IEEE Access
Multidisciplinary : Rapid Review : Open Access Journal

Received 14 May 2024, accepted 8 July 2024, date of publication 29 July 2024, date of current version 13 August 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3434544

RESEARCH ARTICLE

A Multi-Faceted Examination of Social Robots Adoption: Influences of Perceived Enjoyment, Social Attraction, and Pet Experience

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This work was supported in part by the Ministry of Education of the Republic of Korea, and in part by the National Research Foundation of Korea under Grant NRF-2020R1A2C1006001.

This study was conducted in accordance with the guidelines of the Declaration of Helsinki. The research subject is unspecified, and the information collected through the research does not contain sensitive information in accordance with Article 23 of the Personal Information Protection Act of Korea and is exempted from IRB review.

ABSTRACT This research undertakes a thorough investigation into the adoption of social robots, an emerging field of significance as these technologies become more ingrained in daily life. By focusing on critical aspects that shape social robot adoption, this study illuminates the key determinants that influence user intentions. Using partial least squares structural equation modeling (PLS-SEM), the model was analyzed through a significant sample of potential users. The study revealed that human-like qualities such as appearance and behavior play a vital role in perceived enjoyment and social attraction. Furthermore, these factors positively affected perceived value, significantly steering adoption intention. Interestingly, privacy risk increased overall privacy concerns, yet it had no substantial effect on perceived value. Additionally, prior experience with pets was found to negatively influence the relationship between the social robot's appearance and social attraction, providing unique insights that have valuable implications for various industry stakeholders.

INDEX TERMS Social robots, adoption intention, perceived value, privacy risk, pet experience.

I. INTRODUCTION

The technological landscape has witnessed a significant shift with the advent and swift advancement of social robots, essentially redefining the nature of the interaction between humans and machines [1]. These robots, bestowed with abilities to mimic human-like communication and social engagement, have been engineered to serve in diverse domains [2]. Social robots are integrated into various environments such as healthcare where they aid in patient care [3], education where they serve as learning tools [4], entertainment where they provide interactive amusement [5], and domestic assistance where they help with routine chores [6]. As these social robots permeate more into our everyday lives, their acceptance and use have become pivotal areas of interest. Given their expanding influence, it is crucial to delve into the understanding of what drives individuals to adopt these robots.

Humanlike appearance, behavior, and facial expressions play a significant role in the perception and adoption of social robots [7], [8], [9]. Robots that closely resemble humans in their conduct and expressions can foster a sense of familiarity, thus facilitating a smoother interaction process [10]. This resemblance can help to bridge the gap between humans and machines, increasing the acceptance and perceived value of these robots among potential users.

Furthermore, the feelings evoked by interacting with social robots, such as perceived enjoyment and social attraction, are key determinants of user adoption [11], [12]. These

The associate editor coordinating the review of this manuscript and approving it for publication was Claudio Loconsole.

subjective experiences can lead to increased user engagement and favorability, thereby contributing significantly to the adoption intention of social robots [13]. Consequently, examining these factors provides a comprehensive understanding of the user's perspective on social robots.

Privacy concerns, particularly those related to sensor-related privacy risks and overall privacy risks, are increasingly important factors in the use of social robots [14]. As these robots are equipped with cameras, microphones, and sensors to interact with humans, they potentially pose privacy threats that may dissuade users from adopting them [15]. Hence, a thorough examination of these risks is crucial in understanding user attitudes and intentions toward social robots.

Another crucial element in this exploration is the potential moderating effect of the user's previous pet ownership experience. A person's history of interaction with pets could influence their expectations and interactions with social robots, thereby affecting their adoption intention [16].

Despite existing literature on social robots, there are gaps in understanding the interplay between various factors influencing the adoption intention, such as humanlike features, emotional responses, privacy concerns, and personal experience. This paper aims to address these gaps by providing a comprehensive framework that captures the complexity of factors influencing the adoption of social robots. It brings novelty by including the often overlooked factor of pet ownership experience as a potential moderator. The objective of this research is to provide a holistic understanding of the interplay between these factors, thereby contributing to the existing body of knowledge and informing the design and marketing strategies of social robots.

The subsequent sections of this paper are systematically structured as follows: The upcoming section provides an exhaustive review of relevant literature. This is followed by Section III, where we formulate the proposed hypotheses. In Section IV, the research methodology, inclusive of elements like instrument creation, data sampling, and data analysis procedures, is meticulously described. The empirical findings are shared in Section V, and a detailed discussion of these findings is held in Section VI. Finally, in Section VII, the paper draws to a close by discussing the theoretical implications, practical applications, limitations of the study, and potential avenues for future research.

II. LITERATURE REVIEW

A. SOCIAL ROBOT

The realm of social robots has been a burgeoning field of study over the past few decades. Social robots are defined as autonomous or semi-autonomous robots that interact with humans by following social behaviors and rules attached to their roles [17]. These robots extend beyond the utilitarian purpose of typical machinery, aiming to engage in personal and meaningful interactions with people. The literature concerning social robots has underscored their applications across a myriad of contexts. In healthcare settings, social robots have demonstrated the potential in promoting physical and cognitive rehabilitation [3], offer companionship to the elderly [18], and provide support for children with autism [19], [20]. Educational settings have also leveraged social robots as teaching tools to facilitate learning and engagement [21]. In domestic environments, social robots have been used for companionship and assistance with daily tasks [22].

Current research trajectories in the field of social robotics are characterized by a broad spectrum of endeavors, which are primarily categorized into three significant streams. The first stream emphasizes mechanical design, wherein the focus is on refining the actuators responsible for the fluidity and naturalness of the robot's manual and facial movements. This stream endeavors to transcend the traditional mechanical paradigm, enhancing the robots' physical interaction capabilities to mirror the subtlety and complexity of human gestures and expressions.

Concurrently, there exists a substantial body of research dedicated to the computational aspects of social robotics, particularly the processing and analysis of data accrued from interactions with users. Here, the dialogue logs and behavioral patterns constitute a repository from which machine learning algorithms can derive nuanced behavioral models. These models are pivotal for the iterative refinement of the robots' interactive faculties, ensuring that each subsequent interaction is a more attuned and context-aware exchange.

The third research avenue investigates the attributes of social robots that influence their acceptance across various domains. This strand of research is predicated on the premise that different settings necessitate distinct robotic characteristics for successful integration. By discerning these differential factors, researchers aspire to tailor social robots to meet the exigencies of specific environments, thereby promoting a seamless integration into the fabric of those domains.

In our research, we are delving into the collective acceptance of social robots by the individuals. This study focuses on the essence of day-to-day human-robot interactions, aiming to identify the underlying motivations that drive people to incorporate these robots into their everyday lives. By methodically analyzing the psychological foundations and various social dynamics behind this acceptance, our goal is to identify the essential factors that make social robots appealing to individuals. Our research seeks to foster a harmonious relationship between humans and robots, characterized by engaging and beneficial interactions.

B. ANTHROPOMORPHISM OF SOCIAL ROBOTS

The humanlike nature of social robots has been an area of interest, with scholars studying various aspects such as their appearance, behavior, and facial expressions [7], [8], [23], [24], [25]. The anthropomorphic design of social robots has been linked to their acceptance, with robots designed to resemble humans more closely, being perceived as more sociable and likable [26], [27]. The importance of robot behavior and movement has also been highlighted, with more humanlike behaviors contributing to higher user engagement and acceptance [28], [29], [30]. The facial expressions of social robots have been linked to their perceived warmth and friendliness, affecting their social acceptance [10], [31], [32], [33], [34].

