

Article

What Affects the Acceptance and Use of Hotel Service Robots by Elderly Customers?

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Abstract: Against the realistic backdrop of the COVID-19 pandemic and an aging population, emerging robot technology provides a new path for the development of high-quality hotel service. However, little is known about elderly customers' acceptance and use of hotel service robots. This study explores factors that affect elderly customers' acceptance and use of hotel service robots. From the perspective of perception and emotion, based on the technology acceptance model and quality service theory, a hotel service robot acceptance model was constructed for this study, and a structural equation model was used to analyze the data from 218 interviews. The results show that empathy, perceived value, perceived usefulness and perceived ease of use directly affected the elderly customers' intention to use robots. Perceived trust indirectly affected the use intention through perceived usefulness and perceived ease of use. This study provided a theoretical basis for user behaviors regarding hotel service robots and provided guidance for the research and development of hotel service robots and the marketing promotion of hotel managers, which would promote the healthy development of service robots and related industries, such as the hotel service industry.

Keywords: service robot; artificial intelligence; intention to use robots; hospitality; human–robot interaction



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1. Introduction

Tourism is a new way of life in modern society. It has no age limit and can bring people health and improve their quality of life. This has certain practical significance for solving the problem of aging and prolonging the life expectancy of the elderly [1]. With the increase in tourism consumption, people's demand for hotels is also increasing. In light of the aging population, elderly tourists are one of the consumer groups that cannot be ignored in the hotel industry. The sudden COVID-19 pandemic has changed the operation of the hotel industry [2], placing unprecedented pressure on hotels and other tourism-related organizations and causing a decline in revenue [3]. Previous studies [4,5] have confirmed that robots are a potential solution for the hotel industry to combat the pandemic. Therefore, hospitality service industries, such as hotels, need to make changes in their technology and service models in order to cope with the uncertainty of a labor shortage caused by an aging population and the sudden breakout of the pandemic [5].

Robots have gradually entered the public spaces of people's daily lives, which has created a new era for hospitality services [6,7]. With the development of technology, the application of service robots in various fields of people's lives has attracted attention, especially in the hospitality and tourism industries that provide services for people [6,8,9]. Robots are increasingly used in hotel operations, which has been illustrated in the hotel examples of Shangri La Hotels and Resorts, and Marriott International, according to Buhalis and Leung [10]. The hospitality service includes guest reception, room cleaning, room service, consultation, luggage handling and meal preparation [2]. The use of robots in hotels can reduce the use of human resources to a certain extent, can provide customers with new ways of service, communication and feedback, and can provide better service quality [11]. Robot use can attract consumers, highlight the smart technology service

features of hotels and increase their selling points [12]. In hotels, robots can work with human hotel employees to serve guests so as to improve work efficiency and ultimately achieve excellent operation and high-quality service [13]. However, consumers are less willing to use robots as part of the service experience [14]. As a result, understanding why users have such a reaction to hotel service robots is an important research topic.

User research has been conducted on hotel service robots. For example, the study of Xu et al. [15] explored the impact of using robots on hotel leaders and staff management. Their research pointed out that service robots might present a series of potential challenges, such as rising hotel costs and significant changes in hotel management structure and culture, while improving the efficiency of hotel services. Vatan and Dogan [16] pointed out the perception of robots by hotel employees in Turkey. Although there are many advantages in using service robots in hotels, hotel employees still believe that the use of service robots may cause some problems in the process of communication with hotel customers. In addition, Ivanov et al. [17] discussed hotel managers' views on the use of robots in hotels. Mukherjee et al. [18], on the other hand, conducted research on hotel employees' intention to use robots. Although there has been some user research on robots done, most of the current research is carried out from the demographic level, and the user behavior research of systematic hotel intelligent technology is still poorly understood [19]. To the best of our knowledge, there is currently no research that has been conducted on elderly customers' intention to use robots in hotels from the perspective of perception and emotion. As Ranieri et al. [20] pointed out, older adults are increasingly incorporating smart technology-related solutions into their daily lives. Ge and Schleimer [21] conducted a study of interaction with robots in Australian seniors of about 70 years of age of different cultures and languages, and they found that seniors are willing to learn new technologies and can successfully interact with multiple robotics independently. This suggests that robotics has the potential to enhance the sense of belonging, independence and quality of life of older adults, thereby enhancing their well-being. In addition, studies by Shibata et al. [22] demonstrate the utility of robot Paro in improving the social engagement of users, such as the elderly, and reducing negative emotional and behavioral symptoms. This is one of the effective ways to reduce the impact of the new crown virus epidemic. It can be said that the benefits of using robots are diverse and beneficial, whether for hotels or for the elderly. Therefore, against the backdrop of population aging and the rapid development of tourism in the post-epidemic era, it is extremely necessary to carry out research on the acceptance and use of hotel robotics by elderly customers.

