

A Process Mechanism Study of the Impact of Service Robot Anthropomorphic Features on Users' Continuous Usage Intention

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Abstract: Robots replacing the work of human employees is no longer a novelty. In the manufacturing industry, a large number of front-line employees have already been replaced by machines. With the maturity and development of robotics, the replacement of humans with machines is gradually shifting from the manufacturing industry to the service industry. The process by which robotic features affect users' willingness to use under intelligent services has been a hot topic in business management and academic research in recent years. However, anthropomorphism as an intuitive external feature, few studies have explored the process mechanisms of such features on customers' continuous usage intention. Based on Social information processing theory, the article investigates the mechanism by which anthropomorphic appearance features of service robots affect users' continuous usage intention. The results show that users' tendency to anthropomorphize the appearance of service robots positively influences continuous usage intention through the partial mediation of perceived usefulness and perceived enjoyment. In addition, the level of empathy of the service robot moderates the effect of anthropomorphism on perceived usefulness and perceived hedonicity. The findings of this study enrich the research on the processes that influence users' continuous usage intention in service encounters and also provide a useful reference for the management practices of service companies.

Keywords: AI Empathy, Anthropomorphism, User Perception, Continuous Usage Intention, Service Robot

1. Introduction

The robotics industry can be simply divided into industrial robots and service robots [1]. The former is focused on factory production lines and is used to take over dangerous manual work and tedious tasks, while the latter can be used in various scenarios such as service reception, logistics and distribution, and personal companionship. According to the China Robotics Industry Development Report 2021 released by the Chinese Institute of Electronics, the size of China's robotics market is expected to reach 83.9 billion yuan; related financing in the field of service robots exceeds 44 billion yuan. As the technology matures and manufacturing costs fall, service robots are being used in a wider range of applications, and their role is moving from being "cool" to be truly useful and practical. In 2022, the robotic chefs, the epidemic

prevention and inspection robot volunteers, and the sports robots at the Beijing Winter Olympics have won acclaim for their fun and effective work. Service intelligence has become an unstoppable trend [2], and the use of service robots by enterprises is an important part of the development environment. On the one hand, enterprises hope that service robots can play an advantage in reducing labor costs and increasing corporate profits; on the other hand, service robots have replaced traditional human employees, and the existing production and lifestyles of enterprises, employees, and customers have all changed. Enhancing the communication and interaction between users and service robots to enhance service efficiency and improve customer experience has become a focus of manufacturers and enterprises.

A central issue that has long been studied by service companies and academics is user psychology and behavior,

which is influenced by many factors, particularly the performance of service providers [3]. As service providers shift from human employees to humanoid robots, companies expect more and more from them. On the other hand, confronting high-tech service scenarios triggers strong curiosity in a large number of users and attracts them to experience them. While users are increasingly concerned about robot adoption, it is frequent and consistent use that creates value, an area that has received less attention. Effective measures taken by manufacturers and service companies to promote user choice and continued use will not only help to increase users' perceptions and emotions towards machine services; but will also help to increase the adoption of service robots and corporate profits, achieving a win-win situation for both companies and users [4]. However, the process mechanism by which service provider initiatives induce behavioral change in users has been a blind spot in practical management. Much of the academic research on this issue has been based on technology acceptance models to explore how to engage users' initial adoption intentions. Therefore, there is a need for companies and relevant research fields to explore the mechanisms of the process of users' choice and willingness to use machine services.

According to Social information processing theory, people's behavior and attitudes are the result of the process of processing and handling information cues. It can be seen that the judgment of the positive impact on one's psyche generated by analyzing important information around them is a logical prerequisite for people to make choices and increase their willingness to use it. Related studies have found that objects with anthropomorphism are more likely to develop positive psychological feelings, such as anthropomorphic appearance and actions, which in turn lead to future use behavior [5]. In recent years, the marketing field has begun to treat anthropomorphism as a concept that can be manipulated and measured, with attention focused on whether the anthropomorphic brand and product characteristics influence consumer perception and behavior [6, 7]. Want Want, for example, has created a childlike image that has greatly enhanced brand recognition and has become a powerful tool for stabilizing fans. When technology is integrated into a service, anthropomorphic features become an important message that influences the user's perceived attitude [8]. Accordingly, this paper explores the influence of the anthropomorphic appearance of service robots on users' willingness to continue using them and the underlying mechanisms based on Social information processing theory, and explores the corresponding boundary conditions in terms of the level of empathy.