In the current study, we intend to explore the characteristics that influence the anthropomorphism of social robots, specifically focusing on their appearance, behavior, and facial expressions. To the best of our knowledge, there has been a paucity of research that concurrently examines these three attributes. This investigation is predicated on the hypothesis that a robot's external aesthetics, its behavioral repertoire, and the authenticity of its facial expressions significantly contribute to the degree to which individuals attribute human-like qualities to these mechanical entities. By integrating these variables, we aim to build a comprehensive understanding of the factors that facilitate a more natural and relatable interaction between humans and social robots.

C. EMOTIONAL RESPONSES FOR SOCIAL ROBOTS

Perceived enjoyment and social attraction are significant factors when considering the acceptance of new technology, especially in the context of social robots [12], [35], [36]. In the context of social robots, perceived enjoyment can be fostered by robots' engaging interactions, companionship features, and learning support. Social attraction, on the other hand, can be understood as the degree to which a user is attracted to a robot based on its social characteristics [11]. The social attributes of a robot, such as its appearance, behavior, and expressions, can influence its attractiveness and thereby shape users' attitudes toward it. Prior research suggests that people's willingness to interact with robots increases if they find the robots attractive and personable [37], [38].

In our research, we are examining the emotional responses to social robots from two distinct perspectives: the individual and the relational. On a personal level, we are looking into perceived enjoyment to understand how individuals derive pleasure and contentment from interacting with social robots. On the relational front, we are considering the notion of social attractiveness, evaluating how these robots are viewed in terms of their ability to establish and maintain social connections with users. By incorporating these two dimensions of emotional response, our study seeks to provide a multifaceted view of the affective reactions that social robots elicit, recognizing that these reactions are crucial in shaping the overall user experience and the future of human-robot interaction.

D. PRIVACY CONCERNS ARISING FROM SOCIAL ROBOTS

The adoption of social robots is not without challenges. Privacy concerns, particularly those related to sensors and data collection, have been identified as significant barriers to the acceptance of social robots [15], [39]. Privacy risk, particularly in the context of social robots, is a concern that is gaining significant attention in the academic literature. Social robots, often endowed with sensory systems to interact effectively with the environment and the users, raise important issues concerning the collection, use, and potential misuse of personal data [14]. Fernandes et al. [40] argued that the presence of robots in private spaces like homes could lead to an invasion of privacy, as these robots may collect and store sensitive information. This concern is especially prominent when social robots are equipped with video and audio recording capabilities, which can potentially monitor and document personal and intimate details of individuals' lives [41]. Thus, understanding and addressing privacy risks is a significant factor influencing the adoption of social robots, requiring careful consideration and investigation. In this study, to more accurately explore the effects of privacy risk, we introduce sensor-related privacy risk (particularly pertaining to microphones and cameras) as well as the general privacy risk.

E. TRANSFERENCE OF PET EXPERIENCE

Human-animal interaction studies have consistently shown that people form strong emotional bonds with their pets, often viewing them as family members or close companions [42]. This human-animal attachment has profound psychological implications, influencing people's emotional well-being, stress levels, and social interactions [43]. The attachment theory, initially proposed by Bowlby [44], posits that humans have an innate tendency to form strong emotional bonds with others, which is an essential part of our survival and well-being. This theory has been extended to human-pet relationships, explaining the deep emotional connection and bonding between humans and their pets [45]. These psychological bonds and attachment behaviors in human-animal interactions can provide valuable insights into the technology adoption process, specifically in the context of social robots. For instance, Melson et al. [16] suggested that people may transfer their pet-related attitudes and behaviors to robotic pets. Additionally, Epley et al. [46] posited that people tend to anthropomorphize non-human entities, attributing human-like characteristics, motivations, or emotions to them, influencing their acceptance and adoption. Drawing from the attachment theory and the psychological mechanisms at play in human-animal interactions, it is reasonable to hypothesize that pet experience could play a moderating role in the adoption of social robots. People with pet experience may be more inclined to form attachments with social robots and perceive them as more appealing and enjoyable, potentially leading to increased adoption intentions. Given the context of this study centers around domestic usage of social robots, we introduce pet experience as a moderating variable that could potentially shape user perceptions concerning the appearance, behavior, and facial expressions of social robots.

III. CONCEPTUAL MODEL AND RESEARCH HYPOTHESES

The research model, depicted in Figure 1, presents a comprehensive structure that outlines the relationships among key

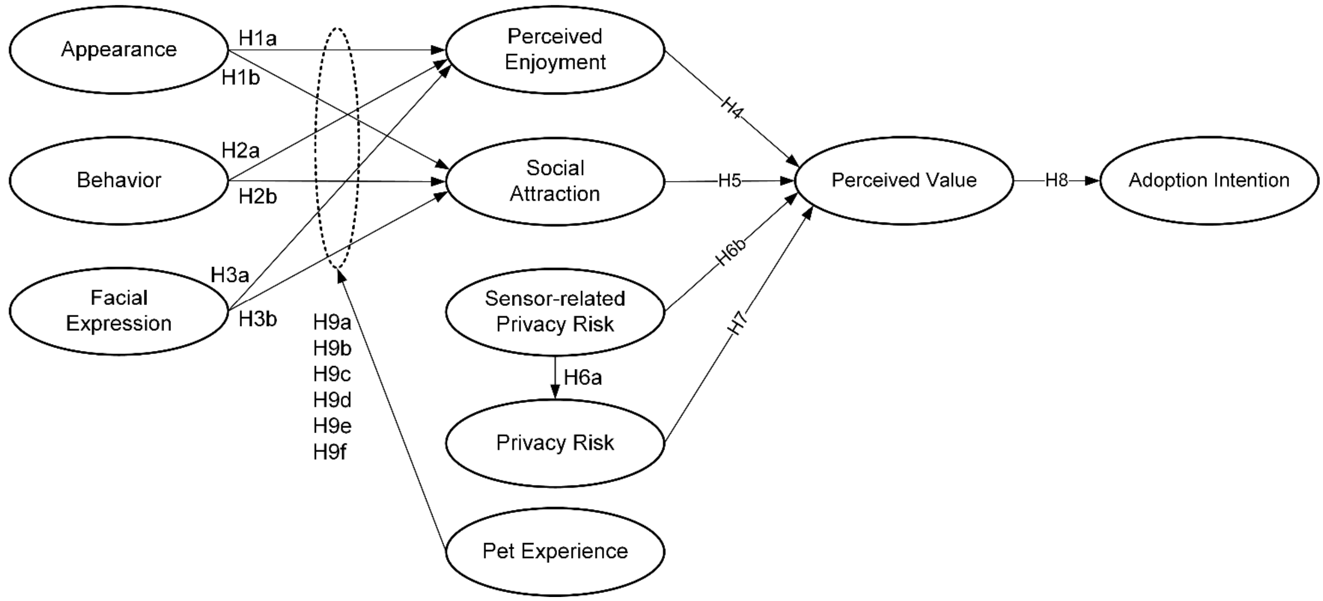

FIGURE 1. **Analytical model.**

constructs in this study. Beginning with three primary predictors: humanlike appearance, humanlike behavior, and facial expressions, their effects on perceived enjoyment and social attraction are examined. Next, these factors are posited to influence perceived value, which subsequently impacts adoption intention. Additionally, sensor-related privacy risks and general privacy risks are introduced to scrutinize their potential effects on perceived value. Lastly, the model encapsulates the pet experience as a moderator, aiming to elucidate its role in shaping the relationships between humanlike appearance, humanlike behavior, facial expressions, and perceived enjoyment.