The technology acceptance model [23] is a model for technology use and verification. It explores the perceived influencing factors for users' intention to use new technologies. The model points out that users' beliefs about the perceived ease of use and perceived usefulness of technology or systems have a positive and significant impact on their intention to use. Because of its simplicity and good theoretical basis, the model has been widely used, including in tourism social media [24] and self-service hotel technology [25]. Hotel service robots are an emerging technology, and the users' behavior may also be affected by the perceived usefulness and perceived ease of use in the technology acceptance model. Therefore, in order to explore elderly customers' intention to use hotel service robots, this study used the technology acceptance model as its theoretical basis. However, the TAM lacks consideration of the perceived value of innovation and technology [26]. Users' perceived value of services is considered to be a prerequisite for better satisfaction than quality [27]. Perceived value is the overall evaluation made after weighing the benefits that users can feel with the costs paid for the technical products or services they can obtain [28]. In the service of hotels and other fields, perceived value includes consumption value [29], transaction value and service value to consumers [30]. Since users seek the value of technical systems or services, the innovative services provided by organizations may not be enough to attract users [31]. Therefore, users should be aware of the rationality and benefits of their investment so that they can perceive the value of new technologies or systems. In order to increase the competitiveness of hotels, it is necessary to fully

understand the utility and impact of perceived value when providing new products or services [32].

Empathy is one of the five dimensions of the service quality theory (SERVQUAL theory) [33]. It is a multidimensional concept [34,35] that covers the emotional dimension and the cognitive dimension [34], but it focuses more on the emotional dimension. Empathy, as a vague theoretical construction, is used to refer to a related but different process, namely, caring for customers and providing them with personalized services [36]. Robots can be used to provide empathic nudges to their human objects, which can enhance their empathy ability [37]. Picarra and Giger [38] mentioned that social robots with high empathy need to show care and support when interacting with users. Parasuraman et al. [39] pointed out that empathy is the core quality that service providers must possess. It requires that service providers and served individuals be highly sensitive to each other's negative or positive changes so as to adjust their actions in real-time [33]. When the service robots interact with the users, they can detect the users' emotions, infer and perceive the users' situations and then give corresponding feedback according to the users' emotional states [40]. Users may feel good about the robot service because of this empathetic feedback process. However, technical systems usually ignore empathy and only provide services at the functional level [41]. Therefore, this study included empathy with an emotional connotation in the study of elderly users' intention to use hotel robots. In addition, perceived trust can be regarded as the degree to which customers feel secure when interacting with service providers [42], which represents customers' intent to take risks [43]. If users believe that robots and other technologies are untrustworthy, they are unlikely to use them in the future [14]. Komiak and Benbasat [42] pointed out that trust in electronic service providers is an important topic. This topic is particularly important for the service robots that provide explanations or information tasks to the elderly [14]. Therefore, this study incorporated perceived trust.

