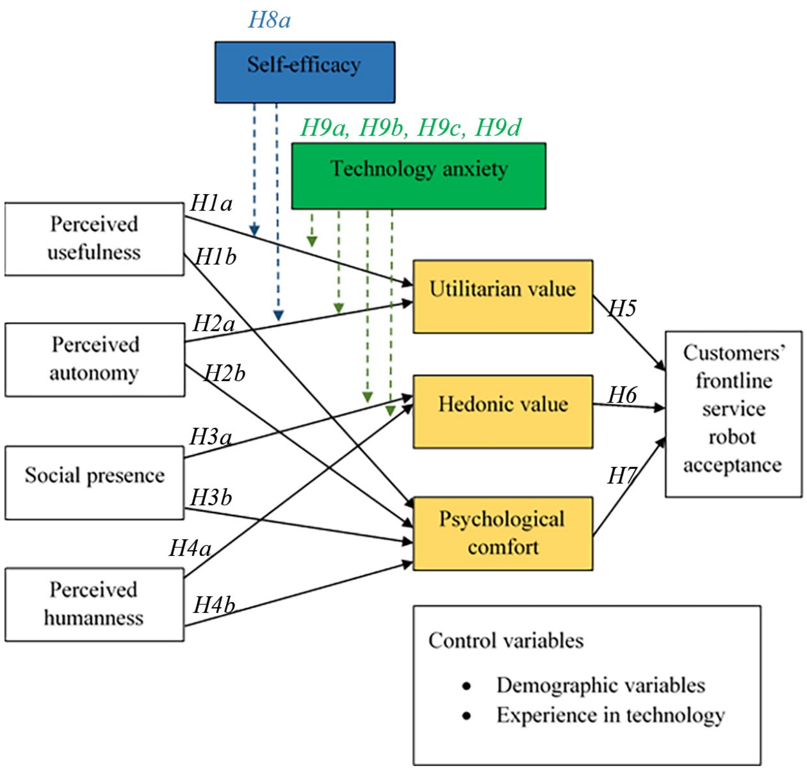
To systematically explore these areas, we used targeted prompts. For the functional dimension, questions included: "Did the robot achieve its purpose today?" and "How would you assess its ability to complete tasks or provide information?". For emotional and social-relational aspects, prompts included: "Did you feel comfortable during your interaction with the robot?", "What aspects of the robot's appearance or behaviour did you enjoy or dislike?" and "How would you compare this interaction to one with a human staff member?

We also acknowledge the potential for self-selection bias, as all participants voluntarily chose to interact with the FSR rather than a human agent. This may indicate higher levels of technological openness or self-efficacy. While this may limit generalizability to more technology-averse users, it enhances ecological validity by capturing rich, experience-based insights from early adopters, a segment critical to understanding the conditions under which FSRs gain initial acceptance. The sample consisted of 30 participants. Of these, 17 were female (56.7%) and 13 were male (43.3%). The majority of participants were between the ages of 20 and 30 (34.3%). Most held a bachelor's degree (59.3%). Regarding prior exposure to technology, 75% of participants, in the qualitative stage, had no previous experience using frontline service robots (FSRs), while 35% had interacted with other advanced technologies such as cleaning robots or chatbots.

The thematic analysis revealed five key themes (Table 1) as critical determinants of FSR acceptance: functional elements, socio-emotional elements, value elements and individual

Journal of Services Marketing
Volume 39 · Number 10 · 2025 · 167–180

Figure 1 Conceptual model



Source(s): Authors' own work

Table 1 Example respondent quotes

Theme	Dimension	Example quote
Functional elements	Perceived usefulness	*". . . I prefer to be serviced by the robot because she provides me a faster service"*
	Perceived autonomy	*"I prefer getting services from the robot because I am confident that I can command the robot. I can easily touch on the robot's screen. . . In case I happened to do something wrong, I can just push the home button to restart it"*
Socio-emotional elements	Social presence	*"She looked at me and smiled. . .greeted me "Sawasdee Kha" with a smiling face. That made me want to interact with her. She looked kind and friendly"*
	Perceived humanness	*"It is such a good idea that the robot has a facial screen like a human"*
Value elements	Utilitarian value	*"I asked the robot to provide me the latest promotion package. She gave me useful and correct information that helped me make the right decision"*
	Hedonic value	*"I am happy with the robot, she is so cute and makes me smile. I have a new experience"*
Individual heterogeneity	Self-efficacy	*". . .I am a young at heart person. Moreover, I have never ignored to learn and have experience with new technology. This behaviour gives me the ability to use new technology such as mobile phone, home appliance and event robots. . .Personally, I think dealing with a service robot is an easy thing for me. . ."*
	Technology anxiety	*". . .My hands are sweating and my heart is beating fast during the interaction with the FSR. . .I try to avoid dealing and learning with new technology because I fear it. . .I love to use the same technology that I am familiar with. . .In terms of service, I prefer to have service with human staff. . ."*
Psychological comfort		*". . . I can confidently say that I am not worried when interacting with her. This feeling is distinct from dealing with other high-tech gadgets. The robot comprehends my words and desires without judgment based on my appearance or attitude. For instance, I might hesitate to ask human staff due to the fear that they could consider my question silly"*

Source(s): Authors' own work

heterogeneity. Additionally, psychological comfort emerged as an important, yet previously unanticipated, theme, underscoring its significance in shaping customer acceptance of FSRs.