A. APPEARANCE

The human-like appearance of social robots is the degree to which a robot resembles a human in terms of physical attributes [7]. Research has suggested that a robot's human-like appearance can enhance overall user enjoyment [35], [47]. In a study by Liu et al. [48], it was observed that robots perceived warm are favored in the hedonic-dominant service context. This indicates that the perceived enjoyment might increase when interacting with robots exhibiting human-like appearances. Waytz et al. [49] found that human-like robots were perceived as more socially attractive, compared to those with less human-like appearances. They suggested that the more a robot resembles a human, the higher the likelihood that people will perceive it as a social entity, thus increasing its social attractiveness. This study builds upon these findings and proposes the following hypotheses:

H1a. The human-like appearance of a social robot positively influences perceived enjoyment.

H1b. The human-like appearance of a social robot positively influences social attraction.

B. BEHAVIOR

The Human-like Behavior of a social robot is defined as the extent to which a robot mimics human actions and responses [7]. Wang et al. [30] found that when robots displayed behaviors like those of humans, it led to increased enjoyment and engagement among the users. This underlines the potential for perceived enjoyment to be positively influenced by human-like robot behavior. Reference [35] revealed a positive correlation between the anthropomorphism of robots and their perceived attractiveness. Their findings suggested that robots demonstrating human-like behaviors were regarded as more socially appealing. Therefore, it can be deduced that human-like robot behavior may enhance social attraction. Building upon this existing research, this study suggests the following hypotheses:

H2a. The human-like behavior of a social robot positively influences perceived enjoyment

H2b. The human-like behavior of a social robot positively influences social attraction.

C. FACIAL EXPRESSION

Facial expressions in social robots refer to the extent to which a robot can mimic human facial gestures to convey emotions and responses [31]. The positive effect of a social robot's facial expressions on perceived enjoyment has been underscored in multiple studies. One such study conducted by Leite et al. [50] reported that robots exhibiting emotional expressions significantly increased user enjoyment. It can thus be inferred that perceived enjoyment could be influenced positively by the facial expressions of social robots. Research has argued that the facial expressions of robots can evoke social attraction [34], [51], [52]. Niculescu et al. [37] found that emotional elements, such as voice pitch, humor, and empathy, can enhance the attractiveness of social robots. This implies that social attraction could be enhanced by the facial expressions of social robots. In light of these findings, this study puts forth the subsequent hypotheses:

H3a: Facial expressions of social robots positively influence perceived enjoyment

H3b: Facial expressions of social robots positively influence social attraction.

D. PERCEIVED ENJOYMENT

Perceived enjoyment refers to the degree to which the use of a specific system is deemed to be pleasurable and gratifying, independent of any performance outcomes arising from the utilization of the system [53]. Existing research literature substantiates that perceived enjoyment can influence the perceived value of a product or service positively [54], [55], [56]. Wang et al. [57] concluded that when users derive enjoyment from an interaction with a robot, they tend to perceive higher value from the experience. Hence, the perceived value may be positively influenced by perceived enjoyment. Thus, this study posits the hypothesis:

H4. Perceived enjoyment gained from utilizing a social robot positively influences the perceived value derived from it.

E. SOCIAL ATTRACTION

Social attraction is defined as the degree to which a person is attracted to interacting with a robot due to its social capabilities [58]. Existing research has suggested a rational basis for the positive relationship between social attraction and perceived value [11], [35], [38]. For example, McLean and Osei-Frimpong [11] provided evidence that social attraction to In-home AI assistants increases usage, indicating that users value AI artifacts more when they find them more attractive. This is due to the positive social cues that led to enhanced user experience and satisfaction. In the context of social robots, a similar mechanism can be assumed. The more socially attractive a robot is perceived to be, the higher the perceived value it provides to the user. Therefore, drawing from this body of research, this study proposes the hypothesis:

H5. Social attraction of a social robot negatively influences perceived value derived from it.

F. SENSORS-RELATED PRIVACY RISKS

Since social robots are equipped with sensors such as microphones and cameras, they can gather private information through audio and video channels [41]. It is crucial to shed light on privacy concerns associated with cameras and video [39]. Privacy risks associated with sensors could be one of the antecedent factors contributing to general privacy risks. Therefore, this study introduces the concept of privacy concerns specifically related to audio and video. This concept is introduced separately from general privacy concerns to examine more intricately the effects of such specific privacy concerns. Several authors found that the possibility of privacy infringement through audio or video recording devices increased the overall perceived privacy risk among users [59], [60]. This suggests that privacy risk through audio or video is likely to heighten overall privacy concerns. Kim et al. [61] discovered a negative relationship between perceived privacy risks and the value that users associate with a system. If users perceive that their privacy might be compromised, specifically through audio or video functionalities, they may perceive lower value in interacting with the system. Consequently, this study proposes the following hypotheses:

H6a. Sensors-related privacy risk associated with a social robot positively influences the general privacy risk.

H6b. Sensors-related privacy risk associated with a social robot negatively influences the perceived value derived from it.

G. PRIVACY RISK

Privacy risk is defined as the potential for an invasion of privacy in the context of interacting with an AI assistant such as a social robot [11]. Scholars have demonstrated that privacy risks associated with artificial technology negatively impact attitudes [62], satisfaction [63], and adoption intentions [64]. This suggests that when users perceive a higher risk in using technology, they tend to value it less. Privacy risk, as the one of sub-factors of perceived sacrifice, negatively affects the perceived value of technology [61]. This suggests that if users perceive a higher risk to their privacy when using social robots, they may attribute less value to them in question. Thus, it can be inferred that the perceived value may be negatively influenced by privacy risk. Accordingly, this study forwards the hypothesis:

H7. Privacy risk associated with a social robot negatively influences perceived value derived from it.

H. PERCEIVED VALUE

Perceived value is defined as the user's overall appraisal of the utility of a product, in this case, a social robot, based on their perception of what is received and what is given [65]. Several researchers have confirmed the significant impact of perceived value on adoption intention in various contexts, such as the Internet [66] and mobile applications [56]. de Kervenoael et al. [13] also supported the positive relationship between perceived value and adoption intention for social robots. Based on these findings, the present study proposes the following hypothesis:

H8. Perceived value derived from a social robot has a positive effect on adoption intention to use it.

I. PET EXPERIENCE

In this study, pet experience is defined as an individual's history of living with a pet or not. Past studies indicate that people who live with pets tend to anthropomorphize pets, attributing them to human-like qualities and behaviors [67]. This propensity may extend to social robots, thus affecting their response to the human-like appearance, behavior, and facial expressions of these robots. For instance, individuals with pet experience may derive greater enjoyment and attraction from robots with more human-like attributes [68]. Additionally, a study by Manzi et al. [69] found that children with pets were more likely to attribute mental states to robots. This suggests that the pet experience could enhance the perceived human likeness of robots, thereby influencing perceived enjoyment and social attraction. Based on these considerations, this study proposes the following hypotheses:

H9a. Pet experience significantly moderates the effects of the appearance of a social robot on perceived enjoyment.