In summary, the aging population and the sudden pandemic of COVID-19 have brought challenges to the human costs, methods and quality of hotel services [44], and robots are potential solutions to these challenges [45]. If tourists do not like robot services, the hotels' introduction of robots to provide service will not last long [46]. Users are less willing to use robots as part of the service experience [14]; hence, user acceptance is still an important obstacle to the application of robots in the service field. Most of the previous studies have carried out research from the perspective of demographics, and the user behavior research of systematic hotel intelligent technology is still poorly understood [19]. We have not found any research on the intention of elderly customers to use robots in hotels to provide services, so it is extremely necessary to consider the use of robots by elderly users in hotel situations. Therefore, the purpose of this study is to understand the response of elderly customers to the use of hotel service robots and to explore the relevant factors that affect users' intentions to use them for services. From the perspective of perception and emotion, this study—with the technology acceptance model and service quality theory as the main theories—explored the relevant influencing factors of elderly customers' use of hotel service robots. In other words, this study explored the impact of perception (i.e., perceived usefulness, perceived ease of use, perceived value and perceived trust) and emotion (i.e., empathy) on the intention of elderly users to use hotel service robots; built a hotel service robot acceptance model; and conducted empirical research with Chinese elderly samples. This study attempted to reveal the influencing factors that affect the technology adoption of elderly customers, with a view to providing useful reference for the design, effectiveness, promotion and service managers of hotel service robots. With the help in the design of highly acceptable hotel service robots, this study aims to improve the smart hotel service experience of hotel customers and to promote the healthy development of service robots and related industries, such as the hotel service industry.

2. Theory and Research Hypothesis

2.1. Technology Acceptance Model

The TAM proposes two important perception factors that affect users' technology acceptance, namely, perceived usefulness and perceived ease of use. Perceived ease of use refers to the degree to which users believe that it is easy and effortless to use a specific technical system or service. Perceived usefulness is interpreted as the extent to which users believe that using a certain technical system or service will improve their work or task performance [23]. In tourism-related studies, the usefulness of technical systems or services had an impact on users' intention to use, which was confirmed in tourism-related research regarding hotel self-service technology [25,47] and tourism search engines [48]. In addition, according to the study by Forgas-Coll et al. [49] on the gender and personality of robot assistants, it has been confirmed that perceived ease-of-use has a positive impact on usefulness, and perceived usefulness and ease-of-use have a positive impact on intention to use. Emerging technologies, such as hotel service robots, make it convenient for elderly tourists to stay in hotels. They can help tourists plan trips, book services, handle check-in or check-out, and provide reminders and other services related to their personal travel and stay in the hotel. Therefore, based on the above literature, the following research hypotheses were proposed:

H1: *Perceived ease of use has a direct and positive impact on the usefulness of hotel service robots.*

H2: *Perceived ease of use has a direct and positive impact on the intention to use hotel service robots.*

H3: *Perceived usefulness has a direct and positive impact on the intention to use hotel service robots.*

2.2. Empathy

Murray et al. [50] interpreted empathy as the ability to understand and present others' feelings, thoughts, behaviors and experiences. Empathy is a multidimensional concept, including at least the cognitive dimension and emotional dimension [51]. In robot technology research, empathy can be seen as the ability and requirement for smooth interaction between users and social robots [52], while between robots and users, even if it is a temporary interaction or contact, subtle attitudes and emotions can be transmitted to each other [53]. Empathy, as an important ability and social skill, needs to be considered [54]. Some pointed out that empathy could have an impact on user technology adoption. For example, Rossi et al. [55] revealed a positive correlation between empathy and user acceptance. In the study of Tan et al. [56] on whether empathy caused by the anthropomorphic appearance and behaviors of a garbage can will affect people's evaluation and intention to use recycling bins, empathy has a significant and positive impact on intention to use. Empathy requires giving priority to reactions and actions from the perspective of users [57]. Therefore, the user's behaviors require timely feedback and presentation from the robot's empathy; as a special group, elderly customers may desire more care and understanding than people in other age groups. Therefore, this study took empathy into consideration and put forward the following hypothesis:

H4: *Empathy has a direct and positive impact on the intention to use hotel service robots.*

2.3. Perceived Trust

Perceived trust involves the user's belief in the reliability of technical systems or services [58] and the potential of technical systems or services to perform the tasks required by users well [59]. Perceived trust has been applied to online websites [60], tourism [61] and self-service hotel technology [25] and has been proven to have a significant impact on users' intention to use. The research of Mukherjee, Baral, Venkataiah, Pal and Nagariya [18] proved that trust has a positive impact on perceptions of two beliefs: perceived usefulness and perceived ease of use. In addition, a study by de Graaf and Ben Allouch [62] found that users' trust in technology will significantly affect their perception of robots' practicability.