The article provides insights into the empirical study of human-robot interaction and enriches the application of Social information processing theory in the process of human-robot interaction, with a view to promoting the market application of service robots and providing practical advice to relevant enterprises and personnel.

2. Literature Review and Hypotheses Development

2.1. *Anthropomorphism and Continuous Usage Intention*

The term anthropomorphism first came from Osamu Tezuka's *Astro Boy*, where the manga gave machines and robots individualistic characteristics. Epley defines anthropomorphism as giving non-human entity characteristics similar to those of humans [9], and by extension, the idea that the entity can present human-like abilities and emotions, thereby enhancing communication and interaction with the user [10]. Anthropomorphic forms include names, language styles, appearance, images, etc.; widely used in fields such as social psychology, human-computer interaction, and healthcare. Service robots are non-human entities that communicate and interact with users and provide services according to the system's automated interface. With the development and maturity of robotics, the range of applications for service robots has gradually expanded. Whether in libraries, shopping malls, hotels or exhibition halls, service robots have become ubiquitous. When confronted with a service robot with human facial features, individuals are often more likely to have the psychological perception that it can provide a similar service experience to that of a human employee than a cold, dull-looking self-service machine, and the ensuing service process is influenced as a result.

User's continuous usage intention refers to the likelihood that a user will continue to use a service robot after initially accepting it [11]. Usage intention only emphasizes the user's intention to respond at a certain point in time, whereas continuous usage intention places more emphasis on the continuity of time [5, 6]. In addition, it is cheaper for companies to retain current customers than to attract new ones, and loyal users generate more revenue. Previous research on IT has also shown that the willingness to continue using IT is key to its success [11, 12]. In this day and age, where technology and the flow of information have made everything move at an accelerated pace, constantly iterating products and marketing methods, i.e. ways of attracting users that are more likely to lead to churn, how to maintain long-term customers have always been a concern for businesses and academics.

The Social information processing theory was originally a response to the popular theory of work attitude needs in organizational psychology. The theory suggests that individuals are provided with a range of information by their environment; and that the information they receive is processed, processed and used to guide subsequent attitudes and behaviors [13]. Social information processing theory was first used in the study of employees' attitudes to work [14]. Early on, it focused on the workplace environment, exploring the effects of a range of information conveyed by different styles of leadership, team working environments, etc. on employees' cognition, attitudes and work behavior.

In recent years, Social information processing theory is

widely used in the field of service hospitality. Based on Social information processing theory, Xu Hong and Tu Hongwei constructed a moderated mediation model to explore the driving mechanisms of environmental quality on tourists' pro-environmental behavior in tourism contexts, specifically that environmental quality positively influences environmental responsibility and that environmental quality also indirectly influences tourists' pro-environmental behavior through environmental responsibility [15]. Liu Xin *et al.* verified the applicability of Social information processing theory in human-robot value co-creation situations by exploring the value co-creation between customers and service robots in the tourism industry [16].

The service provider, as an integral part of the service process, is an important source of information for the user in the process of receiving the service, and any change in the service provider may affect the user's psychological fluctuations, which in turn may influence subsequent behavioral choices [17]. Numerous studies have been conducted to verify that the anthropomorphic appearance of AI has a positive effect on users. For example, Leite *et al.* suggest that anthropomorphic appearance is conducive to increasing consumer trust in robots [18], prompting consumers to build long-term relationships with robots during human-robot interaction [19]. When faced with an unfamiliar non-human entity, customers are more likely to interact with an anthropomorphic actor for reasons such as service interaction or information understanding than in traditional service scenarios, in order to enjoy a higher quality of service.

In summary, when faced with a robot with an anthropomorphic appearance, users indicated that they would continue to use it for future services. Therefore, we hypothesize the following:

H1: Anthropomorphism positively influences continuous usage intention.