H9b. Pet experience significantly moderates the effects of appearance on social attraction.

H9c. Pet experience significantly moderates the effects of behavior on perceived enjoyment.

H9d. Pet experience significantly moderates the effects of behavior on social attraction.

H9e. Pet experience significantly moderates the effects of facial expression on perceived enjoyment.

H9f. Pet experience significantly moderates the effects of facial expression on social attraction.

IV. RESEARCH METHODOLOGY

A. VIDEO STIMULI

In our study, we employed a specifically edited version of the video available on the Emo manufacturer's webpage to better align with the objectives of our research. The original video, which lasts 3 minutes and 50 seconds [70], contains extensive content; however, we carefully selected and edited it down to 1 minute and 49 seconds. This edit focused solely on key segments that showcase the variables being measured in our study, such as Emo's interaction capabilities and behavioral responses. This approach was intended to minimize viewing fatigue for respondents and ensure that their attention was concentrated on the features relevant to our research objectives.

Emo, designed to be similar in size to a small pet, showcases an intriguing blend of traits - it is slightly mischievous, highly intelligent, and imbued with its unique personality and feelings. The video depicts how Emo stays by the user's side, providing companionship, surprising, and occasionally annoying users, thus emulating the dynamics of interaction with a real pet. The video also displays Emo's ability to play games with users and recognize them by their names, features that exemplify its smart and interactive capabilities. Emo's potential as a voice assistant was demonstrated, with the video showing users asking it questions and receiving responses. Further, Emo's multifaceted functionality extends to recording users' lives with photos through a built-in camera, dancing to the music via a high-performance speaker, and being connected to the Internet, thus enabling a broad array of interactive tasks. Examples provided in the video include setting an alarm, controlling lights in the house, and exhibiting various facial expressions. In the video, Emo is also portrayed as needing care from the users, for instance, when it gets cold, adding another layer to the interaction dynamic. It even remembers the user's birthday and celebrates it by playing a song.

The video also showcases human characters interacting with Emo. This allowed for the depiction of more realistic scenarios where Emo's dynamic interactions come into play. For instance, the video demonstrates humans engaging in conversation with Emo, touching its head, dancing along with it, and caring for it when Emo gets cold, thereby humanizing the interactions. The practical utility of Emo is also portrayed with users asking it about the weather, setting an alarm through voice commands, among other actions.

These on-screen human-robot interactions are crucial as they offer a clearer understanding of how such social robots can integrate into everyday human life. By displaying these exchanges, the video aims to elicit participants' perceptions more accurately, providing a richer and more comprehensive context for our study's findings.

B. INSTRUMENT

The instruments for this study were developed by identifying various constructs and corresponding items drawn from the existing literature (Table 1). Appearance was measured using three items, including the suitability of the robot's look, the design suitability for intended use, and the resemblance of the robot's visual aspect to a living creature, sourced from David et al. [7]. Behavior was evaluated based on biological behavior resemblance, the robot's capability of independent mobility, and the realism of its emotional display [7]. The construct of facial expressions was assessed using three items, namely, the clear conveyance of emotions, characterization of expressions, and vibrancy of expressions, with the theoretical foundation laid by Stock-Homburg [71] and Ekman and Friesen [72]. Perceived enjoyment was captured using three items centered on the interesting interaction with the robot, the entertaining prospect it presents, and the potential for forming a bond, as guided by Ashfaq et al. [73]. The social attraction was gauged via items concerning potential friendship, the possibility of quality time, and an inclination towards investing more time with the robot [11]. Privacy concerns were split into two categories: privacy risks by sensors, including microphone and camera-related concerns [14], and general privacy risks related to interaction exposure, personal information revelation, and data loss concerns [62], [74]. Perceived value was measured via items concerning favorable opinions of the robot, potential benefits of cohabitation, and the robot's capacity to improve lifestyle [75]. Finally, adoption intention was evaluated using three items addressing the positive view of robot integration, interest in robotic advancements, and openness to robot collaboration [75]. For control variables, gender was coded as 1 for males and 2 for females. Age was recorded as reported, and pet ownership was dichotomized into those who have never lived with a pet (1) and those who currently live or previously lived with a pet (2).

TABLE 1. List of constructs and items.

Construct	Items	Mean	Source
Appearance	APP1	The look of the robot in the video appears suitable.	David, et al. [7]
	APP2	The robot's design seems well-suited for its intended use.	
	APP3	The visual aspect of the robot is reminiscent of a living creature.	
Behavior	BEH1	The structure of the robot in the video mirrors that of a biological being.	David, et al. [7]
	BEH2	The robot possesses the ability to move independently.	
	BEH3	The emotional expression of the robot is realistically conveyed.	
Facial Expression	FEX1	The robot's facial expressions convey emotion	Stock-Homburg [71] ;Ekman and Friesen [72]
	FEX2	The robot's facial expressions are well characterized	
	FEX3	The robot's facial expressions look colorful	
Perceived Enjoyment	PEN1	The interaction with the robot in the video is likely to be interesting.	Ashfaq, et al. [73]
	PEN2	The prospect of interacting with the robot appears to be entertaining.	
	PEN3	I can see myself forming a bond with the robot.	
Social Attraction	SOA1	I believe I could form a friendship with the robot in the video to me.	McLean and Osei-Frimpong [11]
	SOA2	The possibility of spending quality time with the robot seems promising.	
	SOA3	I could see myself allocating more time to the robot.	
Sensor-related Privacy Risk	SPR1	I am uncomfortable because I feel like the microphone of the robot in the video is spying on me.	Denning, et al. [14]
	SPR2	I am concerned that the robot's microphone is leaking information to someone else.	
	SPR3	The potential for the robot's camera to compromise privacy is concerning.	
	SPR4	There is a concern that the robot's camera could be leaking information to someone.	
Privacy Risk	PVR1	I am concerned that my interactions with the proposed robot will be exposed.	Nguyen, et al. [62] ;Nguyen, et al. [74]
	PVR2	I am apprehensive that the robot might reveal my personal information.	
	PVR3	I worry about losing the robot that stores my data.	
Perceived Value	PEV1	I hold a favorable opinion of the robot in the video.	Kim, et al. [75]
	PEV2	Coexisting with the robot seems to offer potential benefits.	
	PEV3	The robot appears capable of improving my lifestyle.	
Adoption Intention	ADI1	I view the integration of robots into daily human life positively.	Kim, et al. [75]
	ADI2	I am keenly interested in the technological advancement of robots for the benefit.	
	ADI3	I have no objections to collaborating with a robot.	
Pet Experience	PET	1 indicates individuals who have never owned a pet., while 2 indicates individuals who currently live with a pet or have lived with a pet in the past	-
Control Variable	Gender	1 represents males and 2 represents females.	-
	Age	Collected as reported.	