However, the guarantee of effectiveness obtained by people from their interaction with robots depends on the degree of trust people have in robots and the information they transmit [14]. Park and Stangl [63] pointed out that, when new technologies are applied to the hotel service industry, perceived trust is an important antecedent variable. In this study, perceived trust was interpreted as the elderly customers' perception of the reliability of the service or information provided by hotel service robots in terms of quality, privacy protection and security. In summary, the trust of the elderly in hotel service robots may also be an important factor, so it should be taken into account. Therefore, the following hypotheses were proposed:

H5: *Perceived trust has a direct and positive impact on the usefulness of hotel service robots.*

H6: *Perceived trust has a direct and positive impact on the ease of use of hotel service robots.*

H7: *Perceived trust has a direct and positive impact on the intention to use hotel service robots.*

2.4. Perceived Value

Perceived value is understood as the overall tradeoff between perceived benefits and cost sacrifices [64]. However, users' perception of technical systems or services is the basis for technology adoption, so product technology research and development organizations should constantly increase their users' perception and satisfaction with the value of technical systems or services [65]. Perceived value seems to cover different categories of content according to different objects and situations, such as technology types, the committed value of service types and tangible asset value [26]. However, regardless of the type, time, cost and satisfaction can generally be used for tradeoff evaluation [26]. Sheth, Newman and Gross [29] pointed out that perceived value includes the following five kinds of values—function, society, emotion, condition and cognition—while the users' value perception of technology or a system affects their adoption and experience of the technology system. The impact of perceived value on user technology adoption has been verified in previous studies. For example, Venkatesh et al. [66] explored the close relationship between user emotion and user behaviors and pointed out that value, as a motivation, has an impact on consumer purchase decisions [29]. When studying the users' intention to use shared ride services, Wang et al. [67] found that there was a significant positive correlation between perceived value and the users' intent to participate in shared riding. It can be said that users' adoption of technology is affected by its perceived value [68]. Therefore, this study suggested that elderly customers' perceptions of the value of hotel robots would also affect their intention to use. In this study, perceived value was defined as a comprehensive evaluation after weighing the benefits and costs that elderly customers feel when using service robots in hotels. Therefore, the following hypothesis was proposed:

H8: *Perceived value has a direct and positive impact on the intention to use hotel service robots.*

To sum up, the conceptual model, as shown in Figure 1, was proposed in this study.

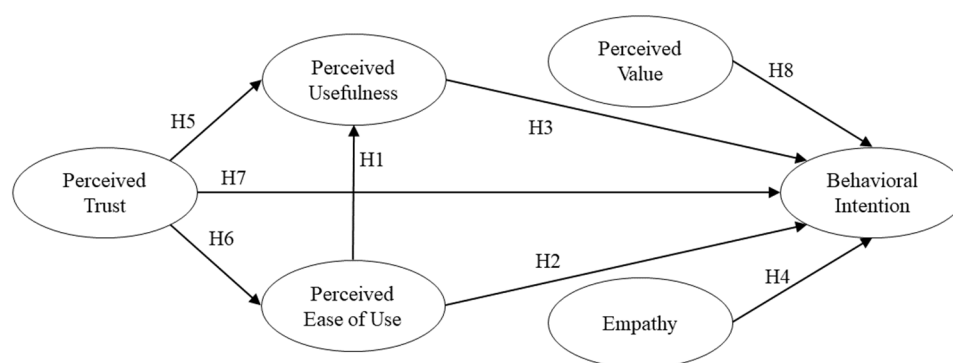


Figure 1. Research Structure.