2.2. The Mediated Role of Perceived Values

Improving the perceived value of users is one of the key factors in the success of a business [20]. Previous research on the perceptual dimension of IT has focused on the perception of the functional level of the system. However, in a service context, enjoyment of the service is an important indicator of the quality of the service product. Therefore, in the context of service intelligence, this paper classifies the perceived value of service robots by users into usefulness and hedonicity.

Perceived usefulness refers to the user's ability to feel that a service robot is capable of performing a service when using it. During human-robot interaction, users tend to perceive robots with anthropomorphic characteristics as being able to demonstrate the same work capabilities as human employees [7]. Perceived usefulness has been shown to be an important factor influencing the willingness of IT users to use [21]. The user's perception of the usefulness of a service robot depends on the experience and outcome that the service robot delivers to the user. Users will perceive the usefulness of service robots when they perceive that they can bring efficient and useful services that can meet their needs, which will lead to a

continued willingness to use them [8, 22].

As a service provider, useful value is an important factor in addressing the needs of users. At the same time, hedonicity is the key to improving the user experience. In this paper, perceived hedonicity is defined as the good service experience and pleasure that the user receives when using a service robot. In the marketing field, there has been a great deal of research showing that anthropomorphic brands evoke a greater sense of warmth in consumers, making the purchase experience more pleasant and heart-warming. In industry, it has also been shown that objects with anthropomorphic features can stimulate customers' psychological emotions. For example, a car front designed with a smiley face [23] can drive happy emotions in users and inspire them to use it.

In summary, this paper infers that users' perceived usefulness and perceived hedonicity of service robots mediates the relationship between service robot anthropomorphism and users' willingness to continue using them. Therefore, we hypothesize the following:

H2: Anthropomorphism positively influences perceived usefulness.

H3: Anthropomorphism positively influences perceived hedonicity.

H4: Perceived usefulness mediates between anthropomorphism and continuous usage intention.

H5: Perceived hedonicity mediates between anthropomorphism and continuous usage intention..

2.3. The Moderating Role of Empathy Level

As an emotion-intensive industry, the emotions of the service provider have been a key issue in academic and practical management, and even a determinant of the perception of the service experience [24]. Intelligence, which is accompanied by more objective, dispassionate and analytical judgments free from subjective emotions, finds the optimal product for the user while the sense of user experience previously triggered by emotional interaction is greatly reduced [25] and affects the user's evaluation, especially for intangible service products. The ability of the service provider to interact emotionally with the user is therefore an important factor influencing the user's perceived attitude.

It has been established that the emotional expression of the service provider is an important factor influencing user behavior [26]. Empathy is the tendency of individuals to share and perceive the emotions of others in the process of interacting with them, and is a manifestation of human social presence that shapes interpersonal relationships in society. Empathy, as one of the five dimensions of the service quality assessment model, is an important indicator for users to evaluate the service quality of service providers. Whereas robots, as products of algorithms and programming, are generally perceived as thoughtless and emotionless, the absence of a sense of control can also lead to a decrease in the user's perception of the robot's level of empathy.

According to Social information processing theory, the formation of individual perceptions and behaviors can be influenced by the characteristics of the information itself, but

also, by factors related to the information provider [14]. The lower the level of empathy of the service robot, the lower the customer's trust and pleasure in its capabilities [27], and the service robot's capabilities are questioned, which in turn reduces the use of the service robot. Conversely, higher levels of empathy indicate that users have some trust in the process and outcome of the service task, are more accepting of the service robot's anthropomorphic tendencies, and believe that the service robot can users bring the same high level of service as human employees. Therefore, we hypothesize the following:

H6: Empathy level moderate between anthropomorphism and perceived usefulness.

H7: Empathy level moderate between anthropomorphism and perceived hedonicity.

Overall, the research model is as follows (Figure 1).

