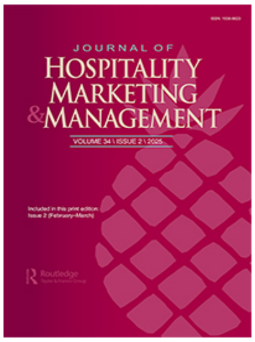

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Robot anthropomorphism at luxury hotels: a dual-congruity mechanism with luxury and task under anxiety

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ABSTRACT

Although service robots have been extensively studied recently, few empirical investigations have focused on the luxury setting. Targeting the setting of luxury hotels, in this study, expectation-confirmation theory and dual-congruity theory are combined to examine the impact of robot anthropomorphism on consumers' expectations of service robots. The findings obtained from a sample of 556 respondents indicated that robot anthropomorphism increased consumers' perceived social capability, performance expectancy, and perceived importance. Furthermore, luxury-technology fit and task-technology fit mediated the effects of social capability, performance expectancy, and perceived importance on the intention to use robotic services. Furthermore, the moderating role of anxiety toward robots in strengthening the effect of luxury-technology fit on the intention to use robotic services was revealed. The findings contribute to an enhanced understanding of consumer psychology in the context of advanced service technologies, offering valuable insights for the strategic implementation of service robots at luxury hotels.

摘要

尽管最近对服务机器人进行了广泛的研究，但很少有实证研究关注豪华环境. 本研究针对豪华酒店的环境，结合期望确认理论和双重一致性理论，考察了机器人拟人化对消费者对服务机器人期望的影响. 从556名受访者的样本中获得的研究结果表明，机器人拟人化提高了消费者的感知社交能力、绩效预期和感知重要性. 此外，豪华技术契合度和任务技术契合度介导了社会能力、绩效预期和感知重要性对使用机器人服务意愿的影响. 此外，还揭示了对机器人的焦虑在加强豪华技术契合对使用机器人服务意愿的影响方面的调节作用. 这些发现有助于在先进服务技术的背景下加深对消费者心理的理解，为豪华酒店服务机器人的战略实施提供了宝贵的见解.

KEYWORDS

Robot; anthropomorphism; luxury hotels; luxury-technology fit; expectation-confirmation theory; dual-congruity theory

Introduction

The COVID-19 pandemic accelerated service robots' adoption in hospitality, enhancing operational efficiency amidst social distancing and helping managers cope with labor

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shortage problems (Chi et al., 2022). These robots embody artificial intelligence, facilitating customer interactions and performing operational tasks (Shin, 2022; Xiong et al., 2021). A series of studies have been conducted on consumer intention to use service robots, particularly those grounded in traditional technology acceptance models such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Belanche et al., 2019, 2020; Byrd et al., 2021; H. Kim et al., 2022).

However, a notable research gap is observed in how robot anthropomorphism – attributing human characteristics to robots – influences customers' intention to use robotic services, especially for the luxury segment (Gonçalves et al., 2024; Shin & Jeong, 2022; Wang & Papastathopoulos, 2023). Service robots are adopted widely in the hospitality industry to assist with operational tasks (Ladeira et al., 2023), making them popular in the economy and middle segments (Y.-C. Wang & Papastathopoulos, 2023). For the luxury segment, since customers expect warm social interactions and human touch, service robots designed to serve the functional needs of the economy and middle segment are hard to implement directly into the luxury segment (Gonçalves et al., 2024; Y.-C. Wang & Papastathopoulos, 2023). Robot anthropomorphism, which can deliver a luxurious, warm human touch in service interactions, has the potential for future robot design specifically for the luxury segment (Baudier et al., 2023). Therefore, to fill the knowledge gap in robot anthropomorphism at luxury hotels and to contribute insights for robot developers for the luxury segment, this study focuses on robot anthropomorphism at luxury hotels.

Scholars have established that augmenting functional and pleasurable experiences with robotic technologies enhances customers' willingness to use and continue using these services (Chen et al., 2022; Liu et al., 2022; Odekerken-Schröder et al., 2022; Wu et al., 2021). There appears to be a research gap in exploring the influence of self-congruity, especially in the context of luxury hotels where the alignment of technology with the luxury environment is crucial (Javornik et al., 2021; Kim, 2023). In this study, we propose bridging this gap by adopting the dual-congruity theory, which encompasses self-congruity and functional congruity. We posit that alongside utilitarian values, self-congruity, particularly in luxury-technology fit (LTF), warrants closer examination. Luxury-technology fit pertains to how well technological innovations align with the luxurious ambiance and services of high-end hotels, which contributes to a sense of psychological congruence for consumers who identify with luxury (Javornik et al., 2021; Peng & Chen, 2021; Shin & Jeong, 2022). In service robots, this fit can enhance the perception of luxury, potentially affecting guests' intention to use these robotic services. Moreover, considering task-technology fit (TTF) as another crucial element, this study investigates how the practical alignment of robot capabilities with specific tasks in luxury hotel settings (de Kervenoael et al., 2020; Romero & Lado, 2021) interacts with the luxury-technology fit of those robots. Dual-congruity theory provides an ideal lens for this investigation, emphasizing the interplay between the psychological alignment of consumer self-concept (i.e., luxury-technology fit) and the practical utility of products (i.e., task-technology fit).

Past research has predominantly treated anxiety toward robots as a hindrance to adopting robotic services (Meuter et al., 2003; Odekerken-Schröder et al., 2022). This perspective has been common in studies exploring technology anxiety across various domains, including computers, mobile phones, and self-service technologies (Meuter et al., 2003; Yang & Forney, 2013). However, the unique context of luxury hotels and the nuanced application of service robots in this sector presents an opportunity to reassess this relationship (Shin &

Jeong, 2022). Considering the emerging integration of service robots in luxury hospitality settings (Shin & Jeong, 2022; Wang & Papastathopoulos, 2023), this study addresses a notable research gap in understanding how anxiety toward robots leverage the effects of luxury-technology fit and task-technology fit on the intention to use robotic services.

This research is conducted to provide a nuanced understanding of the relationship between robot anthropomorphism and customers' intentions to use robotic services by combining expectation-confirmation theory (ECT) and dual-congruity theory (DCT). Specifically, the objective is to explore how the anthropomorphic attributes of robots influence guests' expectations and how these expectations, once confirmed, affect guests' intentions to use robotic services within a luxury hospitality context. This integration of ECT and DCT seeks to explore the mediating mechanisms that could explain the indirect effects of robot anthropomorphism on usage intentions. The mediating roles of social capability, performance expectancy, and perceived importance derived from ECT are examined to ascertain how they contribute to the formation of usage intentions after initial expectations are met.

This study also aims to investigate the dual mediating effects of luxury-technology fit and task-technology fit, concepts drawn from DCT, on the relationship between robot anthropomorphism and the intention to use robotic services. This involves analyzing how the alignment between the robot's design and the luxury context of the service (i.e., luxury-technology fit), as well as the alignment between the robot's functionalities and the tasks it performs (i.e., task-technology fit), influence the intention to use the service. By integrating these theories, we intend to unveil the complex interplay between robot anthropomorphism and service usage intentions, providing a holistic view of the mediatory pathways involved. This research also aims to explore the moderating role of anxiety toward robots in the relationship between luxury-technology fit and the intention to use robotic services. This exploration examines whether the presence of anxiety toward robots can intensify or mitigate the effect of luxury-technology fit on the intention to use such services. This investigation will help in discerning whether anxiety acts as a barrier that the positive perceptions of luxury-technology fit must overcome or if it serves as an enhancer of the relationship, potentially leading to a heightened intention to use when consumers perceive a high degree of congruity between the luxury service environment and robotic technology. By scrutinizing this moderating effect, this study provides deeper insights into the psychological factors that may influence consumer decisions regarding adopting robotic services. This study also addresses a research gap regarding complex emotional responses to technology in luxury settings, offering a more comprehensive understanding of how to integrate service robots in the hospitality industry effectively.