3. Methodology

3.1. Measures

Although the applications of robots in daily life are gradually increasing and their application scenarios are becoming increasingly rich, robots are still a relatively new technology at present. Considering that the research on users' reactions to robots is still in its early stages, it is feasible to adopt survey and research methods [14]. Therefore, this study used questionnaires to collect research data. The measurement indicators for each dimension in this research questionnaire were adapted from relevant theoretical literature research to ensure the reliability and validity of their measurement. There were 6 dimensions and 19 measurement items in the questionnaire. All dimensions, measurement items and their reference sources are shown in Table 1. Questions were answered in numbers from 1 (strongly disagree) to 7 (strongly agree). In addition, the questionnaire also includes demographic content on five aspects, namely gender, age range, educational level, number of hotel stays per year and experience using smart products.

Table 1. Measurement Scale.

Constructs	Items	Sources
Perceived value (PV)	PV1 Compared to the traditional human service in hotels, it is worthwhile for me to use robots to provide services.	[30]
	PV2 Using a robot to provide service in a hotel is a satisfying experience.	
	PV3 Compared to the cost of the service I need to pay, using a robot to provide a service in a hotel is value for money.	
Perceived Trust (PT)	PT1 I feel the service provided by the hotel service robot is real.	[61]
	PT2 I think the service provided by the hotel service robot is clear and reliable.	
	PT3 I feel it is trustworthy to use robots to provide services in hotels.	
	PT4 I feel that hotel service robots have the necessary ability to provide customer service.	
Empathy (EM)	EM1 Robots that provide services in hotels usually understand my specific needs.	[33]
	EM2 Service robots in hotels usually give me personalized attention.	
	EM3 The service robot in the hotel is always convenient when I need it.	
Perceived Usefulness (PU)	PU1 Using a hotel service robot can enhance my hotel stay experience.	[23]
	PU2 Using a hotel service robot can improve the efficiency of service.	
	PU3 Using a hotel service robot takes the stress out of my hotel stay.	
Perceived Ease of Use (PEOU)	PEOU1 Learning to operate a hotel service robot would be easy for me.	[23]
	PEOU2 It would be easy for me to become proficient with a hotel service robot.	
	PEOU3 I will find a hotel service robot easy to use.	
Behavioral Intention to Use (BI)	BI1 I intend to use a hotel service robot for service in the future.	[23]
	BI2 I hope to use hotel service robots to serve in the future.	
	BI3 I plan to use a hotel service robot to serve in the future.	

3.2. Data Collection

The data for this study were collected by questionnaires, and the researchers conducted the survey in one month and a half. The interviewees were surveyed in the bustling commercial street in Zhanjiang City in western Guangdong Province, southern China. These interviewees were obtained through convenient sampling. They were all suitable because they had experience in hotels; most interviewees also had experience using smart products. A total of 237 respondents completed the questionnaire. After a comprehensive analysis of the questionnaire, 218 questionnaires remained valid, with an effective recovery rate of 91.98%. This study was approved by the Academic Committee of Guangdong Ocean University. Each respondent participated in this study voluntarily after understanding the purpose of the study and began to fill in the questionnaire after giving an oral consent.

3.3. Statistical Analysis Method

Partial least squares-based structural equation modeling [69] is a method suitable for early development testing [70]. Considering its advantages in multivariable analysis [71] and good results in small sample studies [72], partial least squares-based structural equation modeling was selected for the analysis of measurement models and structural models. At the same time, according to the suggestion of Hair et al. [73], 5000 repeated samples were used to calculate the significance of the path coefficient in order to obtain a more stable estimation coefficient value.

3.4. Common Method Bias

In order to prevent common method bias [74], this study reduced possible common method bias through the anonymous filling of questionnaires and topic descriptions that were easy to understand. At the same time, according to the suggestions of Wang et al. [75], Harman's Single Factor Test was used to evaluate the common method bias. The results show that the degree of a single factor maximizing the explanation variance was 40.642%; it did not exceed the 50% standard [76], indicating that no common method bias was observed in this study.