These findings underscore the complex interplay between functional benefits, socio-emotional satisfaction and individual differences in shaping customer perceptions of FSRs. Psychological comfort emerges as a crucial mediator, with potential implications for improving FSR design and increasing customer acceptance, especially in environments like retail, where robots are increasingly integrated into service interactions.

Quantitative study

Based on the insights from our literature review and qualitative interviews, we developed a structured questionnaire, which was pretested with 20 respondents to ensure clarity and validity. The measurement scales for all constructs were adapted from established literature. Data collection took place at participating retail service centres located in Phuket and Bangkok, Thailand. The final sample consisted of 388 valid responses, with 208 respondents from Phuket (18% non-response rate) and 180 from Bangkok (12% non-response rate). Upon entering the service centres, customers were given the option to be served either by the FSR (Linda) or a human customer service agent. Those who chose Linda formed the sample group for this study. Immediately following the service interaction, a researcher approached these customers and invited them to participate in the study. Those who agreed completed a self-administered questionnaire before leaving the service centre. The research population thus consisted of Thai retail customers with real-time interaction experience with an FSR, and the unit of analysis was the individual customer. Moreover, Thailand has a sophisticated digital environment with digital technologies evident in banking, commerce and even manufacturing. It is also one of the first countries to adopt Robo Advisors (an AI-based financial planning platform) (Roongruangsee and Patterson, 2024). The majority of respondents were female (86.3%), and most were between the ages of 20 and 30 years (85.5%). In terms of education, 57.0% held a bachelor's degree, while 37.1% had a diploma or equivalent. Although 81.7% of participants reported no prior experience with FSRs, they had just interacted with the FSR at the service centre prior to completing the questionnaire. As interviews were personally administered, missing data was not an issue due to the intervention of the researchers who checked each questionnaire for missing data before the respondent departed.

Measurement

The measurement development for this study involved adapting constructs and scales from existing literature, primarily from studies conducted in Western contexts. To ensure cultural and linguistic appropriateness, we followed a translation and back-translation procedure, as recommended by Hambleton (1993). In this process, a bilingual speaker fluent in both Thai and English translated the original English items into Thai, and another bilingual speaker, whose mother tongue was English, back-translated the items to ensure accuracy. Minor modifications were made to the original scales to ensure that the terminology and phrasing were relevant to FSR context, as some words did not have precise equivalents in the Thai language.

We used established scales for 11 key constructs in this study, each carefully chosen from prominent studies in technology adoption and human–robot interaction. The Cronbach's alpha values were calculated to assess their reliability.

For perceived usefulness, we adopted the three items scale from Heerink *et al.* (2010), which measures the extent to which a robot performs well during service encounters. For perceived autonomy, we adapted items from Kim *et al.* (2016), and Sohn and Choi (2014), which assessed customers' perceived control over their interactions with the robot. After pretesting, one item was dropped, resulting in a Cronbach's alpha of 0.764.

Social presence, based on the scale by Heerink *et al.* (2010), measures the perception of sociability from the robot. The perceived humanness scale, drawn from Gursoy *et al.* (2019), evaluated the robot's human-like features.

For utilitarian value, we adapted a scale from Hong *et al.* (2017) that measures the functional value of the robot, such as its ability to provide faster services and correct information. Hedonic value was measured using the seven-point Likert scale developed by Hong *et al.* (2017), with items like "Interacting with the robot was fun" and "Interacting with the robot made me happy.

The psychological comfort scale, adapted from Spake *et al.* (2003), measures customers' emotional comfort during interactions with the robot. The scale included pairs such as "Uncomfortable – Comfortable" and "Worried – Worry free". For self-efficacy, we used a scale from Turja *et al.* (2019) that measures confidence in interacting with technology.

Technology anxiety, based on Meuter *et al.* (2003), assesses customers' anxiety towards technology use.

Finally, service robot acceptance was measured using the continuance intention scale from Bhattacherjee (2001) and Hong *et al.* (2017).

Control variables included respondents' age, gender, education and past experiences with robots, which were measured using a seven-point semantic differential scale (e.g. "very seldom" to "very often"). These control variables help ensure a more robust test of the model and account for external influences on FSR acceptance.