C. DATA

The subjects for this study were selected from an online panel managed by a professional third-party research agency. The panel was composed of a diverse group of individuals with varying demographic characteristics, reflecting a wide range of potential users of social robots. The purpose of the study, to investigate the factors influencing user engagement with social robots, was explicitly stated in the survey invitation sent to the panelists. To ensure the ethical integrity of our research, the principles of anonymity, voluntariness, and informed consent were rigorously upheld throughout the data collection process. Participants were reassured that their responses would remain confidential and used solely for this study. They were informed that their participation was entirely voluntary, and they had the right to withdraw from the study at any time without any repercussions. Before initiating the survey, informed consent was obtained from all participants. After data collection, a pre-processing procedure was applied to clean and prepare the data for analysis. The data was screened for straight-lining and patterned responses, leading to the exclusion of such entries. After this data filtering, a total of 298 valid responses remained for analysis.

The sample size for our study was meticulously calculated using an a-priori sample size calculator for structural equation models (SEMs) [76], with specific parameters set to ensure the reliability and validity of our findings. With an anticipated small effect size of 0.1, a desired statistical power level of 0.8 (standard for social sciences research to minimize Type II errors), a probability level (alpha) of 0.05 for detecting true effects, along with the complexity of the model involving 10 latent variables and 29 observed variables, the calculator recommended a minimum sample size of 216. This higher sample count not only meets the minimum required but also enhances the generalizability of our findings. In this study, we employed Partial Least Squares SEM, which is known for its flexibility regarding sample size requirements compared to Covariance-Based SEM (CB-SEM). As noted in the literature, PLS-SEM can provide robust results with smaller samples [77], which justifies our choice of 298 participants—above the a-priori analysis recommendation of 216 derived from [76].

Table 2 illustrates the demographic characteristics of the study participants ($N = 298$). Gender is evenly distributed among the respondents, with 50.0% identified as male (n = 149) and 50.0% as female (n = 149). The respondents' ages are also well distributed across three groups: those in their 20s account for 33.9% (n=101), 30s represent 32.6% (n = 97), and those in their 40s constitute 33.6% (n = 100). Additionally, the sample includes both individuals with pet experience and those without, with the former group representing a majority (60.4%, n = 180) and the latter making up the remaining 39.6% (n = 118) of the sample.

TABLE 2. Demographic characteristics of the samples.

Demographics	Item	Subjects (N=298)	
		Frequency	Percentage
Gender	Male	149	50.0%
	Female	149	50.0%
Age	20s	101	33.9%
	30s	97	32.6%
	40s	100	33.6%
Pet Experience	Yes	180	60.4%
	No	118	39.6%

V. ANALYSIS AND RESULTS

The methodology underpinning this study employed PLS-SEM utilizing SmartPLS 4 software, which stands as a potent multivariate analysis technique. This choice was made considering PLS-SEM's aptness for predictive research within intricate model frameworks that encompass multiple dependent constructs alongside potential measurement errors. This methodological approach is particularly beneficial for research that seeks to uncover crucial "driver" constructs within complex model structures that utilize both formative and reflective indicators, as highlighted in seminal works [77]. One of the notable strengths of PLS-SEM lies in its resilience against non-normal data distribution, making it an optimal choice for exploratory studies where model validation and theory testing are paramount [77], [78]. This study's implementation of PLS-SEM meticulously followed the best practices outlined in recent methodological literature, ensuring the analysis's robustness and reliability. The analysis process involved constructing a path model to delineate relationships among the identified constructs, estimating the model parameters to evaluate the proposed hypotheses, and assessing the model's predictive capabilities and the reliability and validity of the constructs.

A. COMMON METHOD BIAS (CMB)

To assess the potential issue of common method bias, this study employed Harman's single-factor test. As Podsakoff et al. [79] suggest, when the variance explained by one single factor is less than 50%, common method variance is unlikely to be a severe issue. The single-factor analysis of our data accounted for 39.473% of the variance, indicating that CMB was not a significant concern in this study. Moreover, we checked the variance inflation factor (VIF) values for all the variables, and none of them exceeded the threshold of 5, as suggested by Hair et al. [78], indicating that multicollinearity was not a severe problem in the dataset.

B. MEASUREMENT MODEL

The evaluation of the measurement model was done by assessing reliability, convergent validity, and discriminant validity. Table 3 reports the results for reliability and convergent validity. All constructs demonstrated good reliability with Cronbach's Alpha and Composite Reliability (CR) values above the recommended 0.7 thresholds [80], [81]. Furthermore, the average variance extracted (AVE) values for each construct exceeded the suggested 0.5 cut-offs [81], signifying satisfactory convergent validity.

Discriminant validity was confirmed using both the Fornell-Larcker criterion [81] and the Heterotrait-Monotrait ratio (HTMT) [82]. As shown in Table 4, the square roots of AVE for each construct (diagonal values) were larger than

TABLE 3. Reliability and convergent validity.

Construct	Items	Mean	St. Dev.	Factor Loading	Cronbach's Alpha	CR	AVE
Appearance	APP1	5.453	1.141	0.857	0.874	0.923	0.800
	APP2	5.191	1.272	0.923			
	APP3	5.161	1.267	0.901			
Behavior	BEH1	4.067	1.471	0.888	0.779	0.872	0.694
	BEH2	3.641	1.445	0.811			
	BEH3	4.560	1.355	0.797			
Facial Expression	FEX1	4.849	1.224	0.929	0.912	0.944	0.850
	FEX2	4.772	1.291	0.937			
	FEX3	4.430	1.446	0.900			
Perceived Enjoyment	PEN1	5.534	1.215	0.916	0.924	0.952	0.868
	PEN2	5.225	1.272	0.948			
	PEN3	5.255	1.280	0.932			
Social Attraction	SOA1	4.711	1.543	0.921	0.915	0.946	0.855
	SOA2	4.802	1.425	0.925			
	SOA3	4.366	1.579	0.927			
Sensor-related Privacy Risk	SPR1	4.651	1.467	0.879	0.914	0.939	0.795
	SPR2	4.960	1.390	0.901			
	SPR3	4.768	1.430	0.877			
	SPR4	5.060	1.307	0.908			
Privacy Risk	PVR1	5.057	1.454	0.912	0.877	0.925	0.804
	PVR2	5.124	1.445	0.935			
	PVR3	5.111	1.437	0.841			
Perceived Value	PEV1	4.772	1.254	0.894	0.880	0.926	0.806
	PEV2	4.832	1.187	0.924			
	PEV3	4.785	1.136	0.874			
Adoption Intention	ADI1	4.742	1.416	0.916	0.912	0.945	0.850
	ADI2	4.819	1.311	0.937			
	ADI3	4.755	1.441	0.914			
Pet Experience	Pet Experience	0.396	0.489	1.000	-	-	-
Control Variable	Gender	0.500	0.500	1.000	-	-	-
	Age	34.909	8.613	1.000	-	-	-

their respective correlation coefficients with other constructs, thereby satisfying the Fornell-Larcker criterion.

Table 5 describes HTMT values among constructs. While it is generally recommended that HTMT values remain below 0.85 as evidence of discriminant validity [82]. There are instances in which constructs with higher HTMT values may still be distinguishable and retain their relevance in a model. Specifically, if constructs are highly correlated, as might be expected in the case of perceived value and adoption intention, the HTMT value may exceed the 0.85 thresholds [83]. As well, it's crucial to consider the theoretical implications of these constructs in the model. Perceived value and adoption intention are central concepts in consumer behavior and technology adoption literature [84], [85], [86], [87]. Both

TABLE 4. Fornell-Larcker scale results.