4. Data Analysis and Results

4.1. Sample Profile

Descriptive demographic statistics are shown in Table 2. There were 218 effective respondents of this study, including 54.6% women and 45.4% men. There were 67 people aged 60–64; 77 people aged 65–69; 34 people aged 70–79; and 14 people aged 80 and above. The educational level of respondents included 32.6% of primary school and below; 37.1% of junior high school; 21.6% of senior high school; and 8.7% of undergraduate and above. Among the respondents, 65.1% had the experience of staying in hotels 1–3 times a year; 50 people stayed in hotels 4–6 times a year; 18 people stayed in hotels 7–9 times a year; and 8 people stay in the hotel 10 times or more every year. Most (194 people, 89%) respondents said they had experience in using smart products.

Table 2. Statistical description.

Items	Frequency	Percentage
Gender		
Men	99	45.4%
Women	119	54.6%
Age		
60–64	67	30.7%
65–69	77	35.3%
70–74	34	15.6%
75–79	26	12.0%
≥80	14	6.4%
Education		
primary school and below	71	32.6%
junior high school	81	37.1%
senior high school	47	21.6%
undergraduate and above	19	8.7%
Number of hotel stays per year		
1–3 times	142	65.1%
4–6 times	50	22.9%
7–9 times	18	8.3%
≥10 times	8	3.7%
Experience with smart products		
Have	194	89.0%
None	24	11.0%

4.2. Measurement Model Analysis

This study evaluated the reliability and validity of the measurement model. The results are shown in Tables 3 and 4. In terms of dimensional reliability, the composite reliability and Cronbach's alpha values could be used for evaluation. According to the suggestions of Hair et al. [77], the values of composite reliability and Cronbach's alpha values should be greater than 0.7. The results of this study show that the composite reliability values of all dimensions are between 0.844 and 0.892, and Cronbach's alpha values are between 0.723 and 0.818, indicating that the dimensional reliability met the requirements. In addition, the factor load of each measuring indicator is also higher than 0.7, which indicates that it had indicator reliability [77]. This study then evaluated the convergent validity of the measurement model. The AVE value of all structures needs to exceed 0.50 to present a sufficient convergence validity level [77,78]. The results are shown in Table 3. The AVE value of all structures exceeds 0.5, meeting the convergence validity requirements. In addition, according to the Fornell-Larker criterion, in order to meet the discriminant validity requirement, the value of the correlation coefficient between all dimensions should be lower than the square root of AVE [77,79,80], and the square root of AVE should not be lower than 0.7 [69]. As shown in Table 3, diagonal numbers represent the square root of the extracted AVE; non-diagonal numbers represent the correlation between structures; and their values meet the requirements of discriminant validity.

Table 3. Reliability and validity values.

Construct	α	CR	AVE	BI	EM	PEOU	PT	PU	PV
BI	0.818	0.892	0.733	0.856					
EM	0.740	0.852	0.658	0.587	0.811				
PEOU	0.723	0.844	0.643	0.520	0.463	0.802			
PT	0.785	0.861	0.609	0.539	0.634	0.541	0.780		
PU	0.776	0.870	0.690	0.606	0.586	0.452	0.437	0.831	
PV	0.792	0.878	0.705	0.593	0.490	0.380	0.584	0.450	0.840

Note: 1. The diagonal is the square root value of the average variance extraction amount; 2. AVE: Average Variance Extracted; 3. CR: composite reliability; 4. α : Cronbach's alpha.

Table 4. Factor Loading and Cross Loading.