All scales exhibited sound reliability with Cronbach's alpha ranging from 0.764 to 0.932.

Validity and reliability

To assess the validity and reliability of the measurements, we conducted a confirmatory factor analysis (CFA) using Amos v21 as the first step in the analysis. We tested for normality, multicollinearity, convergent validity and discriminant validity. The initial CFA results revealed low factor loadings for certain constructs, prompting minor adjustments to several scales. Specifically, we excluded one item each from the hedonic value scale ("Interacting with the robot stimulated my curiosity"), the perceived autonomy scale ("I will be able to influence it"), the social presence scale ("When interacting with the robot I felt like I was talking to a real person") and the perceived humanness scale ("The robot experienced emotions"). Additionally, for technology anxiety, two items were excluded ("I have difficulty understanding most technological matters" and "I feel apprehensive about using technology").

After these adjustments, the model demonstrated excellent fit indices (Table 2): χ^2/df = 1.665, $p < 0.001$, CFI = 0.981, TLI = 0.968, IFI = 0.973, GFI = 0.914, AGFI = 0.889, RMSEA = 0.038, PCLOSE < 0.000 and SRMR = 0.057. These fit indices suggest that the model is parsimonious, with the CFI, TLI and IFI exceeding the recommended threshold of 0.9 (CFI > 0.95 indicates an excellent fit; RMSEA < 0.06 and SRMR < 0.08 indicate good fit). Additionally, factor loadings were statistically significant ($p < 0.001$), with each item having an estimate greater than 0.5, indicating high variance within the construct. Average variance extracted (AVE) values for all constructs were greater than 0.50, confirming convergent validity. Reliability measures were also satisfactory, with Cronbach's alphas exceeding 0.7 and composite reliability above 0.7 (Bagozzi and Yi, 2012; Hair *et al.*, 2010). The AVE values ranged from 0.618 (for perceived autonomy) to 0.824 (for customer acceptance), further supporting the validity of the constructs. Finally, Fornell and Larcker's (1981) method confirmed that the AVE's square root for each construct was higher than the correlation between that construct and any other, thus ensuring both convergent and discriminant validity.

Given that this study relies on a self-administered, cross-sectional survey, the potential for common method variance (CMV) to bias the findings must be considered. To mitigate this risk, we implemented both procedural controls

Table 2 Measurement model evaluation

Measures	Factor loading	α	CR	AVE
Frontline service robot acceptance Source: Bhattacherjee (2001), Hong *et al.* (2017)		0.932	0.934	0.824
I will interact with a service robot again in the future	0.927			
I will strongly recommend others to interact with a service robot	0.916			
I intend to continue interacting with a service robot in other service sectors	0.880			
Utilitarian value Source: Hong *et al.* (2017)		0.896	0.909	0.770
Interacting with a robot enables me to perform a service faster	0.906			
Interacting with a robot helps me navigate to find things in the store faster	0.913			
Interacting with a robot enables me to receive the right information	0.809			
Hedonic value Source: Hong *et al.* (2017)		0.929	0.929	0.813
Interacting with a robot was fun	0.887			
Interacting with a robot made me happy	0.900			
Interacting with a robot gave me enjoyment	0.917			
Perceived usefulness Source: Heerink *et al.* (2010)		0.886	0.888	0.725
I think the robot is useful for me	0.860			
Robot provided convenient service	0.872			
I think the robot provides many services	0.821			
Perceived autonomy Source: Kim *et al.* (2016), Sohn and Choi (2014)		0.764	0.764	0.618
I felt freedom to act when interacting with the robot	0.778			
I felt in control when interacting with the robot	0.794			
Social presence Source: Heerink *et al.* (2010)		0.891	0.864	0.680
It sometimes felt as if the robot was really looking at me	0.836			
I can imagine the robot to be a living creature	0.821			
Sometimes the robot seems to have real feelings	0.817			
Perceived humanness Source: Gursoy *et al.* (2019)		0.887	0.876	0.703
Robot seemed to have a mind of its own	0.845			
Robot has consciousness	0.813			
Robot seemed to have its own free will	0.856			
Psychological comfort Source: Spake *et al.* (2003)		0.896	0.882	0.651
Please tell me how you felt when interacting with the robot:				
1 Uncomfortable – comfortable	0.859			
2 Very tense – very relaxed	0.750			
3 Worried – worry free	0.765			
4 Troubled – peace of mind	0.848			
Self-efficacy Source: Turja *et al.* (2019)		0.901	0.905	0.760
I'm confident in my ability to interact with the robot	0.895			
I'm confident in my ability to control the robot	0.911			
I'm confident in my ability to learn how to use the robot to guide others to do the same	0.806			
Technology anxiety Source: Meuter *et al.* (2003)		0.921	0.942	0.844
When given the opportunity to use technology, I fear I might damage it in some way	0.879			
I have avoided technology which is unfamiliar to me	0.970			
I hesitate to use technology for fear of making mistakes I cannot correct	0.905			