Literature review

The proposed research framework is presented in Figure 1. Both the expectation-confirmation theory (ECT) (Oliver, 1980) and the dual-congruity theory (DCT) (Johar & Sirgy, 1991) are integrated to explain the conceptualization of our model theoretically. Based on the setting of experiencing robot anthropomorphism at luxury hotels (Baudier et al., 2023; Gonçalves et al., 2024), from the ECT perspective, we predict luxury hotels' customers would first set expectations toward robot anthropomorphism in the aspects of handling social interactions (i.e., social

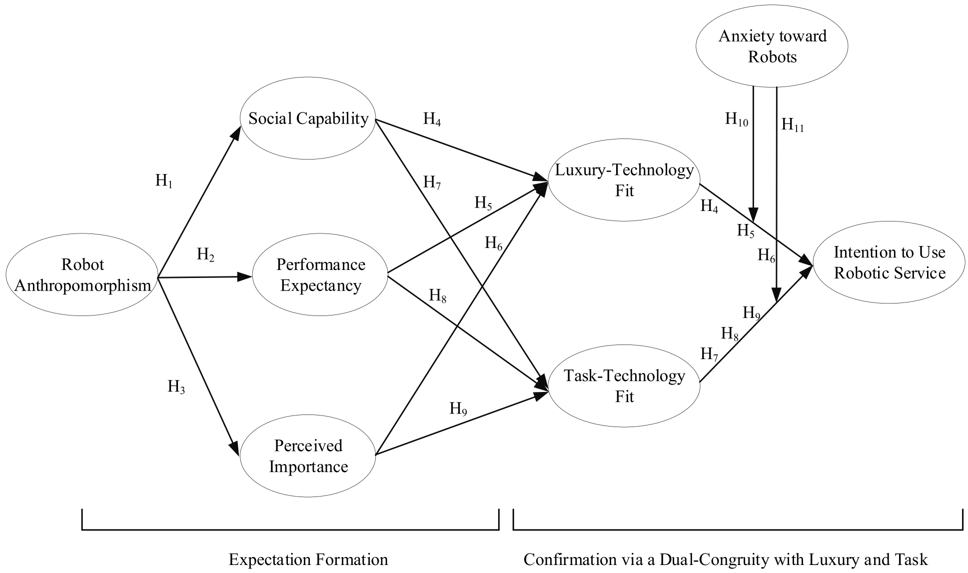

Figure 1. Proposed research framework.

capability), achieving task performance (i.e., performance expectancy), and showcasing the importance of offering the anthropomorphism in robotic service in a luxury hotel experience (i.e., perceived importance). Based on these expectations, customers further confirm their evaluation of robot anthropomorphism at luxury hotels, resulting in their intention toward robotic service. During the confirmation stage of ECT, DCT is utilized to explain customers' evaluation of robot anthropomorphism at luxury hotels. Following Shin and Jeong (2022) about technology implementation for luxury service, we argue that luxury hotels' customers would not only evaluate how the robot anthropomorphism undertakes the planned tasks (i.e., task-technology fit) but also how the robot anthropomorphism matches with the luxury segment (i.e., luxury-technology fit). The following sections review and justify the theories and the proposed hypotheses.

Expectation-confirmation theory

Expectation-confirmation theory (ECT), a well-established concept in consumer satisfaction and information systems, is becoming increasingly relevant in the context of service robots in the hospitality industry. As proposed by Oliver (1980), the fundamental premise of ECT posits that satisfaction is a function of initial expectations, perceived performance, and the extent of confirmation or disconfirmation of those expectations. ECT elucidates consumer satisfaction in four stages: expectation, performance, confirmation, and satisfaction. First, consumers form expectations about a product or service influenced by prior experiences and external communications (Bhattacherjee, 2001). The performance stage involves the actual experience with the product or service, where consumers assess its efficacy against their expectations (Parasuraman et al., 1985). Confirmation, the third stage, is a critical comparison phase in which consumers evaluate whether the actual performance meets, exceeds, or falls short of their initial expectations (Oliver, 1980). Positive alignment leads to confirmation, whereas a mismatch results in disconfirmation. The final stage, satisfaction, is the outcome of this evaluation process. Satisfaction arises when consumers' expectations are met or exceeded, leading them to positively assess the product or service (Anderson & Sullivan, 1993). This theory provides a comprehensive framework for understanding consumer behavior and satisfaction, which is crucial for businesses and service providers in enhancing customer experiences and loyalty.

In the context of service robots in the hospitality industry, ECT can be applied to understand the intention of customers to continue using these robots. Service robots can assist human front-line employees, especially with repetitive tasks, such as check-in and accommodation procedures, information requests, and meal services (Song et al., 2022). Several studies have also provided insights into the application of ECT in understanding customers' intentions and interactions with service robots in the hospitality industry. For instance, Tuomi et al. (2021) explored the impacts of robotization in the hospitality sector, offering empirical accounts of the current state of the art of service robotics deployed in hospitality service encounters (Tuomi et al., 2021). This study contributes to understanding how customers' initial expectations of robotic service are confirmed or disconfirmed in actual hospitality settings, thus influencing their overall satisfaction and behavioral intentions. In summary, ECT can provide valuable insights into understanding the intention of customers to continue using service robots in the hospitality industry. This emphasizes the importance of meeting or exceeding customer expectations to ensure these robots' satisfaction and continued use. Customers' expectations about these robots' performances can significantly influence their satisfaction and intention to continue using these services.

Dual-congruity theory and dual-congruity factors

Dual-congruity theory, a fundamental framework in consumer behavior research, is extensively applied in various domains, including tourism and hospitality studies, and offers critical insights into consumer decision-making processes. This theory, rooted in the foundational works of Johar and Sirgy (1991), elucidates how consumer behavior is intricately influenced by two key attributes: value-expressive and utilitarian. These attributes are conceptualized as self-congruity and functional congruity, respectively; each has distinct implications for understanding consumer preferences and actions. Dual-congruity theory is a pivotal analytical tool in consumer behavior, particularly in tourism and hospitality research. This approach facilitates a deeper understanding of the intricate dynamics between consumer self-identity and product or service choices. This is especially relevant in tourism, where consumer decisions often reflect personal values and self-concepts, aligning with self-congruity principles defined by Johar and Sirgy (1991). These decisions are not driven solely by value-expressive attributes; they are also significantly influenced by utilitarian attributes, emphasizing the role of functional congruity in consumer choices.

As a critical component of dual-congruity theory, functional congruity focuses on aligning a consumer's utilitarian criteria and the practical attributes of a product or service. This concept, initially established by Samli and Sirgy (1981) and further developed by Johar and Sirgy (1991), distinguishes itself from self-congruity by centering on consumer choices' performance and utility aspects. Functional congruity is essential for understanding consumer evaluations of the practicality and utility of products or services, a perspective emphasized by researchers such as Suh et al. (2010). Sirgy et al. (1991), Markus (1980), and Abelson (1976) delve deeper into the cognitive processes that underpin these evaluations, illustrating how abstract schemas related to self-congruity can indirectly influence and activate the more concrete schemas of functional congruity. This interplay significantly impacts consumer attitudes and behaviors, as demonstrated by studies such as Suh et al. (2011), which investigate the effects of avatar similarity and perceived diagnosticity on consumer evaluations.

This study considers luxury-technology fit to be the self-congruity factor that predicts consumers' continuance intention. This conceptualization aligns with dual-congruity theory's emphasis on self-congruity, which is the psychological alignment between a consumer's self-concept and a brand or product's perceived values or symbolic meanings. In the context of luxury hospitality services, luxury-technology fit represents how well technological innovations within a luxury service environment resonate with the affluent consumer's self-image and expectations of luxury. Although luxury-technology fit refers to the match between the luxury hotel image and robotic technology, such a match covers customers' self-image with the luxury image (Kim, 2023). This is because customers at luxury hotels tend to take the luxury hotel image to represent their self-image (Kim, 2023; Lo & Yeung, 2020). This is why they are concerned about the luxury-technology fit of service robots adopted at luxury hotels (Shin & Jeong, 2022). This fit is crucial because it reflects the value-expressive attribute of consumer behavior, where decisions are influenced by how well the service aligns with personal values and self-concept, particularly in luxury settings (Johar & Sirgy, 1991).

In this study, task-technology fit is positioned as the functional congruity factor. It assesses the alignment between a consumer's utilitarian criteria and the practical attributes of the technology used in service robots. Task-technology fit focuses on the utility and performance aspects of consumer choices, embodying the utilitarian attribute of dual-congruity theory. Understanding how consumers evaluate the practicality and utility of products or services is essential, especially in robotic services in hospitality (Samli & Sirgy, 1981; Suh et al., 2010). In essence, while luxury-technology fit addresses the value-expressive, self-congruity aspect by aligning luxury services with consumer identity, task-technology fit addresses the utilitarian, functional congruity aspect by ensuring that the technology effectively supports its intended tasks. Both fits are integral to understanding and predicting consumer behavior within the dual-congruity theory framework, particularly in luxury hospitality services, where both self-identity and practical utility play pivotal roles in shaping consumer preferences and actions.