Items	BI	EM	PEOU	PT	PU	PV
BI117	0.856	0.475	0.399	0.418	0.479	0.483
BI218	0.836	0.521	0.480	0.456	0.509	0.496
BI319	0.876	0.510	0.454	0.505	0.564	0.542
EM18	0.475	0.831	0.323	0.575	0.476	0.432
EM29	0.496	0.811	0.409	0.471	0.503	0.388
EM310	0.457	0.790	0.395	0.498	0.445	0.371
PEOU114	0.352	0.298	0.782	0.443	0.311	0.225
PEOU215	0.428	0.414	0.789	0.391	0.363	0.286
PEOU316	0.464	0.397	0.833	0.467	0.407	0.389
PT14	0.372	0.489	0.442	0.740	0.321	0.363
PT25	0.500	0.620	0.399	0.834	0.401	0.538
PT36	0.328	0.382	0.374	0.727	0.248	0.447
PT47	0.459	0.466	0.471	0.814	0.373	0.470
PU111	0.519	0.483	0.418	0.391	0.856	0.353
PU212	0.491	0.463	0.285	0.322	0.825	0.382
PU313	0.499	0.512	0.413	0.372	0.811	0.388
PV11	0.515	0.400	0.282	0.467	0.408	0.847
PV22	0.439	0.438	0.354	0.479	0.350	0.830
PV33	0.531	0.401	0.328	0.524	0.372	0.843

Note: The values in bold are factor loadings.

4.3. Structural Model Analysis

After the analysis of the measurement model, the structural model was analyzed. According to the suggestions of Hair, Ringle and Sarstedt [73], 5000 repeated samples were used to calculate the significance of the path coefficient. Table 5 and Figure 2 are the path coefficients and their significance evaluation results. As shown in Figure 1, the perceived ease-of-use had a positive impact on the perceived usefulness ($\beta = 0.305$, $t = 3.771$; $p < 0.001$) and intention to use ($\beta = 0.184$, $t = 3.680$; $p < 0.001$) in using the hotel service robots, so H1 and H2 were supported. Perceived usefulness had a positive impact on elderly tourists' intention to use hotel service robots ($\beta = 0.271$, $t = 4.779$; $p < 0.001$), which confirmed H3. The results show that empathy had a significant positive impact on intention to use ($\beta = 0.175$, $t = 2.728$; $p < 0.01$), so H4 was confirmed. This study also showed that perceived trust had a direct and positive impact on perceived usefulness ($\beta = 0.272$, $t = 3.112$; $p < 0.01$). Furthermore, perceived trust also had a direct and positive impact on perceived ease of use ($\beta = 0.541$, $t = 9.802$; $p < 0.001$), which indicated that elderly tourists trusted hotel service robots to provide relevant services, so H5 and H6 were supported. However, perceived trust had no direct effect on users' usage intentions ($\beta = 0.039$, $t = 0.508$), so H7 was not supported. In addition, the research also showed that perceived value had a direct and positive impact on intention to use ($\beta = 0.292$, $t = 4.864$; $p < 0.001$), so H8 was supported. The results show that perceived trust had the greatest impact on the intention to use, with the second influential being perceived usefulness and the third being perceived ease of use.

Table 5. Research hypothesis empirical results.

Research Hypothesis			Path Coefficients	Standard Deviation	t-Value	p-Values	Result
PEOU	→	PU	0.305	0.081	3.771	0.000	H1 Support
PEOU	→	BI	0.184	0.050	3.680	0.000	H2 Support
PU	→	BI	0.271	0.057	4.779	0.000	H3 Support
EM	→	BI	0.175	0.064	2.728	0.006	H4 Support
PT	→	PU	0.272	0.088	3.112	0.002	H5 Support
PT	→	PEOU	0.541	0.055	9.802	0.000	H6 Support
PT	→	BI	0.039	0.077	0.508	0.611	H7
PV	→	BI	0.292	0.060	4.864	0.000	Nonsupport H8 Support