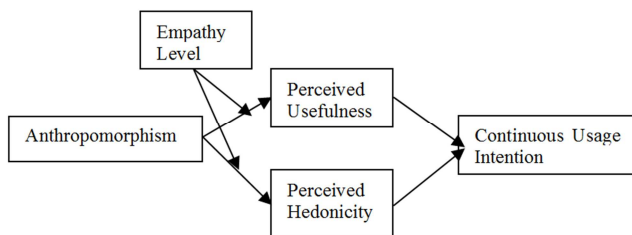


Figure 1. Conceptual framework.

3. Method

3.1. Survey Instrument and Sample Demographics

In terms of education, the sample data showed that universities and above accounted for 56.9% of the total number of people. In terms of gender, men made up the largest proportion of the sample, accounting for 71.6% of the total, in line with the HAI (Human-Centered AI Initiative) report, which states that the AI user population is predominantly male. In terms of age distribution, the largest number of respondents were aged 19-23, accounting for 48.5% of the total sample.

Table 1. Sample demographics and characteristics.

Variable	Category	N=334	
		Frequency	Percentage
Gender	Female	239	71.6
	Male	95	28.4
Age	16 or younger	21	6.3
	16-18	138	41.3
	19-23	162	48.5
	23 or older	13	3.9
Education	High school or less	144	43.1
	University degree	178	53.3
	Master's or PHD degree	12	3.6

This study used well-established domestic and international scales that have been tested in the Chinese context, including the Anthropomorphism Scale, the Empathy Level Scale, the Perceived Usefulness Scale, the Perceived Enjoyment Scale and the Continuity of Use Scale. The content of the questionnaire was fine-tuned to suit the context of this paper, using a 7-point Likert scale, where 1

means 'strongly disagree' and 7 means 'strongly agree'.

The anthropomorphic scale refers to a scale developed by Bartneck et al [28] (Cronbach's $\alpha=0.896$). The scale contains four question items. The reliability of the scale is high.

The Empathy Level Scale refers to a study by Ronan et al [29] (Cronbach's $\alpha = 0.883$). The scale contains 3 question items. The reliability of the scale is high.

The Perceived Usefulness Scale refers to research by Davis [30] (Cronbach's $\alpha = 0.829$). The scale contains four question items. The reliability of the scale is high.

The Perceived Hedonicity Scale refers to a study by Holsapple and Wu et al [31] (Cronbach's α value = 0.881). The scale contains three question items. The reliability of the scale is high.

The Continuous Usage Intention refers to the study by Bhattacharjee et al [32] (Cronbach's $\alpha = 0.845$). The scale contains three question items. The reliability of the scale is high.

3.2. Research Procedure

This paper uses the Credamo platform system to distribute and collect data. 400 questionnaires were distributed, and the sample data were distributed in several provinces and cities, including Fujian, Jiangxi, Xinjiang Uyghur Autonomous Region, Jiangsu, Hebei, Anhui, and Shandong. To ensure the quality of the data, questionnaires that took too long or too short to fill in and those with obvious regularity of options were removed from the semantics of the questionnaire. After the screening, 334 valid questionnaires were finally obtained, with a valid return rate of 83.5%.

4. Empirical Results

4.1. The Test of Validity

CFA was conducted to validate the measurement model. The five-factor model (anthropomorphism, empathy level, perceived usefulness, perceived hedonicity, and continuous usage intention) was set as the hypothesis model and the other factor models were competing models. The data fit of the four models was compared and the model with the best fit was selected. As can be seen from Table 2, the fit of the other alternative competing models was significantly worse than the fit of the five-factor model ($X^2/df = 2.069$, CFI = 0.967, RMSEA = 0.057, SRMR = 0.0428). Therefore, the table indicates better sample discriminant validity.

Table 2. Results of structural equation model.

Model	X^2/df	CFI	TLI	RMSEA	SRMR
Five-factor model	2.069	0.967	0.959	0.057	0.0428
Four-factor model (AN+PU)	7.693	0.789	0.746	0.142	0.2030
Four-factor model (AN+PH)	8.411	0.766	0.718	0.149	0.1952
Three-factor model (AN+PU+PH)	10.591	0.689	0.635	0.170	0.1299
Two-factor model (AN+PU+PH+EI)	14.196	0.565	0.498	0.199	0.1476
One-factor model (AN+PU+PH+EI+CI)	15.145	0.530	0.462	0.206	0.1516

In addition, as the variables were measured from a web-based questionnaire completed by the users, the data may be subject to homogeneous method bias. Therefore, it was necessary to conduct a Common Method Variances (CMV) test for this, and this study used SPSS 25.0 software to conduct a Harman one-way analysis of variance on all data for each variable in the questionnaire. The Harman single-factor model explained 39.628% of the total variance, well below the desired 40% criterion. These results suggest that common method variance was not a major concern in this study.