Hypothesis development

Anthropomorphism and social capability

Anthropomorphism in service robots in the hospitality industry refers to the extent to which these robots are designed to resemble and mimic human characteristics and behaviors. Anthropomorphism incorporates visual features and psychological dimensions, such as service autonomy, to create a more humanlike consumer experience. Studies have shown that service robots' visual features and autonomy can impact consumer acceptance and intention to use those robots (Kim et al., 2023). Anthropomorphism also shapes customer attitudes, psychological ownership, and customer responses toward service robots (Ladeira et al., 2023). Social capability in service robots in the hospitality industry refers to the ability of robots to interact and engage with customers in a socially acceptable and comfortable manner. It encompasses the robots' capacity to understand and respond to human emotions, communicate effectively, and establish customer rapport.

Research suggests that service robots can alleviate customers' social discomfort in hospitality encounters by providing a dehumanized alternative to human service providers (Liu et al., 2023). Empathy and information sharing in human-robot interactions contribute to visitors' intentions to use social robots in hospitality services (de Kervenoael et al., 2020). Studies have found a positive effect of anthropomorphism on the likability and first impressions of service robots as providers (Blut et al., 2021). Additionally, it has been suggested that anthropomorphic features' warmth and competence perceptions positively affect expected service quality (Yoganathan et al., 2021). Chang et al. (2023) also found that anthropomorphism affects social capability by enhancing social interactions and relationships with nonhuman entities, increasing empathy and emotional connection. Furthermore, the positive impact of social connections with others on consumers' reactions to robot anthropomorphism has been confirmed, adding to the understanding of the potential benefits of anthropomorphism in service robots (Han et al., 2023).

The luxury segment reveals why social capability is customers' critical expectation in robot anthropomorphism. Customers at luxury hotels pay higher costs to enjoy a hotel experience than those at lower-tiered hotels (Cetin & Walls, 2016). One reason is that they hope to enjoy warm social interactions during their luxury stay or even be healed by social interactions (Liu et al., 2024). As mentioned above, anthropomorphism in robot design can allow users to enjoy more affluent and better social interaction (Chang et al., 2023; Yoganathan et al., 2021), so robot anthropomorphism would be valued for customers at luxury hotels. Hence, according to the ECT framework, we argue that when anthropomorphism in a service robot leads to heightened social capability, the robot meets and potentially exceeds customer expectations. As per ECT, this alignment and potential over-achievement of expectations can lead to higher satisfaction levels. Therefore, anthropomorphism in service robots can be seen as a strategic design choice to enhance social capability, positively influencing customer satisfaction and acceptance in the hospitality industry. Hence, we propose the following hypothesis:

H_1: Anthropomorphism has a positive effect on social capability.

Anthropomorphism and performance expectancy

Performance expectancy in service robots refers to the perceived effectiveness and usefulness of robots in performing tasks and delivering services. It is a measure of how well robots are expected to meet the needs and expectations of users. In hotel service, customers prioritize assurance and reliability as the most critical aspects of robots' service quality, while responsiveness is considered a low priority (Chiang & Trimi, 2020). Additionally, the adoption of service robots is influenced by users' performance goal orientations, specifically their desire to achieve and avoid failure. These motivational drivers directly influence the adoption of service robots, and challenge appraisal acts as a mediator in this relationship (Tojib et al., 2022). Research has emphasized the importance of performance expectancy in shaping the adoption and utilization of service robots in the hospitality industry. Studies have highlighted that a high-performance expectancy is linked to customers' increased willingness to use service robots, reflecting their confidence in the robots' ability to effectively complete service tasks (Yang et al., 2022). Furthermore, service robots are incorporated into hospitality to enhance operational efficiency and customer experiences, improving service performance and customer satisfaction (Tuomi et al., 2021).

Customers at luxury hotels value warm interaction a lot when evaluating luxury service performance (Cetin & Walls, 2016; Chalke et al., 2023). So, we argue that robot anthropomorphism can improve customers' performance expectancy because robots' anthropomorphic features can directly support luxury hotel customers' performance expectations of having enjoyable interactions. Evidence from the literature suggests that anthropomorphism in service robots can positively affect performance expectancy (Zhang et al., 2021). Yang et al. (2022) indicated that anthropomorphism can improve the user experience by making interactions more intuitive and natural. This improved experience can lead to increased expectations of robot performance. Yam et al. (2021) found that robots with anthropomorphic features engage users more effectively, leading to higher satisfaction levels. Therefore, we propose the following hypothesis:

H_2: Anthropomorphism has a positive effect on performance expectancy.

Anthropomorphism and performance importance

Perceived importance for service robots refers to the subjective evaluation of the significance or value attributed to these robots by individuals. It is influenced by various factors, such as the robot's humanlike attributes and capabilities, including the theory of mind (Söderlund, 2022a). Additionally, informational cues such as anthropomorphism and social influence shape the perception of robot trust, affecting the acceptance of service robots (Ladeira et al., 2023). Perceptions of service robots as more humanlike and capable of agency and experience can lead to more positive evaluations and higher customer satisfaction, especially in the face of robot service failures (Yam et al., 2021). Furthermore, the ability of service robots to recognize themselves can enhance perceptions of service quality, mediated by perceptions of learning capacity and theory of mind (Söderlund, 2022b).

Perceived importance is closely linked to perceived usefulness and perceived ease of use, which are significant factors in customer attitudes toward service robots (Li & Wang, 2021). Moreover, the perceived usefulness of service robots is an important underlying mechanism affecting consumers' attitudes toward adopting service robots in different service settings (Park et al., 2021). The perceived importance of service robots is also influenced by fundamental psychological motivations, attitudes, and perceived values (Cha, 2020). Encounters with service robots are perceived as social interactions that affect customers' perceptions of responsibility for service outcomes and the overall service experience (Jörling et al., 2019).

Within the ECT framework, anthropomorphism in service robots can positively affect the perceived importance of these robots in the hospitality industry. This effect arises from the premise that human-like characteristics in robots elevate guests' expectations regarding the quality and personalization of service, leading to an enhanced perception of the robots' significance and value when these expectations are met or exceeded. Several studies have shed light on this relationship, providing valuable insights into how anthropomorphism influences the perceived importance of service robots. Han et al. (2023) highlighted that anthropomorphism may increase consumers' perceptions of psychological closeness to robots, leading to more favorable attitudes toward those robots. This sense of psychological closeness may increase the perceived importance of service robots, as individuals may value their interactions with anthropomorphic robots more highly due to the emotional connections they experience. Furthermore, Odekerken-Schröder et al. (2022) found that anthropomorphism impacts the perceived quality of core services provided by robots, indicating that the human-like attributes of robots may enhance the perceived importance of the services the robots deliver. Based on the above, the following hypothesis is proposed:

H_3: Anthropomorphism has a positive effect on perceived importance.

Luxury-technology fit

Luxury-technology fit refers to the alignment and integration of technological innovations in the context of luxury services, particularly in luxury hotels. This concept has gained attention in recent research, as scholars have sought to understand the impact of technology on guest satisfaction, loyalty, and overall brand engagement in the luxury hotel industry (Shin & Jeong, 2022). The relationship between consumers and their favorite luxury hotels is strong and lasting, indicating the significance of understanding how technology can enhance this relationship (Peng & Chen, 2021).

Luxury hotels have explored various technological implementations to redefine luxury services and enhance guest experiences. For instance, augmented reality (AR) has been identified as particularly effective for capturing luxury brands' artistic, magical, and fantastical elements, which can be extended to luxury hotel experiences (Javornik et al., 2021). Additionally, the relationships between contactless hospitality services and customers' willingness to pay for such services have been studied, contributing to the knowledge of technology implementation in the hospitality industry and its impact on hotel amenities (Hao et al., 2023). Additionally, research has been conducted on the effects of technology on guest satisfaction and loyalty in a luxury hotel setting, providing insights into the perception of technological services in luxury hotels (Shin & Jeong, 2022).

As highlighted by Liu et al. (2023) and de Kervenoael et al. (2020), social capability in service robots is critical for effective human-robot interactions in hospitality. When robots exhibit advanced social capabilities, they align better with the sophisticated ambiance and personalized services expected in luxury hotels. In this vein, luxury-technology fit represents a form of self-congruity in which the luxury aspect of technology must resonate with the guest's expectations of a luxury experience. The dual-congruity theory suggests that guests are more likely to use robotic services when there is a harmonious alignment between the luxury standards of the technology (Technology Fit) and the social capabilities of the service robots. This fit ensures that the technology fulfills practical needs and aligns with the luxurious image and standards that guests expect. Therefore, we propose the following hypothesis:

H_4: Luxury-technology fit mediates the relationship between social capability and the intention to use robotic services.