Constructs	1	2	3	4	5	6	7	8	9
1. Appearance	0.894								
2. Behavior	0.505	0.833							
3. Facial Expression	0.561	0.600	0.922						
4. Perceived Enjoyment	0.610	0.510	0.615	0.932					
5. Social Attraction	0.485	0.590	0.505	0.614	0.924				
6. Sensor-related Privacy Risk	-0.003	-0.052	-0.003	0.034	-0.053	0.891			
7. Privacy Risk	0.091	0.066	0.124	0.124	0.049	0.682	0.897		
8. Perceived Value	0.537	0.497	0.503	0.669	0.671	-0.020	0.018	0.898	
9. Adoption Intention	0.503	0.503	0.455	0.656	0.676	-0.054	0.032	0.832	0.922

Note: The values on the diagonal represent the square root of AVE.

TABLE 5. HTMT matrix.

Constructs	1	2	3	4	5	6	7	8	9
1. Appearance									
2. Behavior	0.609								
3. Facial Expression	0.629	0.708							
4. Perceived Enjoyment	0.678	0.596	0.671						
5. Social Attraction	0.541	0.698	0.551	0.666					
6. Sensor-related Privacy Risk	0.065	0.096	0.047	0.064	0.068				
7. Privacy Risk	0.122	0.104	0.143	0.141	0.091	0.757			
8. Perceived Value	0.610	0.601	0.560	0.741	0.745	0.040	0.069		
9. Adoption Intention	0.563	0.598	0.498	0.714	0.739	0.071	0.051	0.928	

constructs provide distinct yet interconnected insights into the user's decision-making process regarding the adoption of new technology. The high correlation is expected and reflective of established theories. Therefore, this study decided to retain both constructs in the model.

C. HYPOTHESIS TEST

In the assessment of the structural model, a bootstrapping procedure with 5000 resamplings was performed to calculate path coefficients, t-values, and confidence intervals (CI). This resampling approach is a robust method in PLS-SEM that ensures more accurate estimates, especially in large models with many constructs [88]. The results demonstrated that our structural model accounts for a substantial portion of the variance in adoption intention, specifically 69.7%. This high R^2 value indicates that the model provides a strong explanation for the adoption intention of social robots. In other words, the variables identified in the study account for nearly 70% of the adoption intention, which is a considerable amount, thus underscoring the predictive strength of the model. Next, the path coefficients were examined. Path coefficients in PLS-SEM provide information about the strength and direction of the relationship between variables [89]. In conclusion, the bootstrapping procedure with 5000 resamples provides reliable statistical estimates for the structural model, which explains a substantial amount of the variance in adoption intention. Figure 2 and Table 6 show the detailed results of the SEM analysis.

Figure 3 illustrates the interaction between pet experience and the relationship between a social robot's appearance and perceived enjoyment. The graphic includes two lines: the thicker line signifies respondents with no prior experience of cohabiting with pets, while the thinner line represents respondents who have had, or currently have, pets. The perceived enjoyment derived from the increased humanlike appearance of the social robot is amplified for individuals without pet experience, compared to those with pet experience. This enhancement in enjoyment is steeper and more pronounced for individuals without pet experiences as the level of humanlike appearance of the social robot ascends.

VI. DISCUSSION

This study has examined the various factors that affect the adoption of social robots.

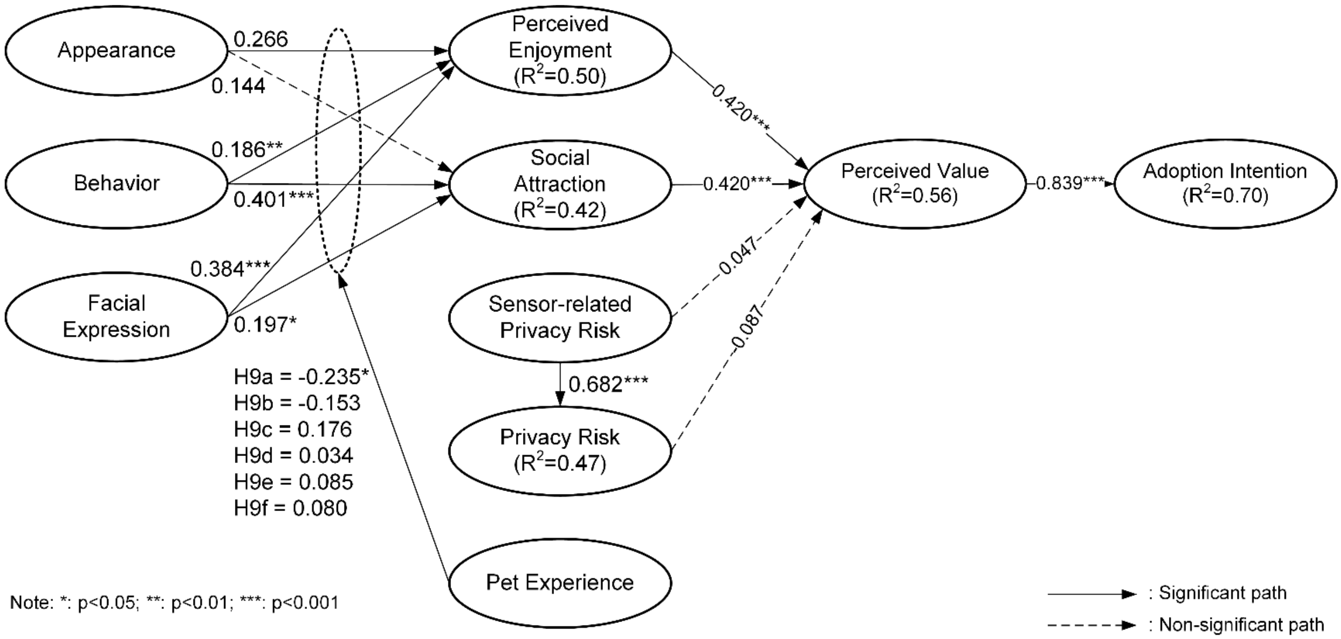

FIGURE 2. The path coefficients of the research model.

TABLE 6. Summary of the results.

H	Cause	Effect	Coefficient	*T*-value	*P*-value	Result
H1a	Appearance	Perceived Enjoyment	0.266	3.518	0.000	Supported
H1b	Appearance	Social Attraction	0.144	1.637	0.102	Not Supported
H2a	Behavior	Perceived Enjoyment	0.186	2.701	0.007	Supported
H2b	Behavior	Social Attraction	0.401	5.693	0.000	Supported
H3a	Facial Expression	Perceived Enjoyment	0.384	4.682	0.000	Supported
H3b	Facial Expression	Social Attraction	0.197	2.293	0.022	Supported
H4	Perceived Enjoyment	Perceived Value	0.420	6.684	0.000	Supported
H5	Social Attraction	Perceived Value	0.420	6.880	0.000	Supported
H6a	Sensor-related Privacy Risk	Privacy Risk	0.682	18.755	0.000	Supported
H6b	Sensor-related Privacy Risk	Perceived Value	0.047	0.736	0.462	Not Supported
H7	Privacy Risk	Perceived Value	-0.087	1.442	0.149	Not Supported
H8	Perceived Value	Adoption Intention	0.839	39.126	0.000	Supported
H9a	Pet × Appearance	Perceived Enjoyment	-0.235	2.020	0.043	Supported
H9b	Pet × Appearance	Social Attraction	-0.153	1.238	0.216	Not Supported
H9c	Pet × Behavior	Perceived Enjoyment	0.176	1.482	0.138	Not Supported
H9d	Pet × Behavior	Social Attraction	0.034	0.275	0.783	Not Supported
H9e	Pet × Facial Expression	Perceived Enjoyment	0.085	0.654	0.513	Not Supported
H9f	Pet × Facial Expression	Social Attraction	0.080	0.593	0.553	Not Supported
CV	Gender	Adoption Intention	0.126	1.907	0.057	Not Significant
CV	Age	Adoption Intention	0.003	0.085	0.933	Not Significant

Note: CV stands for control variable.