4.2. Descriptive Analysis and Hypothesis Testing

The data were correlated using SPSS 25.0 software. As can be seen from Table 3, service robot anthropomorphism was significantly and positively correlated with perceived usefulness ($R=0.231$, $p<0.01$), perceived hedonicity ($R=0.249$, $p<0.01$), level of empathy ($R=0.243$, $p<0.01$), and willingness to consistently use ($R=0.236$, $p<0.01$); perceived usefulness and perceived hedonicity were significantly and positively correlated with the level of empathy ($R=0.421$, $p<0.01$; $R=0.366$, $p<0.01$), and continuous usage intention ($R=0.631$, $p<0.01$; $R=0.674$, $p<0.01$) were significantly positively correlated; the level of empathy was also significantly positively correlated with continuous usage intention ($R=0.439$, $p<0.01$), lending support to H1.

Table 3. Descriptive statistical analysis of variables.

	1	2	3	4	5
1. Anthropomorphism	1				
2. Perceived Usefulness	0.231**	1			
3. Perceived Hedonicity	0.249**	0.624**	1		
4. Empathy Level	0.243**	0.421**	0.366**	1	
5. Continuous Usage Intention	0.236**	0.631**	0.674**	0.295**	1
Mean	3.75	4.83	4.73	4.78	4.68
SD	1.41	0.97	1.05	1.21	1.02

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This study used cascade regression to analyze and test perceived hedonicity and perceived usefulness mediating effects, and the results are shown in Table 4.

Table 4. Results of the mediational analysis.

Variable	Model1	Model2	Model3
Gender	-0.111	-0.070	-0.107
Age	-0.002	0.018	0.052
Education	-0.146	-0.061	-0.060
AN	0.265***	0.111*	0.086*
PU		0.590***	
PH			0.642***
R ²	0.101	0.415	0.472
ΔR^2		0.314	0.371
F	9.247	46.625	58.562

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model1 and Model2 were used to verify the mediating role of perceived usefulness between anthropomorphism and continuous usage intention, and Model2 added the mediating

variable PU to Model1. The regression results showed that the regression coefficient for AN changed from 0.265 ($p<0.001$) to 0.111 ($p<0.05$), and the positive effect of PU on CI remained significant ($\beta = 0.590$, $p<0.001$), suggesting that PU partially mediated the effect of AN on CI, as verified by H1 and H4. Similarly, Model1 and Model3 were used to validate the mediating role of PH between AN and CI. The regression results showed that the coefficient of the direct effect of AN on CI changed from 0.265 ($p<0.001$) to 0.086 ($p<0.05$) with the addition of the mediating variable PH, while the positive effect of PH remained significant ($\beta=0.642$, $p<0.001$), suggesting that PH partially mediated the effect of AN on CI, as validated by H1 and H5.

In addition, using Hayes' research methodology [33], H4 and H5 were further tested. analyses at 95% confidence intervals were conducted using the PROCESSv3.3 plug-in for SPSS. The results show that perceived usefulness and perceived hedonicity play a mediating role between anthropomorphism and users' continuous usage intention, with mediating effects of 0.0565 (LLCI = 0.0258, ULCI = 0.0950) and 0.0808 (LLCI = 0.0386, ULCI = 0.1273), respectively, with no upper or lower bound of the 95% confidence interval containing 0, i.e. hypotheses H4, H5 were further tested.

Table 5. Bootstrap effect analysis.