Performance expectancy, as defined by Chiang and Trimi (2020) and Tojib et al. (2022), relates to service robots' anticipated effectiveness and reliability. In luxury hotels, where guest expectations are high, the performance of service robots must align with the perceived value and exclusivity of hotel services. This alignment, termed luxury-technology fit, is essential for guests to perceive robotic services as an integral part of their luxury experience. Therefore, the impact of performance expectancy on the intention to use robotic services is hypothesized to be mediated by luxury-technology fit, which ensures that technology complements luxury ambiance.

H_5: Luxury-technology fit mediates the relationship between performance expectancy and intention to use robotic service.

Perceived importance, as described by Söderlund (2022a, 2022b) and Ladeira et al. (2023), involves individuals' subjective valuation of service robots, influenced by their humanlike attributes and capabilities. In luxury settings, integrating technology must resonate with guests' perceptions of the essential aspects of luxury experiences. This means that guests' perceptions of the importance of these services will lead to more excellent intentions to use these services when these perceptions align with the luxury standards provided by the technology. This fit is proposed to mediate the relationship between guests' perceived importance of robotic services and their intention to use them, reflecting how well the technology integration meets the guests' expectations of luxury.

H_6: Luxury-technology fit mediates the relationship between perceived importance and intention to use robotic services.

Task-technology fit

To understand the application of task-technology fit (TTF) in service robots within the hospitality industry, it is essential to consider the alignment between the tasks that service robots are expected to perform and the technology integrated into these robots. The TTF model emphasizes the compatibility between the requirements of tasks and the capabilities of the technology utilized by robots. Several studies have provided insights into the application of TTF in the context of service robots in hospitality. de Kervenoael et al. (2020) illustrated the role of TTF in ensuring that the technology integrated into social robots aligns with the tasks related to enhancing visitor experiences and interactions within hospitality settings. Romero and Lado (2021) focused on exploring perceptions of prevention efficacy at hotels in Generation Z regarding service robots and COVID-19, highlighting the relevance of TTF in ensuring that the technology integrated into service robots effectively supports tasks related to guest safety and health.

When the technology of service robots aligns well with their social capabilities (high TTF), guests are more likely to perceive these robots as effective and capable of fulfilling their social interaction needs (Zhang et al., 2022). This perception enhances guests' acceptance and willingness to engage with robots, increasing their intention to use robotic services. TTF acts as a crucial mediator by ensuring that robots' technological attributes support their social interaction capabilities, thereby influencing guests' usage intentions.

H_7: Task-technology fit mediates the relationship between social capability and the intention to use robotic services.

Guests' intention to use robotic services is influenced by their belief that these robots will perform their services effectively (Zhong et al., 2022). If the technology within the robots is perceived to be capable of meeting these performance expectations (high TTF), guests are more likely to use the robotic services. The TTF mediates this relationship by bridging the gap between what guests expect from robots in terms of performance and the technology's actual capabilities. A high TTF ensures that the technology meets or exceeds performance expectations, positively influencing guests' intention to use the service.

H_8: Task-technology fit mediates the relationship between performance expectancy and guests' intention to use robotic service.

The guests' intention to use robotic services partially depends on how important they perceive these services to be (de Kervenoael et al., 2020). The technology of the service robots aligning with the tasks that guests find necessary (high TTF) reinforces the perceived value and utility of the robotic services. This alignment enhances guests' confidence in the robots' ability to meet their needs and expectations, increasing their willingness to use the services. TTF thus mediates this relationship by ensuring that the technological capabilities of the robots are aligned with what guests deem necessary, influencing their usage intentions.

H_9: Task-technology fit mediates the relationship between perceived importance and intention to use robotic service.

Anxiety toward robots

Anxiety toward robots, a concept gaining traction in human-robot interaction, refers to the apprehension and fear individuals experience in the presence of or when thinking about robots. The roots of robot anxiety can be traced to several psychological and sociocultural factors. Mori's Uncanny Valley theory (Mori, 1970) posits that as robots become more human-like in appearance and behavior, they evoke eerie and uncomfortable feelings in humans, contributing to anxiety. This response is often attributed to difficulty categorizing robots as fully human or mechanical, leading to cognitive dissonance and discomfort (MacDorman & Ishiguro, 2006; Mori, 1970). Efforts to mitigate robot anxiety focus on designing approachable and user-friendly robots, focusing on nonthreatening appearances and behaviors. Research in human-robot interaction emphasizes the importance of creating robots that respect personal space, exhibit social cues, and are transparent in their actions (Breazeal, 2003; Dautenhahn, 2007).

However, in examining the relationship between anxiety and consumer intention to use service robots in the luxury hospitality service, anxiety – typically viewed as a negative emotion – may paradoxically enhance the intention to use service robots. According to Huang et al. (2024), not all negative affect should be avoided, as individuals often exhibit novelty-seeking tendencies that lead them to explore situations that evoke fear or discomfort (Carroll, 2003). This is particularly relevant in the case of service robots, where anxiety may trigger mechanisms such as curiosity and what has been termed the "enjoyment of fear" (Hitchcock, 1949). In Huang et al. (2024)'s research, they also found negative affect positively influences consumers' intention to use service robots. Another study by Yang and Forney (2013) also identified consumer technology anxiety as an essential moderator for forming use intention. Additionally, dual-congruity theory offers a nuanced framework for understanding guest interactions with service robots. We propose anxiety toward robots as a moderator to enhance the positive effects of luxury-technology fit on the intention to use robotic service. Specifically, this effect suggests that guests experiencing higher anxiety toward robots perceive a stronger positive relationship between luxury-technology fit and their intention to use such services.

H_{10}: Anxiety toward robots moderates the relationship between luxury-technology fit and intention to use robotic service; specifically, higher levels of anxiety toward robots can enhance the positive relationship between luxury-technology fit and intention to use robotic service.

Within the framework of dual-congruity theory, we explore the nuanced interplay between task-technology fit and consumer behavior, particularly in the presence of anxiety toward robots. We suggest that anxiety toward robots moderates the relationship between task-technology fit and the intention to use robotic services. This hypothesis is rooted in the understanding that task-technology fit, which represents functional congruity, ensures the alignment of technological capabilities with the specific tasks of service robots in hospitality (de Kervenoael et al., 2020; Romero & Lado, 2021), but the presence of anxiety toward robots can significantly strengthen this positive relationship. Anxiety, a psychological factor influenced by sociocultural and individual predispositions (MacDorman & Ishiguro, 2006; Mori, 1970), can hinder technology adoption. The mental security of perceived task-technology fit is crucial for anxious individuals, as it can transform their apprehension into acceptance, enhancing their willingness to engage with robotic services (Breazeal, 2003). Therefore, we propose that when anxiety toward robots is high, it would strengthen the positive relationship between task-technology fit and intention to use robotics. Such justification is consistent with previous studies proposing anxiety as a moderator for forming use intention (Yang & Forney, 2013). Therefore, we propose the following hypothesis:

H_{11}: Anxiety toward robots moderates the relationship between task-technology fit and intention to use robotic services; anxiety toward robots can enhance the relation between task-technology fit and intention to use robotics.

Method

Sample and data collection

The sampling process was meticulously orchestrated by contracting the services of Meta Survey Marketing Research, a renowned market research firm. The data collection phase was strategically scheduled for November 2023, ensuring timely execution and optimal response rates. The survey instrument was innovatively distributed across multiple digital platforms to capture a wide and diverse sample. The survey was disseminated through an array of social media channels, notably Facebook and Instagram, known for their expansive user bases and high engagement rates. Additionally, the survey was circulated via LINE@, a popular communication app that offers an effective medium for accessing a broad demographic. Furthermore, Meta Survey Marketing Research utilized its official website as a pivotal distribution channel, leveraging its online presence to attract potential respondents.

The selection criteria for respondents were stringently set to ensure the relevance and quality of the data collected. Participants were required to meet two essential qualifications: first, had firsthand experience with service robots in the hotel industry, which ensures the participants were aware of functional tasks that robots can do; second, had utilized ChatGPT, which ensures that the participants were experienced with the most advanced quality of language processing that can be implemented in service robots at luxury hotels (Gursoy et al., 2023). This dual criterion was instrumental in targeting individuals who could provide informed and pertinent insights into the intersection of advanced technology and hospitality services. To incentivize participation and enhance response rates, respondents who successfully completed the survey were rewarded with LINE points. This strategy not only encouraged participation but also ensured a higher level of engagement and thoughtfulness in the responses. The survey yielded a substantial response, culminating in the collection of 556 valid questionnaires.

The majority of the survey participants were female, accounting for 58.81% of the total. A total of 34.48% of the patients were aged 31 to 40 years. Regarding educational background, the majority of respondents, constituting 57%, reported having attained a university-level education. Geographically, the distribution of respondents was skewed toward northern Taiwan, with a substantial 50.18% residing in this region. The demographic details of the respondents are summarized in Table 1.