Note(s): α = Cronbach's alpha; CR = composite (construct) reliability; AVE = average variance extracted. Loadings are standardized; all *t*-values are significant ($p < 0.001$). Fit statistics: $\chi^2 = 561.63$, CFI = 0.981, GFI = 0.914, AGFI = 0.889, RMSEA = 0.038, SRMR = 0.057
Source(s): Authors' own work

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(MacKenzie and Podsakoff, 2012) and CMV assessments (Malhotra *et al.*, 2006). Specifically, we conducted an exploratory factor analysis in which all study constructs were entered, and the number of factors was constrained to one without a rotation solution. The results revealed that the total variance accounted for was 44%, with no single factor explaining the majority of the covariance, suggesting that CMV did not pose a significant threat to the validity of our findings.

Results

After confirming the validity of the measurement model, we used SmartPLS3 to test the relationships specified in our conceptual model. The structural equation modelling results indicated that utilitarian value was the most significant predictor of customer acceptance of FSRs (β = 0.507, $p < 0.00$), supporting *H5*, followed by psychological comfort ($\beta = 0.228$, $p < 0.00$; *H7*) and hedonic value ($\beta = 0.168$, $p < 0.00$; *H6*), refer Table 3.

In terms of predicting utilitarian value, the functional dimensions of perceived usefulness (β = 0.278, $p < 0.00$) and perceived autonomy (β = 0.171, $p < 0.00$) both demonstrated positive and significant effects, supporting *H1a* and *H2a*, respectively. For hedonic value, social presence had the strongest positive effect (β = 0.423, $p < 0.00$), followed by perceived humanness ($\beta = 0.224$, $p < 0.05$), which corroborates *H3a* and *H4a*. Additionally, psychological comfort was found to be significantly associated with three of the four antecedent constructs: perceived autonomy (β = 0.275, $p < 0.00$; *H2b*), perceived humanness ($\beta = 0.211$, $p < 0.00$; *H4b*) and perceived usefulness (β = 0.108, $p < 0.05$; *H1b*). However, social presence did not significantly impact psychological comfort ($\beta = 0.069$, $p = 0.243$), thus *H3b* was not supported, potentially because the robot's small analog facial screen limited users' ability to clearly perceive its social cues, thereby weakening the intended effect of social presence on psychological comfort.

The analysis of the moderating effects revealed that self-efficacy strengthens the relationship between perceived usefulness and utilitarian value ($\beta = 0.133$, $p < 0.05$), consistent with *H8a*. Moreover, technology anxiety moderates the relationship between functional factors (i.e. perceived usefulness) and utilitarian value. Specifically, higher levels of technology anxiety weakened the association between perceived usefulness and utilitarian value (β = −0.112, $p < 0.10$), in line with *H9a*. Additionally, technology anxiety moderated the relationship between socio-emotional factors (e.g. social presence) and hedonic value, leading to a weaker association ($\beta = -0.116$, $p < 0.05$), supporting *H9c*.

Finally, the mediation analysis demonstrated that utilitarian value fully mediates the relationships between perceived usefulness and customer acceptance of FSRs (β = 0.194, $p < 0.00$), and between perceived autonomy and customer acceptance (β = 0.156, $p < 0.00$). Hedonic value also fully mediates the relationships between social presence and customer acceptance of FSRs (β = 0.069, $p < 0.00$), and between perceived humanness and customer acceptance (β = 0.038, $p < 0.012$). Additionally, psychological comfort fully mediates the relationships from perceived usefulness (β = 0.032, $p < 0.040$), perceived autonomy (β = 0.056, $p < 0.015$) and perceived humanness (β = 0.047, $p < 0.023$) to customer acceptance of FSRs. The overall model demonstrated good fit indices (SRMR = 0.036, $R^2 = 0.725$, NFI = 0.860).

Beyond the standardize path coefficients (β) and statistical significance, we evaluated effect sizes (Cohen's f^2) to assess the practical relevance of the three primary predictors of customer acceptance: utilitarian value, hedonic value and psychological comfort. According to Cohen's (1988) guidelines, effect sizes