Effect path	Mediator	Effect	SE	LLCI	ULCI
Direct effect		0.0326	0.0283	-0.0230	0.0882
Mediating effect	PU	0.0565	0.0175	0.0258	0.0950
	PH	0.0808	0.0232	0.0386	0.1273

Model4 and Model6 in Table 6 were used to test the effect of the independent variables AN on PU and PH, and a positive effect of AN on PU and PH could be obtained ($\beta=0.260$, 0.277 , $p<0.001$), and hypotheses H2 and hypothesis H3 were tested.

Model4 and Model5 were used to verify the moderating effect of EL between AN and PU. Model5 added the interaction term between AN and EL to Model4 for regression analysis and showed that the interaction term had a significant effect on PU ($\beta=0.108$, $p<0.05$), and hypothesis H6 was verified. Similarly, Model6 and Model7 were used to test the moderating effect of EL between AN and PH, indicating that the coefficient of the interaction term was significantly positive ($\beta=0.137$, $p<0.05$), and hypothesis H7 was tested.

Table 6. Results of the modulatory analysis.

Variable	Model4	Model5	Model6	Model7
Gender	-0.069	-0.083	-0.006	-0.020
Age	-0.033	-0.013	-0.084	-0.074
Education	-0.144	-0.092	-0.133	-0.086
AN	0.260***	0.157**	0.277***	0.191**
EL		0.361***		0.293***
AN×EL		0.108*		0.137*
R ²	0.095	0.228	0.102	0.201
ΔR^2		0.132		0.099

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As shown in Figures 2 and 3, to examine the effect of anthropomorphism on perceived usefulness and perceived hedonicity at different levels of empathy, the empathy levels were divided into a low empathy level group and a high empathy level group based on the mean of the variables plus or minus one standard deviation, and a simple slope analysis was performed [34]. In Figure 2, it can be seen that anthropomorphism has a strong positive effect on perceived usefulness for service robots with high levels of empathy, while for service robots with low levels of empathy, this effect is not significant, further supporting hypothesis H6. This effect is relatively weak for service robots with low levels of empathy.

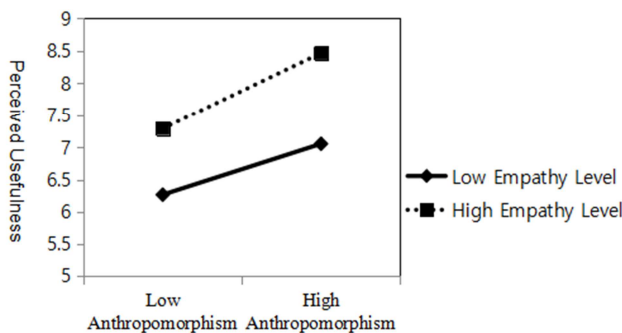


Figure 2. Moderating effect of empathy level.

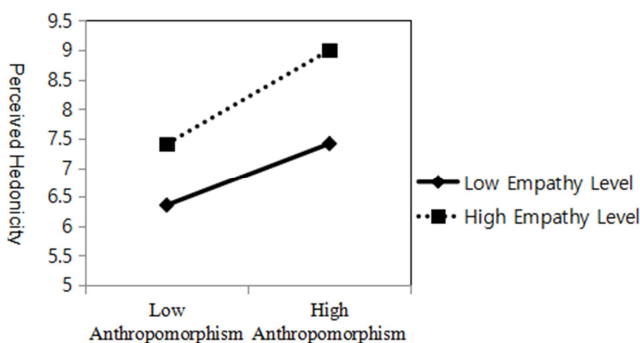


Figure 3. Moderating effect of empathy level.

5. Conclusion

5.1. Conclusions

This paper focuses on exploring the process mechanisms of service robot characteristics on users' willingness to continue using them, applying Social information processing theory to the context of human-robot interaction. Three main conclusions can be drawn.

Firstly, the anthropomorphic appearance features of service robots effectively increase users' willingness to continue using them. Physical appearance is a technology of simplicity and operability and is an important factor influencing user behavior [35].

Secondly, the process mechanism of the service robot's facilitative effect on users' willingness to continue using it is partially mediated by perceived hedonicity and perception. The similar capabilities and familiar emotions to those of

human employees conveyed by the service robot's anthropomorphic features simultaneously increase users' competence and emotional closeness to the service robot. This leads them to perceive the service robot as useful and effective and to continue to use it.