Measurements

In this study, we employed a Likert-type scale to measure various constructs, each rated on a scale ranging from 1 (strongly disagree) to 7 (strongly agree). This approach ensured a consistent methodology across different domains, with Cronbach's alpha coefficients for all the constructs falling between .82 and .90, underscoring a high level of internal consistency.

Robot anthropomorphism was assessed using a five-item scale developed by Bartneck et al. (2009), focusing on anthropomorphic and aesthetic attributes pertinent to robot attractiveness in service settings; a Cronbach's alpha of 0.90 was obtained. "Social capability" evaluates the social interaction skills of service robots in the hotel industry and is operationalized through a five-item scale adapted from Bartneck et al. (2009) and refined by de Ruyter et al. (2005), with a reliability coefficient of 0.86. Performance expectancy was explored to understand its impact on information technology acceptance and usage, particularly regarding service robots in the hospitality industry. This construct was measured using a scale based on the extended unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. (2012), for which the Cronbach's alpha was 0.88. The construct of perceived importance was used to explore the significance individuals attribute to certain technology aspects, specifically in hospitality service robotics. This was operationalized using a six-item scale, drawing upon the works of Agarwal and Prasad (1998), Heerink et al. (2010), and Larcker (1981), and resulting in a reliability coefficient of 0.87. Luxury-technology fit was quantified using a three-item scale derived from Shin and Jeong (2022) to assess the congruence between technological advancements and hotel

Table 1. Descriptive statistics.

Items	Frequency	Percent
Gender		
Male	217	39.03%
Female	327	58.81%
Transgender Female	1	0.18%
Transgender Male	1	0.18%
Gender Variant/Non-Conforming	1	0.18%
Prefer not to answer	9	1.62%
Age		
Under 20	11	2.00%
21-30	92	16.79%
31-40	189	34.48%
41-50	130	23.72%
51-60	24	4.37%
Above 60	102	18.61%
Education		
Less than high school diploma	11	1.98
Senior high school	70	12.59%
Some college, but no degree	59	10.61%
Associates degree	30	5.40%
Bachelor's degree	317	57%
Master's degree	61	10.97%
Profession degree	3	0.54%
Doctorate	5	0.90%
Location		
Northern Taiwan	279	50.18%
Central Taiwan	121	21.76%
Southern Taiwan	146	26.26%
Eastern Taiwan	9	1.62
Outlying Islands	1	0.18

luxury experience, yielding a Cronbach's alpha of 0.82. Similarly, task-technology fit evaluated the alignment of technology with intended tasks based on a three-item scale influenced by the research of Wang et al. (2021), demonstrating a reliability of 0.85. Furthermore, we examined the intention to use robotic service in the hotel industry, which is a critical construct for understanding guest acceptance of robotic technology in service delivery. This was measured using a six-item scale, informed by the studies of Lin and Mattila (2021) and Barbarossa et al. (2015), and a Cronbach's alpha of 0.90 was obtained. Finally, anxiety toward robots was measured using a five-item scale based on Song and Kim (2022). It focused on the dynamics of human-robot interaction in retail service robots and its impact on consumer acceptance, reflected by a Cronbach's alpha coefficient of 0.84. Previous research has indicated a correlation between gender, age, and education with the intention to use robotic services (Chi et al., 2023; Said et al., 2024). Consequently, gender, age, and education were incorporated as control variables in the present study.

Common method variance

To address the potential issue of common method variance (CMV) in our research, we adhered to the guidelines proposed by Podsakoff et al. (2012). Their recommendations emphasize incorporating both procedural and post hoc statistical remedies to mitigate the risk of CMV. As part of our procedural methods, we ensured that the survey responses were collected anonymously. This approach was intended to reduce evaluation apprehension and social desirability bias, thereby diminishing the likelihood of common method bias. Additionally, the questionnaire was designed to ensure no items had inherently "correct" or "incorrect" answers. This strategy aimed to minimize the respondents' tendencies to provide socially desirable responses or to respond in a manner consistent with perceived researcher expectations. Furthermore, following the recent recommendations by Cooper et al. (2020), we utilized various statistical techniques to address concerns regarding CMV in post hoc statistical remedies. Specifically, we employed (a) Harman's single factor test and (b) a method factor modeling approach. For Harman's single-factor test, we performed an exploratory factor analysis on all items of our focal variables. This analysis identified the first factor accounting for 43% of the variance, which is below the 50% threshold, indicating that CMV is not a significant issue (Cooper et al., 2020). Furthermore, we applied Podsakoff et al. (2003) unmeasured common latent method factor technique by loading the items of our focal variables onto their respective latent factors and a latent common method variance factor. The model incorporating the additional method factor exhibited a better fit (χ^2 (69) = 98.97, SRMR = 0.033, RMSEA = 0.047, CFI = 0.980) compared to the hypothesized model (χ^2 (84) = 170.88, SRMR = 0.061, RMSEA = 0.073, CFI = 0.942). Nevertheless, the difference in CFI (ΔCFI = 0.038) was below the threshold of 0.050, as suggested by Bagozzi and Yi (1990), indicating that CMV is unlikely to influence our results significantly.

Results

Reliability and validity

Before initiating the structural equation modeling (SEM) analysis, it was essential to perform a confirmatory factor analysis (CFA) to ascertain the suitability of the measurement model. This involved employing a series of metrics suggested by Hair et al. (2010) to scrutinize the model and establish the validity of the scales. During this process, items with lower factor loadings were eliminated, specifically in performance expectancy and luxury-technology fit (see Table 2). For performance expectancy, the first and fourth items were removed. From the luxury-technology fit construct, the first item was excluded. Following the item deletion, the modified model underwent further overall model fit evaluation and tests for reliability and validity. The analysis indicated that the chi-square-to-degrees of freedom ratio was less than the recommended maximum of 3 (χ^2 = 314.738, *df* = 113; χ^2/df = 2.785). Additionally, critical indices such as the NFI (.90), TLI (.90), CFI (.95), IFI (.95), RFI (.96), and RMSEA (.07) were calculated, yielding results consistent with an acceptable model fit (Hair et al., 2010). The reliability of the measurement scales was also evaluated using Cronbach's alpha and composite reliability (CR). In this study, the construct coefficients ranged from 0.82 to 0.91, while the composite reliability (CR) values surpassed the 0.7 threshold, aligning with Nunnally's (1994) criteria for reliability. Convergent validity was assessed through the average variance extracted (AVE) values, which spanned from 0.66 to 0.83, exceeding Hair et al. (2010) recommended minimum of 0.50. These results indicate that the measurements exhibit satisfactory convergent validity

Table 2. Confirmatory factor analysis results.

Constructs and items	Mean	S.D.	Factor loadings	CR	AVE
Robot Anthropomorphism				.90	.63
Fake ———————– Natural	3.92	1.41	.78		
Mechanical ———————– Humanlike	4.07	1.49	.81		
Unconscious ———————– Conscious	3.80	1.48	.76		
Artificial ———————– Livelike	3.76	1.54	.83		
Moving rigidly ———————– Moving elegantly	3.92	1.47	.79		
Social Capability				.86	.56
The hotel service robot appears to listen attentively.	5.18	1.08	.75		
The hotel service robot appears to say appropriate things.	5.29	1.00	.81		
The hotel service robot listens without interrupting when the customer is talking.	5.35	1.07	.74		
The hotel service robot seems to remember the detailed information about the customer's questions.	5.26	1.06	.72		
The hotel service robot appears to be polite.	5.46	1.02	.72		
Social Presence				.90	.66
Interacting with the hotel service robot feels like talking to a real person.	4.93	1.20	.78		
Sometimes, the hotel service robot seems to look at a person.	4.87	1.26	.81		
I can imagine the hotel service robot as a living creature.	4.74	1.30	.75		
I often think the hotel service robot is a real person.	4.47	1.41	.88		
Sometimes, the hotel service robot seems to have real feelings.	4.42	1.44	.82		
Performance Expectancy				.83	.62
The hotel service robot will improve the quality of the hotel stay.	5.14	1.15	.79		
The hotel service robot will allow me to access service faster.	5.34	1.12	.79		
Overall, the hotel service robot will be useful during the hotel stay.	5.45	0.97	.76		
Perceived Importance				.87	.53
It is essential to have service robots at the hotel front desk.	5.15	1.11	.76		
It is essential to have service robots for a concierge.	5.14	1.20	.77		
It is essential to have service robots for bell/room service.	5.30	1.19	.75		
It is essential to have service robots to clean the room.	5.14	1.23	.69		
It is essential to have service robots as a server.	5.13	1.05	.78		
It is essential to have service robots to carry the baggage.	5.59	1.11	.59		
Luxury-Technology Fit				.78	.64
The technological functions of the hotel service robot seem appropriate technology for the hotel brand.	5.32	1.04	.81		
The image of the hotel service robot seems to match with the hotel brand image.	5.29	1.09	.80		
Task-Technology Fit				.85	.65
The technologies' functions of the hotel service robot seem sufficient in helping me to complete my service needs.	5.30	1.01	.83		
The technologies functions of the hotel service robot seem appropriate in helping me to stay at the hotel.	5.44	1.03	.79		
In general, the technological functions of the hotel service robot seem fully meet my service needs in a hotel stay.	5.27	1.09	.80		
Intention to Use Robotic Service				.90	.60
Next time I visit a hotel, I will consider staying at a hotel with service robots.	5.21	1.13	.79		
I welcome the adoption of service robots in hotels.	5.39	1.13	.82		
I predict that I will frequently use robot service at a hotel in the near future.	5.29	1.19	.79		
I would accept service robots serving me at a hotel because it will be the norm in the future.	5.43	1.14	.79		
I do not mind a service robot serving me over a human service employee.	5.37	1.20	.74		
I am willing to adapt to using service robots in hotels, as they will greatly reduce human contact.	5.29	1.17	.73		