Table 3 Path coefficients and hypothesis testing

Main effects	Model relationships	β	t	Sig	Hypothesis supported
H1a	Perceived usefulness → utilitarian value	0.278	5.239	0.000	Yes
H1b	Perceived usefulness → psychological comfort	0.108	1.938	0.027*	Yes
H2a	Perceived autonomy → utilitarian value	0.171	3.391	0.001	Yes
H2b	Perceived autonomy → psychological comfort	0.275	5.373	0.000	Yes
H3a	Social presence → hedonic value	0.423	7.663	0.000	Yes
H3b	Social presence → psychological comfort	0.069	1.169	0.243	No
H4a	Perceived humanness → hedonic value	0.224	4.273	0.000	Yes
H4b	Perceived humanness → psychological comfort	0.211	4.135	0.000	Yes
H5	Utilitarian value → FSR acceptance	0.507	8.006	0.000	Yes
H6	Hedonic value → FSR acceptance	0.168	3.555	0.000	Yes
H7	Psychological comfort → FSR acceptance	0.228	3.745	0.000	Yes
Interaction effect: self-efficacy (SE)					
H8a	Perceived usefulness × SE → utilitarian value	0.133	2.379	0.018	Yes
H8b	Perceived autonomy × SE → utilitarian value	−0.096	1.782	0.075	No
Interaction effect: technology anxiety (TA)					
H9a	Perceived usefulness × TA → utilitarian value	−0.112	1.699	0.045*	Yes
H9b	Perceived autonomy × TA → utilitarian value	−0.029	0.535	0.593	No
H9c	Social presence × TA → hedonic value	−0.116	2.401	0.017	Yes
H9d	Perceived humanness × TA → hedonic value	−0.027	0.556	0.578	No

Note(s): *Significant at 0.05 level (one-tailed)
Source(s): Authors' own work

are classified as small (≥0.02), medium (≥0.15) and large (≥0.35). Utilitarian value demonstrated a medium effect (f^2 = 0.276), underscoring its central role in influencing acceptance. In contrast, both hedonic value (f^2 = 0.036) and psychological comfort (f^2 = 0.064) exhibited small effect sizes, indicating comparatively weaker but still statistically significant contributions. These findings are consistent with the standardized path coefficients: utilitarian value (β = 0.507) exerted a substantially stronger influence on customer acceptance than psychological comfort (β = 0.228) and hedonic value (β = 0.168), (refer Table 3) reflecting the pattern observed in their respective f^2 values.

In summary, our findings support both the sRAM proposed by Wirtz *et al.* (2018) and the degree of robotics adoption model by Xiao and Kumar (2019). We found that both functional elements (perceived usefulness and perceived autonomy) and socio-emotional elements (social presence and perceived humanness) significantly influence customer perceptions of value and psychological comfort with in turn, drive FSR acceptance. Moreover, our results align with Gursoy *et al.* (2019), demonstrating that both utilitarian and hedonic value are positively associated with customer acceptance of FSRs. In addition, control variables (age, gender, education and prior FSR experience) were tested but showed no significant effects on FSR acceptance and are therefore not discussed further.

Discussion

Our research provides a comprehensive understanding of FSRs customer acceptance, contributing to the ongoing development of models such as the TAM (Davis, 1989) and the TCV (Sheth *et al.*, 1991). These models suggest that customer acceptance of technology is influenced by both functional dimensions and socio-emotional aspects. Collectively, the path coefficients and Cohen's (f^2) results highlight the predominant influence of cognitive evaluations, particularly perceptions of functional value, over affective experiences in shaping customer acceptance of service robots. Nevertheless, the statistical significance of emotional factors such as enjoyment and comfort indicate that these elements remain important considerations in the design and implementation of service robot technologies. Our findings confirm the relevance of the aforementioned models in the context of FSRs and provide a nuanced understanding of the mechanisms through which these factors influence FSR acceptance.

According to functional and socio-emotional dimensions, the results provide robust support for the conceptual models proposed by Wirtz *et al.* (2018) and Xiao and Kumar (2019), which suggest that customer acceptance of FSRs is shaped by both functional and socio-emotional dimensions. Customers' perceptions of perceived usefulness are central to this acceptance process, as customers expect robots to deliver accurate, relevant and timely information. In this study, participants highlighted that the robot's ability to provide correct information – such as promotions, product inquiries and location directions – contributed to their perception of the robot's usefulness, thus reinforcing the utilitarian value aspect outlined in the TAM. This finding aligns with De Graaf *et al.* (2015), who identified perceived usefulness as a critical determinant of customer acceptance in various robot usage contexts.

Our study underscores the pivotal role of functional dimensions in influencing customer acceptance of FSRs, particularly perceived usefulness and perceived autonomy. As hypothesized, perceived usefulness emerged as the strongest predictor of utilitarian value (β = 0.278, $p < 0.00$), supporting the notion that customers are more likely to accept FSRs when they perceive them as providing efficient, useful and accurate service (Wirtz *et al.*, 2018). In this case, the FSRs that provided clear, timely information – such as product knowledge, promotions and directions – were deemed helpful, leading to greater customer satisfaction. This aligns with De Graaf *et al.* (2015), who posited that the perception of usefulness is central to the adoption of new technologies.