Thirdly, the level of empathy of the service robot moderates the relationship between anthropomorphism and perceived usefulness and perceived hedonicity; the level of empathy significantly enhances the customer's perception level, which in turn enhances the user's continuous usage intention.

5.2. Theoretical Contributions

The current research adds several new insights to the knowledge in the service robot characteristics and continuous usage intention literature. Firstly, this paper expands the domain of service robot research to the combination of mechanical features and empathetic features for effective service robot implementation. Previous literature on robotics has mostly focused on the Technology Acceptance Model, focusing only on the level of functionality of service providers [36]. Perceived usefulness and perceived ease of use, as fundamental, inherent embodiments of robot capabilities, can only unilaterally assess the level of capability of service robots [37]. However, Huang et al suggest that researchers need to consider various robot features together such as mechanical, analytical, intuitive, and empathetic to successfully use service robots [36]. By jointly studying service robot appearance features and emotional features, this paper enriches the study of service robot feature interactions.

Secondly, our results unveil the process mechanisms by which service robot features influence customer attitudes, building upon Social information processing theory. Existing literature has demonstrated that the emotions expressed by virtual robots through voice, tone of voice, and content have a significant impact on the user's perception of the product and ultimately customer outcomes [38], but these effects have not been empirically tested yet for service robots. Our paper successfully applied Social information processing theory to the context of intelligent service. Further, we empirically tested which type of service robot feature is perceived more favorably in continuous usage intention.

5.3. Managerial Implications

As AI technology matures and costs fall, more and more industries (such as elderly care, education, and logistics) are using service robots and are receiving good feedback. Based on the findings of this paper, we offer the following recommendations for how companies can use service robots.

Firstly, our findings suggest that the characteristics of service robots stimulate future continued use by enhancing users' perceptions of their usefulness and hedonicity. Despite the rapid development of both service robot technology and applications, there is relatively little relevant academic

research [37]. This paper provides some specific recommendations for the application of service robots in enterprises. Therefore, companies should select service robots with anthropomorphic characteristics and capable of expressing emotions, as appropriate for different service scenarios, especially where human opportunities for communication and interaction arise. In addition, service approaches should be constantly updated in order to maintain long-term user contact. Companies need to keep an eye on how well the robot is working to ensure that it can efficiently and consistently provide a pleasant and useful service to customers.

Secondly, companies need to consider paying more attention to the development of technologies that incorporate the service language and body movements of human employees into robotic systems, so that customers feel that service robots can have the emotion and ability to perform competently. In addition, employees within the company need to take the initiative to treat the server robot as a 'colleague' and create a warm and welcoming service atmosphere, thereby enhancing positive user sentiment towards the service robot. In addition, for users, they are used to receiving services passively. Therefore, during the initial use of a service robot, users do not fully utilize its functions and therefore do not experience the service experience to the maximum. Therefore, it is necessary to give the user some tips and assistance so that the user can fully enjoy the intelligent service as much as possible.

5.4. Limitations and Suggestions for Future Research

Although this paper provides preliminary evidence of the interaction between extrinsic and empathic features of service robots and the process mechanisms that influence users' willingness to use them. However, this paper has several limitations that should be addressed by future researchers.

Firstly, the selection of the study population was limited by the incomplete range of influencing factors included in the study. This may limit the generalisability of our findings. Future researchers will need to validate this finding in different service industries, combining different combinations of characteristics of service robots. In addition, ongoing user use is a complex process and it will be necessary to select smarter, humanoid service robots for validation in the future to enhance the generalisability of the study's findings.

Secondly, this paper only investigates the impact of different characteristics of service robots on customers' willingness to use them, and future researchers are advised to consider other environmental and organizational factors in a comprehensive manner. For example, the attitudes of companies applying service machines may moderate the impact of service robots themselves on users. In addition, the survey respondents, although consistent with the age distribution of the robot-using group, are limited to the younger age group, and the lack of an older sample affects the empirical results to a certain extent; the mechanisms

influencing the continuous usage intention could be explored in a broader group in the future.

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