(Table 2). As shown in Table 3, the squared root of AVEs and the correlations among constructs were compared to establish discriminant validity (Fornell & Larcker, 1981). The findings demonstrated that the correlations among the constructs were lower than the squared root of the AVE values, thus confirming discriminant validity.

Table 3. Means, standard deviations, correlations, and reliability.

Variables	Mean	S.D.	1	2	3	4	5	6	7	8
1. Robot anthropomorphism	3.90	1.24	0.77							
2. Social capability	5.31	0.84	0.46***	0.77						
3. Performance expectancy	5.31	0.89	0.49***	0.75***	0.79					
4. Perceived importance	5.24	0.89	0.45***	0.66***	0.79***	0.93				
5. Luxury-technology fit	5.25	0.93	0.46***	0.65***	0.70***	0.72***	0.88			
6. Task-technology fit	5.34	0.91	0.40***	0.71***	0.74***	0.73***	0.78***	0.83		
7. Intention to use robotic service	5.33	0.95	0.42***	0.65***	0.74***	0.74***	0.77***	0.80***	0.77	
8. Anxiety toward robots	4.41	1.08	−0.19***	−0.18***	−0.18***	−0.08***	−0.14***	−0.13***	−0.18***	0.77

$n = 556$. ***$p < 0.001$. The diagonal data is the values of the square root of AVE.

Hypothesis testing

To validate the hypotheses, we employed Mplus 8.4, a robust tool for structural equation modeling (SEM) (Muthén & Muthén, 2017). To ensure the robustness of our findings, bootstrapping was performed with 2000 iterations, leveraging the bootstrapping maximum likelihood (ML) method and thereby enhancing the reliability of our results. The model demonstrated an excellent fit with the data, as evidenced by the goodness-of-fit indices ($\chi^2 = 513.215$, $df = 196$, $\chi^2/\text{df} = 2.618$; CFI = 0.952; TLI = 0.943; IFI = 0.952; RMSEA = 0.062), which indicated that the model was appropriate for testing the proposed hypotheses. Table 2 and Figure 2 visualizes the hypotheses testing results. Specifically, H1 posited that robot anthropomorphism positively impacts social capability. This hypothesis was supported ($\beta = 0.61$, $p < 0.001$), indicating that the human-like characteristics of service robots significantly enhance their perceived social capabilities. H2 suggested that robot anthropomorphism positively influences performance expectancy. The results endorsed this hypothesis ($\beta = 0.65$, $p < 0.001$), indicating that anthropomorphic traits in robots lead to higher expectations regarding their performance. H3 proposed that robot anthropomorphism has a positive effect on perceived importance. The data supported this hypothesis ($\beta = 0.61$, $p < 0.001$), indicating

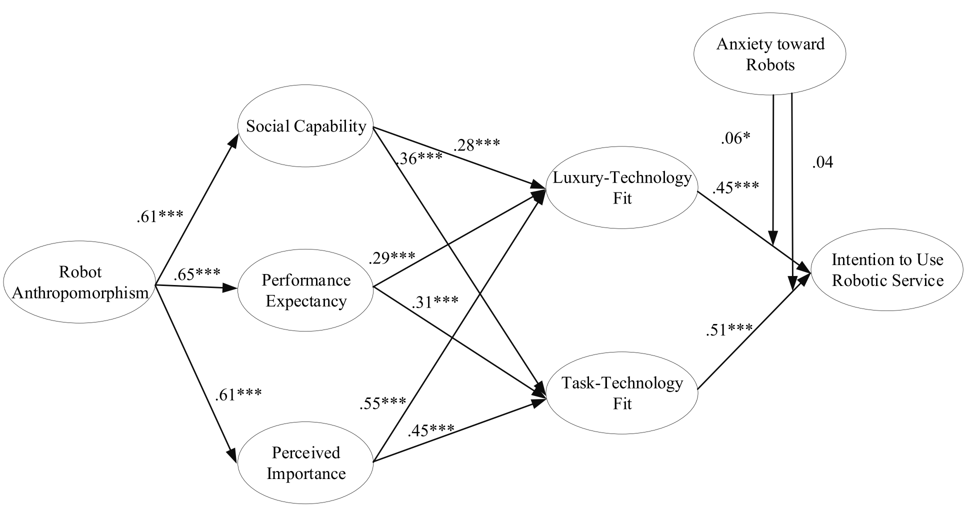

Figure 2. Hypotheses testing results.

that the human-like features of robots are crucial in shaping guests' perceptions of the importance of these robots in enhancing their overall service experience.

The full mediation model revealed significant standardized path coefficients between social capability and luxury-technology fit ($\beta = 0.28$, $p < 0.01$), as well as between luxury-technology fit and intention to use robotic service ($\beta = 0.45$, $p < 0.01$). This finding supports H4 and suggests that luxury-technology fit has a noteworthy indirect effect of .12 (95% confidence interval: [.06, .22]). Additionally, we calculated the standardized path coefficients between performance expectancy and luxury-technology fit ($\beta = .29$, $p < 0.01$). H5 was supported by the indirect effect of .15 (95% confidence interval: [.03, .31]) between performance expectancy and the intention to use robotic service through luxury-technology fit. Similarly, the standardized path coefficients between the perceived importance and luxury-technology fit were calculated ($\beta = .55$, $p < 0.01$). H6 was supported by the indirect effect of .29 (95% confidence interval: [.16, .46]) between the perceived importance and intention to use robotic service through luxury-technology fit.

The standardized path coefficients linked social capability with task-technology fit ($\beta = 0.36$, $p < 0.01$) and the task-technology fit with the intention to use robotic services ($\beta = 0.51$, $p < 0.01$). These results substantiate H7, indicating that the congruence between task-technology fit exerts a significant indirect influence of .18 (95% confidence interval: [.10, .29]). Furthermore, the analysis revealed standardized path coefficients between performance expectancy and the congruence of task-technology fit ($\beta = .31$, $p < 0.01$). H8 is supported by the indirect influence of .18 (95% confidence interval: [.06, .33]) on the intention to use robotic services, mediated by task-technology fit. In a similar vein, the standardized path coefficients between perceived importance and task-technology fit were significant ($\beta = .45$, $p < 0.01$). H9 is corroborated by an indirect effect of .27 (95% confidence interval: [.15, .44]) on the intention to use robotic services, mediated through task-technology fit. Tables 4 and 5 summarize these direct and indirect effects.

To test the hypothesized latent interactions, we employed the latent moderated structural equations (LMS) approach, which enhances model power, reduces bias in estimates, and allows for the estimation of latent interaction effects (Cheung et al., 2021; Maslowsky et al., 2015). It is worth noting that the LMS approach has been increasingly adopted in recent research to test moderating effects within the SEM framework. Studies such as Wallace and Coughlan (2023), Pan et al. (2024), and Lin and Chang (2024) have successfully employed this method to examine moderating relationships in various contexts, demonstrating its growing acceptance and relevance in the field. Following the LMS procedure, the first step involved conducting a confirmatory factor analysis (CFA) to estimate a measurement model, thereby assessing the construct validity of latent variables. This was done using the maximum likelihood estimator with robust standard errors (MLR). The second step was to estimate the baseline model that excludes the latent interaction effect to establish baseline fit indices. Next, in the third step, we incorporated the latent interaction term and compared this model to the baseline model via the loglikelihood difference test ($\Delta -2LL$; Maslowsky et al., 2015). A significant change in the loglikelihood after adding the interaction effect indicates that the model containing the interaction term is preferable over the baseline model. Finally, in the fourth step, we interpreted the interaction effects by using bootstrapping methods to generate confidence intervals for the slopes.