Moreover, perceived autonomy – the extent to which users feel they have control over their interaction with the robot – was another significant predictor, influencing both utilitarian value and psychological comfort (β = 0.171, $p < 0.05$). The ability to interact with the robot through voice commands or touch empowered users, reducing their anxiety and increasing their confidence in the robot's abilities. This is consistent with the findings of Nikou and Economides (2017) and Dabholkar and Bagozzi (2002), who emphasized that autonomy is a critical factor in reducing cognitive load and increasing user satisfaction with technology.

The results also highlight the importance of socio-emotional dimensions, with social presence emerging as the most significant predictor of hedonic value (β = 0.423, $p < 0.05$). Customers who interacted with robots that exhibited social cues, such as eye contact, smiling and friendly greetings, reported higher levels of enjoyment and reduced anxiety. These findings are consistent with Heerink *et al.* (2010) and Van Doorn *et al.* (2017), who argued that robots displaying social presence would enhance customer engagement and reduce anxiety.

In addition, perceived humanness – the extent to which the robot resembles human characteristics such as facial expressions and gestures – was positively associated with hedonic value and psychological comfort (β = 0.224, $p < 0.05$). This finding aligns with the work of Latikka *et al.* (2019) and Schuetzler *et al.* (2018), who stress the role of human-like features in fostering emotional connections and enhancing customer engagement. However, the results also suggest the potential pitfalls of excessive human-likeness. While moderate human-like features, such as friendly faces and empathetic language, can enhance engagement, overly human-like robots may provoke discomfort, in line with the uncanny valley theory proposed by Mori *et al.* (2012).

Perceived autonomy emerged as another critical factor in our study, influencing both utilitarian value and psychological comfort. Customers who felt in control of their interactions with the FSRs, whether through voice commands or touch, experienced higher levels of satisfaction and comfort. When users feel they have control over their interaction with technology, their satisfaction and comfort are significantly enhanced, ultimately increasing their acceptance of the FSR.

Psychological comfort was found to be an important mediator in the relationship between both functional and socio-emotional dimensions and FSR acceptance. Customers who perceived the robot as providing comfort, reassurance and reducing anxiety during the interaction were more likely to accept the technology. This aligns with the work of Molnar *et al.* (2018), who argued that comfort with a service provider –

whether human or robotic – should leads to greater trust and acceptance of automated technologies. In our study, psychological comfort was particularly influenced by perceived autonomy and perceived humanness. Customers who felt in control and those who perceived the robot as more human-like were more likely to feel at ease during their interactions. This highlights the importance of designing FSRs that foster not only functional effectiveness but also emotional connection, creating environments where customers feel secure and comfortable.

However, contrary to our expectations, social presence did not significantly predict psychological comfort (β = 0.069, p = 0.243). This may stem from the robot's limited expressiveness and small screen, which made its social cues less perceptible. While social presence enhanced hedonic value, it did not promote emotional ease. Its effectiveness may depend on contextual factors such as cultural norms, prior experience with robots or expectations of authenticity. In collectivist cultures like Thailand, scripted or overly human-like behaviours may feel unnatural, reducing rather than enhancing comfort. We identify this as a potential boundary condition and suggest it warrants further investigation.

In addition, self-efficacy did not moderate the relationship between perceived autonomy and utilitarian value (*H8b*). One possible explanation is that autonomy may be broadly valued across user segments, regardless of confidence in technology use, thus reducing the strength of moderation. Similarly, technology anxiety did not significantly moderate the effects of autonomy or perceived humanness (*H9b*, *H9d*). Most participants (81.7%) had no prior experience with FSRs but engaged in a structured environment where they could opt into robot interaction and receive support from nearby staff. This likely reduced situational stress and weakened the influence of anxiety. These results suggest that user traits interact with environmental and cultural conditions, pointing to boundary effects that future research should examine more closely.

Interestingly, while psychological comfort was significantly influenced by perceived autonomy and perceived humanness, social presence did not significantly impact psychological comfort (β = 0.069, p = 0.243). This suggests that FSRs perceived as socially present do not automatically generate comfort for all customers, especially when the social cues are not perceived as sufficiently engaging or human-like.

According to mediation and moderation effects, our mediation analysis reveals that both utilitarian value and psychological comfort fully mediate the relationships between functional dimensions (i.e. perceived usefulness and perceived autonomy) and FSR acceptance. This finding aligns with the TCV, which suggests that utilitarian value directly influences FSR acceptance through the provision of practical, useful information. Similarly, hedonic value and psychological comfort fully mediate the relationship between socio-emotional dimensions (i.e. social presence and perceived humanness) and FSR acceptance. These results underscore the dual importance of designing FSRs that not only offer functional benefits but also provide emotional comfort, as both elements are critical to driving customer acceptance.