Our findings show a significant correlation between the appearance of a social robot and perceived enjoyment. This finding aligns with previous research that demonstrated a preference for warm robots in service contexts focused on hedonic experiences [90]. This relationship suggests that the visual appeal and human-like aesthetics of a robot play a crucial role in influencing how enjoyable users find interacting with the robot. On the other hand, our analysis yields an intriguing outcome that appearance does not impact their social attraction. Essentially, this implies that the degree to which users perceive these robots as sociable or likable is not directly driven by their human-like physical characteristics.

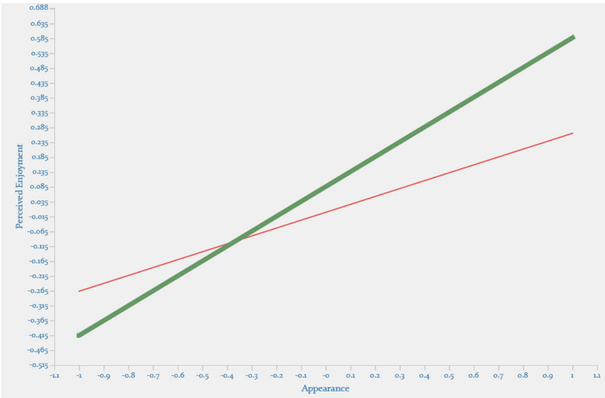

FIGURE 3. Moderating effect of pet experience on the association between appearance and perceived enjoyment.

This contrasts with the common presumption that a robot's human-like appearance would enhance its appeal and facilitate more comfortable and engaging interactions [49]. However, this lack of correlation could also be an indication of other attributes overshadowing appearance, such as behavioral traits or functional benefits.

The positive relationship found between behavior and both perceived enjoyment and social attraction aligns with former works that highlight the influence of a robot's behavior on enjoyment [30] and social appeal [35]. The more a robot behaves in a way that users can predict or understand, the more likely they are to find the interaction enjoyable. Also, the behavior of the robot can significantly influence its perceived likability or attractiveness.

Our findings also suggest a significant link between facial expression and perceived enjoyment and social attraction. This result is corroborated by the research of past research, emphasizing the importance of expressive robots in fostering user pleasure. Leite et al. [50] and social attractiveness [34], [51], [52]. The findings suggest that the ability of a social robot to display and convey emotions through facial expressions plays an important role in enhancing user engagement and affinity towards it.

The empirical evidence shows a positive correlation between perceived enjoyment and perceived value, reflecting the sentiment in prior studies [54], [55], [56]. In essence, the enjoyment experienced during the interaction with the social robot enhances the perceived utility or worth that users associate with it. This could be because when the interaction with the robot is enjoyable, it generates positive emotions, making the overall experience valuable to the user

Additionally, our study presents substantial evidence confirming the impact of social attraction on perceived value within the sphere of human-robot interaction. This suggests that when individuals find a robot socially appealing, they are more likely to perceive it as valuable. This finding echoes the research by McLean and Osei-Frimpong [11], where the social attractiveness of an artificial agent was found to enhance the perceived value of the interaction. This can be attributed to the social nature of humans, who often attribute value to interactions that fulfill their social needs or elicit positive social responses.

In this study, we observed a significant positive relationship between sensor-related risk and privacy risk within the context of social robots, which underlines the concerns users have about the potential misuse of data collected by a robot's sensors. Interestingly, however, our findings diverge when it comes to the correlation between sensor-related risk and perceived value. Contrary to the anticipated relationship that a higher perceived risk would correspond to a lower perceived value, our results show no significant correlation. This may indicate that while users are conscious of the privacy risks associated with the robot's sensors, they separate these concerns from their perception of the robot's overall value. This complex relationship can be attributed to the perceived benefits outweighing privacy concerns. As pointed out by Caine et al. [91], people often accept certain risks in return for considerable benefits. Alternatively, it might be that users feel sufficiently protected by existing data protection measures or believe that the probability of misuse is low.

The empirical findings of this study showed a significant influence of perceived value on adoption intention in the context of social robots. This echoes prior research, which highlighted the critical role of perceived value in shaping adoption intentions toward emerging technologies [56], [66]. The result underscores the importance of delivering value through functionality and benefits to encourage the adoption of social robots.

The results from this study revealed that previous companion experience with pets could negatively moderate the relationship between a social robot's appearance and perceived enjoyment. This suggests that individuals who have owned or interacted with pets in the past may have different expectations and standards for anthropomorphism. They might be less likely to be amused by the robot's appearance if it does not meet or exceed their experiences with real pets. This aligns with the findings by Melson et al. [16], who suggested that previous pet ownership could influence people's interactions with and perceptions of robotic companions. Thus, designers and developers of social robots must take into consideration the diverse experiences and expectations of their potential users, especially those who have or have had pets.

VII. CONCLUSION

A. THEORETICAL IMPLICATIONS

The present study's primary theoretical contribution lies in examining the intricate relationship between social robots' human-like attributes and the subsequent user responses in terms of perceived enjoyment and social attraction. While previous research has investigated social robots' acceptance and usefulness [15], [92], [93], less attention has been given to perceptual elements like perceived enjoyment and social attraction driven by the robots' anthropomorphic qualities such as appearance, behavior, and facial expression. This research adds to the existing body of knowledge by providing empirical evidence that these human-like attributes can significantly influence perceived enjoyment and social attraction, thereby addressing this literature gap. Additionally, this study represents an advancement in understanding the direction of technological anthropomorphization of social robots, specifically considering the simultaneity of appearance, behaviors or gestures, and facial expressions. By focusing on these key variables of human-likeness in social robots, our research highlights the integrated impact these anthropomorphic features may have on individual acceptance. This comprehensive approach allows for a deeper exploration of how social robots' human-like qualities can influence users' perceptions and, ultimately, their willingness to embrace these technologies. This perspective offers a meaningful contribution to the discussion on social robot acceptance, emphasizing the relevance of a comprehensive view of anthropomorphism in influencing user experiences and adoption decisions.