The results indicated that the measurement model which revealed a good fit to the data (χ^2 [499] = 1029.433, $p < 0.001$; CFI = 0.94, TLI = 0.93, RMSEA = 0.04, SRMR = 0.04). All

Table 4. The results of the direct effects.

Path	Direct effect
Social Capability–>Luxury-Technology Fit	0.27***
Performance Expectancy–>Luxury-Technology Fit	0.29***
Perceived Importance–>Luxury-Technology Fi	0.54***
Social Capability–>Task-Technology Fit	0.37***
Performance Expectancy–>Task-Technology Fit	0.34***
Perceived Importance>Task-Technology Fit	0.47***
Luxury-Technology Fit–>Intention to Use Robotic Service	0.47***
Task-Technology Fit–>Intention to Use Robotic Service	0.50***

$n = 556$. ***$p < 0.001$.

factor loadings for the eight constructs were significant ($p < 0.001$), indicating robust construct validity. Then, we estimated the proposed baseline model without the interaction term, which also demonstrated adequate fit (χ^2 [514] = 1570.194, $p < 0.001$; CFI = 0.93, TLI = 0.93, RMSEA = 0.05, SRMR = 0.05). Next, we included the interaction term in the model. The comparison of loglikelihood values between the baseline and interaction models yielded TRd ($df = 1$) = 4.51 ($p = 0.03$), signifying a significant improvement in model fit with the addition of the interaction term. This allowed us to proceed with estimating the structural model that includes latent interactions for hypothesis testing.

The coefficient for the interaction term between luxury-technology fit and anxiety toward robots exhibited a positive and statistically significant association with the intention to use robotic service (β=.06; $p < 0.05$). The results showed that anxiety toward robots strengthens the positive effect of luxury-technology fit on intension to use robotic. Moreover, we plotted the moderating effect with the Johnson-Neyman technique (Johnson & Neyman, 1936). Figure 3 reveals that the higher the level of anxiety toward robots, the higher the positive effect of luxury-technology fit on the intention to use robotic service. Furthermore, the moderating effect of anxiety toward robots insignificantly influenced the impact of task-technology fit on intention to use robotic services (β=.04; $p > 0.05$). Thus, H10 was supported, but H11 was not supported.

Table 5. The results of indirect effect.

				Bias-corrected 95% CI		Percentile 95% CI		
Hypothesis	Path	Estimates	Standard error	Lower	Upper	Lower	Upper	Result
H4	Social Capability–>Luxury-Technology Fit–>Intention to Use Robotic Service	0.12***	0.04	0.06	0.22	0.06	0.2	Support
H5	Social Capability–>Task-Technology Fit–>Intention to Use Robotic Service	0.15***	0.07	0.03	0.31	0.03	0.3	Support
H6	Performance Expectancy–>Luxury-Technology Fit–>Intention to Use Robotic Service	0.29***	0.08	0.16	0.46	0.15	0.46	Support
H7	Perceived Importance–>Luxury-Technology Fit–>Intention to Use Robotic Service	0.18***	0.05	0.1	0.29	0.1	0.28	Support
H8	Social Capability–>Task-Technology Fit–>Intention to Use Robotic Service	0.18***	0.07	0.06	0.33	0.05	0.31	Support
H9	Performance Expectancy–>Task-Technology Fit–>Intention to Use Robotic Service	0.27***	0.07	15	0.44	0.15	0.43	Support

$n = 556$. ***$p < 0.001$.

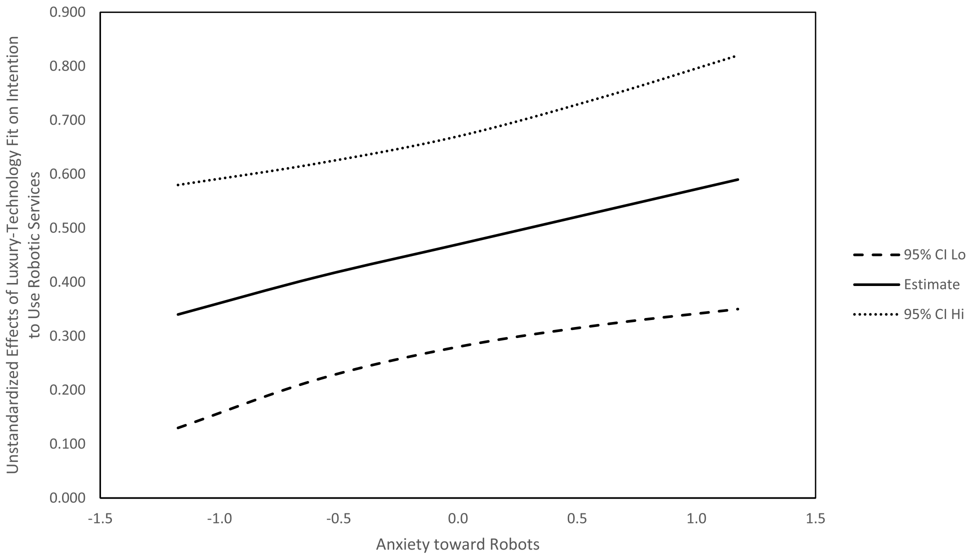

Figure 3. Unstandardized effects of luxury-technology fit on intention to use robotic service with the moderating effect of anxiety toward robots.

Robustness checks

In this study, we conducted robustness checks to revalidate the findings, thereby enhancing the credibility and generalizability of our results. The robustness checks involved collecting an additional sample, this time from the U.S., to test the applicability of our model in a different cultural context. We recruited adults from Connect, an online source of high-quality participants by CloudResearch. We paid respondents $2 for a survey we expected to take about 10 minutes. Respondents were eligible for a bonus of up to 50 cents if they provided additional text responses in the survey. All respondents were 18 years or older and were U.S. residents. Finally, 551 valid U.S. adults were collected. This approach not only allowed us to reexamine the validity of our statistical indicators, such as NFI, TLI, CFI, IFI, RFI, and RMSEA, but also to assess the generalizability of our findings across diverse cultural settings.

The results of this validation exercise were quite revealing. The American sample exhibited the same patterns as did the original Taiwanese sample, underscoring the consistency of our findings across distinct cultural landscapes, and the model fit was also high (NFI=.90, TLI = .91 CFI = .92, IFI = .92, RFI = .88 and RMSEA = .07). This congruence suggests that the constructs and relationships examined in our study hold true beyond the initial cultural context, providing a robust foundation for the theoretical and practical implications of our research. The similarity between the outcomes of the American and Taiwanese datasets not only reaffirms the validity of our model but also significantly strengthens its external validity, thereby enhancing its relevance and applicability in a global context.

Discussion

Based on the ECT and dual-congruity perspectives, this study has substantiated a series of hypotheses concerning the role of robot anthropomorphism in the context of luxury hotels.

First, the positive influence of robot anthropomorphism on social capability, performance expectancy, and perceived importance delineates the pivotal role of anthropomorphic features in enhancing the perceived social and functional competencies of robots in hotel settings. This finding aligns with the findings of existing literature that underscore the importance of anthropomorphic design in fostering user engagement and satisfaction (Tsai et al., 2021).

Furthermore, the mediating effects of both luxury-technology fit and task-technology fit on the effects of social capability, performance expectancy, and perceived importance the intention to use robotic services are particularly noteworthy. These findings suggest that the congruence between robotic technology and both the luxury ambiance of the hotel and the tasks the robot is designed to perform is crucial for positive user intentions. This finding aligns with dual congruity theory, which posits that both fit with user tasks and the broader contextual environment significantly influence technology acceptance (Wang & Papastathopoulos, 2023).

Significantly, the study also revealed that anxiety toward robots not only exists but also strengthens the relationship between luxury-technology fit and the intention to use robotic services. This finding suggests a nuanced dynamic in luxury hotel settings where, even if guests experience anxiety toward robots, a strong alignment between the high-end nature of the service environment and the technological sophistication of the robots can positively influence their intention to use such services. This finding contributes to the existing body of knowledge by highlighting the complex interplay between user emotions and technology-environment fit in shaping technology acceptance behaviors (Akdim et al., 2023).