The analysis of moderating effects offers additional insights into the dynamics of FSR acceptance. Self-efficacy was found to strengthen the relationship between perceived usefulness and utilitarian value, with individuals who felt more capable of interacting with the robot being more likely to appreciate its functional benefits. This finding is consistent with Crant (2000), this suggests that individuals with higher self-efficacy are more proactive and confident in adopting new technologies. Conversely, technology anxiety moderated several key relationships in a negative direction. Higher levels of technology anxiety weakened the association between perceived usefulness and utilitarian value (β = −0.112, $p < 0.10$), as well as between social presence and hedonic value (β = −0.116, $p < 0.05$). This highlights the significant role of individual differences in technology acceptance. Customers experiencing technology anxiety tend to be less responsive to the positive attributes of the robot, which emphasizes the need for addressing psychological comfort and reducing anxiety in FSR design. These findings align with Hsu *et al.* (2019), who suggest that individuals with high anxiety towards technology are less likely to appreciate its functional and emotional benefits. These findings underscore the intricate relationship between functional and socio-emotional factors in influencing customer perceptions of FSRs. They emphasize the need to consider individual psychological traits, such as self-efficacy and technology anxiety, in the design and implementation of FSRs. Understanding how these factors interact can inform the development of more effective and user-friendly robots, ensuring that both functional performance and emotional comfort are addressed to enhance customer acceptance.

Theoretical contributions

This study provides a more nuanced theoretical understanding of FSR acceptance in a retail service context, integrating key models such as the TAM (Davis, 1989), the sRAM (Wirtz *et al.*, 2018) and the TCV (Sheth *et al.*, 1991).

The study makes several significant theoretical contributions to the understanding of FSRs and consumer acceptance, as well as other AI-based services (e.g. financial advisory, health, hospitality services; Roongruangsee and Patterson, 2024). Our research expands on and integrates key models in technology acceptance and customer behaviour, including the TAM (Davis, 1989), the TCV (Sheth *et al.*, 1991) and the sRAM (Wirtz *et al.*, 2018).

A key contribution is the identification of psychological comfort as a critical mediator in the relationship between functional and socio-emotional dimensions and FSR acceptance. Our findings show that psychological comfort – which encompasses feelings of security, reassurance and anxiety reduction – plays a pivotal role in driving customer acceptance of FSRs. This mediator provides a deeper understanding of the customer decision-making process, suggesting that comfort, both in terms of functional performance and emotional security, is central to the adoption of new technologies, aligning with the work of Molnar *et al.* (2018). By showing that both functional (e.g. perceived usefulness) and socio-emotional (e.g. perceived humanness) factors influence psychological comfort, we extend the existing models of technology acceptance and offer new insights into how emotional comfort can enhance the effectiveness of FSRs.

Our research provides empirical support for the conceptual models proposed by Wirtz *et al.* (2018) and Xiao and Kumar (2019), which emphasize that customer acceptance of FSRs is shaped by both functional and socio-emotional dimensions. This dual dimension framework underscores the complexity of

FSR acceptance, highlighting that both functional utility and emotional engagement must be addressed to ensure successful customer adoption. These findings align with the TCV, which emphasizes the importance of both utilitarian and hedonic value in customer evaluations of products and services.

Another theoretical contribution to the literature is the identification of a contingency model (moderating effects). Unlike previous studies that limit their investigation to direct effects, we demonstrate that self-efficacy and technology anxiety act as moderators. These moderating effects introduce a more nuanced understanding of FSR adoption, showing that individual psychological traits significantly influence how customers perceive and react to FSR. This shift in focus from "what" drives FSR acceptance to "when" or "under what conditions" these relationships occur contributes new insights to the technology acceptance literature.

Finally, our study introduces a comprehensive psychological pathway that integrates functional dimensions (e.g. perceived usefulness, perceived autonomy), socio-emotional dimensions (e.g. social presence, perceived humanness), psychological comfort and customer acceptance. This pathway illustrates how utilitarian and hedonic values, as well as psychological comfort, mediate the relationships between FSR attributes and acceptance, providing a comprehensive model that advances our understanding of customer technology adoption. The identification of psychological comfort as a crucial mediator bridges the gap between functional utility and emotional engagement, making a significant contribution to both the TAM and TCV models.

The findings provide real-world empirical insights into FSR acceptance by examining customer interactions in actual service settings, extending beyond laboratory or hypothetical contexts. This enhances the external validity of TAM and TCV, demonstrating their applicability and offering valuable guidance for businesses deploying FSRs. Additionally, this research lays a foundation for future studies and offers practical implications for the design and implementation of FSRs across various AI-based technological service contexts.

Managerial implications

Our study offers several valuable insights for practitioners considering the implementation of FSRs in retail and other service settings. Firstly, the importance of functional effectiveness cannot be overstated. FSRs must be designed to meet customers' expectations for accurate, relevant and timely information. In the context of retail, this includes providing product information, promotional information and directions. If FSRs fail to meet these functional requirements, their utility is undermined, which can lead to dissatisfaction and reduced acceptance. This is particularly critical given that utilitarian value was the strongest predictor of FSR acceptance (β = 0.507; Cohens f^2 = 0.276). To enhance this dimension, managers should prioritize features that improve speed, reliability and clarity, such as minimizing the number of on-screen steps to complete a task, using large, clearly labelled icons for ease of navigation, ensuring real-time product and service information is readily accessible and providing simple fallback options (e.g. return to home screen, "help" button) to reduce confusion.