The second key contribution lies in the understanding that perceived enjoyment and social attraction contribute to perceived value. Previous studies have primarily focused on perceived ease of use and perceived usefulness as primary antecedents of perceived value [13], [94], often overlooking the potential role of enjoyment and attraction in this context. By illustrating the influence of perceived enjoyment and social attraction on perceived value, this study provides a more nuanced understanding of value perception in the context of social robot usage. Additionally, this study sets itself apart by distinguishing perceived enjoyment from an individual perspective and social attraction from a relational perspective as emotional responses, representing a notable step forward in the investigation of user engagement with social robots. This dual framework enables us to capture both "intrinsic" and "extrinsic" dimensions of user interaction, offering a more comprehensive understanding of the factors that drive social robot adoption. Furthermore, our findings indicate that the appearance and facial expressions of social robots have an influence from an intrinsic viewpoint, directly impacting users' perceived enjoyment. Conversely, the behavior of social robots has a notable effect from an extrinsic perspective, enhancing social attraction among users. This nuanced differentiation highlights the multifaceted nature of social robots' influence on perceived value, emphasizing the importance of considering both the internal and external emotional responses elicited by these technologies. Through this approach, our study provides a deeper understanding of how different attributes of social robots influence users' value perception and adoption intentions.

Thirdly, this study adds to the existing body of knowledge regarding privacy concerns within the domain of social robots. Although previous literature has indicated that privacy risk can influence user attitudes toward technology [95], [96], the specific privacy issues associated with social robots—particularly those equipped with cameras and microphones—remain under-researched. In particular, the concept of sensors-related risk, which involves potential privacy breaches through these data collection mechanisms inherent in social robots, has not been extensively explored. To address this gap, the present study introduces and investigates the notion of sensors-related risk. Our findings suggest that sensors-related risk contributes to the overall perception of privacy risk. However, the relationship between sensors-related risk and perceived value does not appear to be statistically significant. This potential offsetting effect implies that while privacy concerns might reduce the perceived value of social robots, the benefits from human-robot interactions facilitated by technological tools such as cameras and sensors might counterbalance this reduction. This nuanced understanding underscores the complexity of privacy considerations in the context of social robots, where the technological advantages of enhanced interaction capabilities may mitigate the impact of privacy risks on users' valuation of these devices. This balance between privacy risks and the utility of interaction features offers a new perspective on how individuals weigh the pros and cons when forming attitudes towards social robots, contributing to the ongoing discussion on privacy concerns in the era of increasingly sophisticated robotic companions. This finding suggests a discrepancy that warrants further investigation in future studies, potentially leading to a deeper understanding of privacy risk dynamics within the context of social robot use.

Lastly, the study offers a novel insight into the role of personal experience with pets as a moderating factor. Existing studies [16] have explored the influence of pet ownership on perceptions of robotic pets but have not considered how such past experiences could moderate the impact of human-like attributes on perceived enjoyment or social attraction. The findings suggest that companion experience with pets may negatively moderate the relationship between a social robot's appearance and social attraction, thereby extending the understanding of user heterogeneity in responses to social robots. This distinction highlights the nuanced relationship between social robots and pets. While both can provide enjoyment through interaction, they differ significantly in terms of maintenance, like feeding requirements, levels of communication, and the fundamental nature of being biological versus mechanical. This contrast illustrates the complexity of transferring experiences from pet companionship to interactions with social robots. Understanding this dynamic is important for designing social robots that can effectively emulate the positive aspects of pet ownership while addressing the unique challenges posed by their mechanical nature. By examining the moderating effect of pet experience on the perception of social robots, this study provides insights into the diverse ways individuals may perceive and interact with social robots, influenced by their prior experiences with living pets. This insight contributes to the discourse on human-robot interaction by illustrating the importance of considering personal backgrounds in the acceptance and enjoyment of social robots. Future research could delve deeper into this area by considering different aspects of pet ownership, such as the duration and type of pet, and the impact on social robot interaction.

B. IMPLICATIONS FOR PRACTITIONERS

The practical implications of this study are manifold and beneficial for a diverse range of stakeholders. Firstly, the robust link established between a social robot's human-like appearance and both perceived enjoyment and social attraction underscores the importance of aesthetic design considerations. For developers and designers, it suggests the potential value of anthropomorphic design cues in social robots [97]. This could involve making the robot's exterior more lifelike or incorporating elements that users find visually appealing. For example, a robot designed for a childcare center could incorporate vibrant colors and soft shapes to make it more appealing and less intimidating to children.

Secondly, our findings indicate that social robots' behavior plays an important role in enhancing perceived enjoyment and social attraction. As such, developers and marketers should consider placing greater emphasis on the robot's movement capabilities and behavior patterns, aiming for biomimicry or human-like actions [98]. This could include designing robots to express emotions, carry out tasks in a human-like manner, or interact dynamically with users. For instance, a robot designed to assist the elderly might benefit from being able to perform a range of movements that mimic human caregivers, such as reaching out a hand for support or nodding in understanding.

Thirdly, the study's findings related to sensors-related risk serve as a critical reminder for policymakers and public officers about the importance of regulatory measures for privacy protection. Given that sensors-related risk can significantly increase overall privacy risk, regulations should be considered to monitor and control the data collection capabilities of social robots. For example, policymakers might consider enforcing transparency about data collection practices or implementing strict data security and privacy standards for social robot developers.

Finally, the effect of perceived value on adoption intention highlighted by this study suggests the importance of articulating the benefits and overall value of social robots to prospective users. This has implications for those involved in marketing and sales, suggesting that their communication strategies should emphasize the specific advantages that users can glean from these technological solutions. These benefits can range from the provision of increased convenience in performing daily tasks to the potential companionship these robots can offer, or even improvements in the overall quality of life. For example, a social robot that is designed to be used at home could be marketed with a focus on its capacity to provide an additional level of security for the household [6], its ability to keep company to those who live alone [99], or its competence in aiding with routine household tasks. By highlighting these aspects, marketers can effectively enhance the perceived value of the social robot, which in turn, based on our findings, could positively influence the intention to adopt these innovative technological companions.

C. LIMITATION AND FUTURE RESEARCH

Despite the insightful findings of this study, some areas for potential improvement provide a pathway for future research. This study primarily focused on static robot attributes such as appearance, behavior, and facial expression, with less emphasis on dynamic attributes such as adaptability or learning capabilities of the robot, which may significantly influence user perceptions. Furthermore, this research was conducted within a specific cultural context, which might limit its generalizability. Different cultures might have diverse perceptions of technology and robots, necessitating further cross-cultural studies. Also, our study utilized videos to present the robots' usage and functionalities, as opposed to allowing participants to interact with the robots directly over a period of time. As a result, we did not employ commonly used scales such as the Robot Social Attribute Scale (RoSAS) and the Human-Robot Interaction Evaluation Scale (HRIES), which are typically used in studies involving prolonged interactions with robots [100], [101], [102]. Instead, we adapted measurement items from various studies that were more suitable for evaluating participants' perceptions based on indirect exposure through video presentations. While this approach was appropriate for our research context, it does represent a limitation in terms of the depth of interaction participants had with the robots. Additionally, we introduced and explored the concept of sensors-related privacy risk in social robots, but further research is required to delve deeper into the multifaceted dimensions of this concept, including understanding different ways in which users perceive and mitigate these risks. Hence, future research may wish to address these areas. Finally, it should be noted that literature suggest over 300 participants for traditional SEM [103], [104]. Future research could explore the effects of even larger samples on the stability and generalizability of the model results. Expanding the sample size could also allow for more nuanced subgroup analyses within the structural model.

DECLARATION

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Conflicts of Interests/Competing Interests: The authors declare no conflict of interest.

Data Availability: The data used in this this study are available from the corresponding authors upon reasonable request.

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