Theoretical implications

First, by integrating ECT and DCT, this study examined the mechanisms by which robot anthropomorphism at luxury hotels leads to the formation of luxury hotel customers' use intention toward robotic service. This study is one of the first attempts to conceptualize and examine robot anthropomorphism, explicitly focusing on luxury hotels (Gonçalves et al., 2024; Shin & Jeong, 2022). Unlike the past hospitality robot research on emphasizing the task-technology fit for designing the functional aspects of service robots (e.g., Tavitiyaman et al., 2022), this study proved the essential of emphasizing luxury-technology fit for designing service robot anthropomorphism for luxury hotels. We highlight the importance of anthropomorphism for designing robots at luxury hotels because luxury hotel customers desire warm social interactions and human touch, even when interacting with smart technology (Baudier et al., 2023; Shin & Jeong, 2022). The findings of this study can direct the traditional task-oriented investigation of technological design for service robots to a new path of luxury-oriented technology design for luxury hotels' robots.

Moreover, the findings of this study offer a novel extension to the ECT by revealing that robot anthropomorphism transcends the traditional cognitive domain of performance expectations to influence the social and symbolic aspects of service interactions (Bhattacherjee, 2001; Venkatesh & Davis, 2000). Anthropomorphic features are demonstrated to enhance social capabilities, performance expectancy, and perceived importance, which indicates that expanding ECT to include affective and relational dimensions within service robotics is imperative. This broadens the ECT framework, traditionally confined to postage evaluations, to preemptively include design elements that can positively influence user satisfaction and acceptance. In the realm of DCT, this study provides empirical substantiation of the mediating roles of luxury-technology fit and task-technology fit within a luxury service context. This finding endorses a nuanced perspective of DCT, advocating for a model that incorporates the intricacies of technology attributes with the luxuriousness of the service environment. The findings suggest that customer acceptance is intricately tied to this dual alignment, necessitating a sophisticated approach to understanding and implementing technology congruent with the task requirements and the overarching service milieu.

Additionally, the study's insights into the dynamics of robot anxiety posit a counter-intuitive theoretical contribution to the technology acceptance literature. The finding that anxiety may amplify the intention to use robotic services under a pronounced luxury-technology fit suggests that traditional models where negative emotions are viewed as barriers to acceptance should be reevaluated (Song & Kim, 2022; Zhu et al., 2023). This suggests that under specific conditions, such as in the presence of solid congruence with the luxury context, anxiety can catalyze rather than inhibit engagement, revealing a complex emotional interplay that demands further scholarly attention. Finally, the implications for anthropomorphic design are underscored by the positive impacts of robot anthropomorphism on consumer experience dimensions. This study enriches the literature by offering empirical evidence of the advantages of imbuing robots with human-like features. These characteristics can significantly enhance both functionality and social interaction within the service encounter, which highlights the critical role of anthropomorphic design in the strategic deployment of robotic services in the hospitality sector.

Practical implications

The integration of anthropomorphic service robots in the hospitality industry has profound implications for hotel practitioners in several key areas, as evidenced by recent findings. First, considering the positive influence of anthropomorphism on social capabilities, performance expectancy, and perceived importance, robots with human-like features such as expressive facial expressions, natural language processing, and gestures must be incorporated (Ladeira et al., 2023). This approach can significantly enhance guest interactions and satisfaction, as customers tend to respond more positively to human-like entities. However, it is important for hotel practitioners to consider the balance between human-likeness and functionality. While anthropomorphism can enhance performance importance, it is crucial to avoid the uncanny valley effect, where robots that appear almost human can elicit feelings of discomfort (Lin et al., 2022). Therefore, the design of service robots should balance human-likeness and functionality to optimize performance importance and guest comfort. Second, the enhanced perception of the performance importance attributed to these robots by guests highlights the need for the strategic deployment of these robots in critical service areas. Hotel practitioners should consider the types of tasks assigned to robots, as research suggests that emotional-social tasks are better suited for highly human-like service robots, which can mitigate the adverse effects that may arise from their use (Lin et al., 2022). This indicates that service robots in hotels could be strategically deployed in roles that require social engagement, such as greeting guests or providing information, rather than just mechanical tasks. In addition, hotel staff should be trained to seamlessly integrate robot services with traditional human services, creating a cohesive and efficient guest experience.

The mediating effect of the concept of luxury-technology fit on the relationships between various factors (social capability, performance expectancy, and perceived importance) and the intention to use robotic services has several practical implications for hotel practitioners, especially those in the luxury segment. Because the congruence between luxury service expectations and technological innovations is a critical factor, hotel managers should focus on integrating robotic services that align with the high standards and unique ambiance of luxury hospitality (Belanche et al., 2021; Seyitoğlu & Ivanov, 2021). This involves selecting and customizing robotic technologies that not only perform efficiently but also embody luxury in their design, interaction quality, and service delivery. For instance, robots employed in luxury hotels should have sophisticated, elegant designs and offer personalized, high-end service experiences that resonate with the expectations of luxury clientele. Additionally, marketing strategies should emphasize how these technologically advanced services enhance the luxury experience rather than replace the human touch to appeal to guests who value both innovation and exclusivity. By ensuring a harmonious blend of high-tech capabilities with the bespoke nature of luxury hospitality, hoteliers can effectively enhance guest satisfaction and drive greater intentions to use robotic services, thereby maintaining a competitive edge in the luxury hotel market.

The findings that task-technology fit mediates the effects of social capability, performance expectancy, and perceived importance on the intention to use robotic services provide essential insights for hotel practitioners. This emphasizes the necessity for a strategic alignment between the capabilities of service robots and the specific tasks they are intended to perform in a hotel setting. Hotel managers should prioritize the selection and implementation of robots based on their compatibility with and effectiveness in fulfilling specific service tasks. For instance, robots with high social capability are best suited for guest-facing roles, such as reception or concierge services, where interpersonal interactions are key. Performance expectancy should match the complexity and demands of the tasks; simpler tasks could require basic robotic solutions, whereas more complex services could benefit from advanced robotic technologies. Furthermore, understanding the perceived importance of these tasks by guests can guide the allocation of robotic resources to areas with the highest impacts on guest satisfaction (Alma Çallı et al., 2023). Regular training and updates for both staff and technology are crucial for maintaining an optimal task-technology fit. By ensuring that robotic services are technologically advanced, contextually relevant, and guest-centric, hotel operators can significantly enhance the efficiency of their services and improve the overall guest experience, thereby encouraging greater intentions to use these services.

The finding that anxiety toward robots moderates the relationship between luxury-technology fit and the intention to use robotic services, particularly given that this relationship strengthens when anxiety is high, offers critical insights for hotel practitioners, especially in the luxury segment. Luxury hotels that are good at securing luxury-technology fit for their robots can target customers who are anxious about robots and can predict an overall win of use intention from these anxious customers. Luxury hotels should focus on introducing robotic technology that is reassuring and aligned with luxury service expectations. This can be achieved through several strategies. First, introducing robots should be gradual and accompanied by thorough guest education about their functionality and safety features (Lin et al., 2020) and clear communication about how these robots enhance the luxury experience. Second, ensuring that the robots' design and interaction style complement the luxury ambiance can help make the robots less intimidating and more appealing (Shin & Jeong, 2022). Training hotel staff to assist and guide guests in interacting with robots can further improve user experience.

Limitations and future work

Concentrating on a high-end service milieu may not encapsulate the intricate dynamic characteristics of other hospitality sectors, where cost efficiency and less emphasis on luxury fundamentally alter service delivery and consumer expectations. Given the mercurial nature of technological evolution, the robotic services appraised herein may not represent the vanguard of emerging advancements. The anticipated obsolescence of current robotic designs necessitates continuously reassessing consumer responses to nascent robotic functionalities that supersede those evaluated in this study. Moreover, the presupposed level of anthropomorphism in current robotic services is a variable of profound significance. Deviations in anthropomorphic design features could lead to disparate consumer reactions, particularly concerning social capabilities, performance expectancy, and perceived importance. Future research must, therefore, encompass a broader spectrum of the hospitality industry, including but not limited to budget accommodations, resorts, and varied service contexts, to ascertain the transferability and robustness of the initial findings.

On the other hand, investigations into the ramifications of the evolving design attributes of service robots for consumer acceptance are imperative. As technological advancements furnish increasingly sophisticated service robots, their acceptance and integration into the consumer experience will warrant methodical and dynamic analysis. Such future endeavors will validate the extant findings and enrich the discourse on anthropomorphic design in robotic services, ensuring relevance and applicability in an ever-advancing technological landscape. Finally, we suggest future studies to examine the moderating effects of luxury-technology fit and task-technology fit on improving use intention. Scholars may take another theoretical perspective to explore how the fit types would leverage the formation of use intentions.

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