Secondly, our research highlights psychological comfort as a critical determinant of FSR acceptance (β = 0.228). Our original recommendation emphasized the importance of helping customers feel at ease during human–robot interaction. In this context, anthropomorphic design elements, such as a friendly appearance, subtle facial expressions and a calm, empathetic tone of voice, play an essential role in fostering hedonic value and emotional reassurance. These features can reduce user anxiety, build rapport and trust. However, we recognize that overly human-like characteristics may be perceived as artificial or unsettling, especially in collectivist cultures like Thailand, where emotional expression tends to be subtle and relational harmony is highly valued. Rather than promoting highly anthropomorphized designs or formal customer training programmes, we suggest culturally sensitive design paired with experiential, low-pressure exposure, such as allowing customers to interact with robots in welcoming environments supported by human staff. These design and deployment choices should be carefully tailored to local expectations and validated through real user feedback.

Thirdly, the study shows that perceived autonomy significantly influences both utilitarian value and psychological comfort (β = 0.171). Customers who felt in control of the interaction, such as choosing between voice or touch input, experienced higher satisfaction and reduced anxiety. Therefore, FSRs should provide multi-modal interaction options and include clear visual cues and confirmation prompts (e.g. "Would you like me to repeat that?") that help reinforce a sense of control and predictability.

Moreover, while the results suggest that individuals with high self-efficacy are more likely to accept FSRs, targeting such users directly may not be operationally feasible. Instead, firms can support the development of self-efficacy by offering low-pressure, hands-on experiences, such as brief interactive demos or staff-assisted introductions at the point of service (i.e. human "greeters"). These micro-interactions help hesitant users build confidence without the need for formal training programmes.

Similarly, for customers with higher levels of technology anxiety, firms can ease discomfort through human "Greeters", simple onboarding instructions and gradual exposure to the robot's functionality. Starting with basic, easy-to-complete tasks and ensuring that human support is readily available can foster early comfort and encourage future use. Over time, repeated interactions in supportive environments can help reduce anxiety and increase acceptance. These approaches offer realistic, customer-centric alternatives to enhance both emotional ease and functional appreciation of FSRs. Moreover, service providers deploying FSRs should target customers with high self-efficacy and low technology anxiety to encourage acceptance. Customers who feel confident in their ability to interact with technology are more likely to appreciate the functional benefits of FSRs. Firms can take steps to increase self-efficacy by offering robot literacy programmes that familiarize customers with the technology and build their confidence. Repeated use over time might also reduce anxiety staff. These approaches can help reduce anxiety and foster positive initial (and future) interactions with FSRs.

Limitations and research directions

While this research significantly advances understanding of customer acceptance of FSRs in a retail context, there are several limitations that warrant consideration. Firstly, the self-selection bias in the survey sample may limit the generalizability of the findings. The participants self-selected, meaning the sample represents only those customers who have a propensity to engage with FSRs, potentially excluding those who are more hesitant or unfamiliar with the technology. This bias is compounded by the young age of the sample, with 85.5% of respondents falling within the 20–30-year age range. This cohort is generally more inclined to adopt new technologies, making it difficult to capture insights from older demographics who may have different attitudes towards technology adoption. Future research using a quota sampling approach would be beneficial in ensuring a sample that includes older age groups and potentially uncovers additional insights into how different age cohorts accept and interact with FSRs.

Another limitation arises from the contextual scope of the study. Data collection occurred during the initial phase of FSR introduction in Thailand, specifically by one service firm. As other service providers, including hotels, department stores and restaurants, have since integrated FSRs, it would be valuable to conduct a longitudinal study to examine whether customers' acceptance of FSRs evolves over time. This could provide insight into whether initial enthusiasm or novelty effects drive early adoption, and whether these effects diminish or grow stronger as customers become more accustomed to the technology. Such a study could also help identify whether customers' perceptions and acceptance shift as FSRs become more common in different service settings.

To further enhance the generalizability of the findings, future research should consider applying the proposed psychological pathway model across a variety of research contexts. External validity could be increased by applying the model to different categories of service firms, such as nursing homes, health care and tourism, and by exploring the model in diverse cultural contexts. Thailand, with its collectivist culture, may exhibit different FSR acceptance patterns compared to more individualistic cultures like those in Western countries (Hofstede, 1980). Understanding how cultural contexts impact FSR acceptance could provide a richer, more nuanced understanding of customer attitudes towards service robots.

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