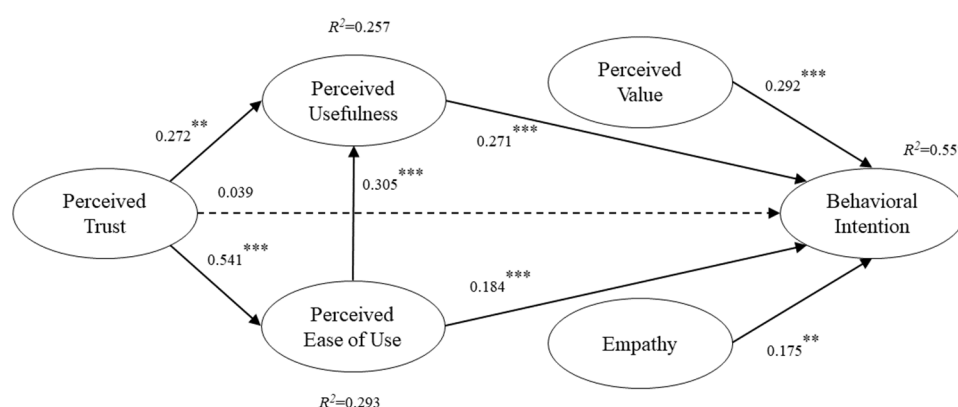


Figure 2. Research Results. Note: **: $p < 0.01$; ***: $p < 0.001$.

This study evaluated the predictive relevance of Q2. A value greater than 0 indicates that the model had predictive relevance [73,81]. The results show that the Q2 values of perceived usefulness, perceived ease-of-use and intention to use are 0.167, 0.177 and 0.390, respectively, which are greater than 0, indicating that the model had predictive relevance. The determination coefficient R2 can be used to evaluate the explanatory power of the research model. The higher R2, the stronger the explanatory power of the model. Falk and Miller [82] mentioned that R2 values greater than 10% have independent explanatory power.

In this study, the R^2 value of intention to use is 0.557; the R^2 value of perceived ease-of is 0.293; and the R^2 value of perceived usefulness is 0.257, indicating that the R^2 in this study has reached the level. In general, the model proposed in this study had an explanatory power. In addition, the goodness of fit of a model is also an indicator. Tenenhaus et al. [83] suggested that a value greater than 0.36 represents good fitness. The goodness of fit of the calculation model in this study is 0.498 and greater than 0.36, indicating that the sample data in this study fitted the proposed model well. In addition, the standardized root mean square residual (SRMR) is an evaluation index for the overall fitness of PLS path modeling, and a value less than 0.08 indicates a good fitness of the model [84]. Our evaluation results show an SRMR value of 0.068, indicating a good model fit.

5. Discussion

Ranieri, Guerra, Angione, Di Giacomo and Passafiume [20] pointed out that the elderly still have a good affinity for technology—which indicates that the impact of intelligent technologies, such as robots, on the daily life of the elderly is gradually increasing, and the possibility of its application in the daily life of users is also increasing. The hospitality service industry, such as hotels, needs to change its technology and service models in order to cope with the uncertainty of a labor shortage caused by an aging population and a sudden pandemic [5]. In the face of uncertain global health issues, such as COVID-19, social robotics has emerged as a beneficial way of assisting or potentially replacing humans in providing services. Certainly, as an emerging technology, service robots have gradually entered the hospitality service industry, such as hotels, to provide services for customers. However, users are less willing to use robots as part of the service experience [14]. This study aims to reveal the factors affecting elderly customers' intentions to use hotel service robots and to construct and demonstrate a hotel service robot acceptance model. The results show that empathy in the emotional dimension and perceived trust, perceived value, perceived usefulness and perceived ease of use in the cognitive dimension had a positive impact on elderly customers' intention to use robot services in hotels. Among them, empathy, perceived trust, perceived usefulness and perceived ease of use had a direct impact on intention to use; perceived trust indirectly impacted intention to use by positively influencing perceived ease of use and perceived usefulness. In addition, perceived ease of use positively impacted usefulness, which further impacted the intention to use indirectly. The research results will help increase the understanding of the user behavior of the elderly on hotel service robots, enrich the theory of elderly user behavior and provide theoretical guidance for the design, management and marketing of hotel service robots.

The research results show that perceived usefulness and perceived ease of use had a positive impact on intention to use, which is consistent with previous research results on tourism technology [25,85]. This illustrates that elderly tourists will use the hotel robots if they find hotel robots easy to use and useful, can easily interact with them and perceive that the robots are helpful to their service needs during their stay in the hotels or travel. Elderly customers become more aware of technology and more interested in trying it. Users are very happy to use hotel service robots for service or tourism planning. Therefore, in the early stage of the development of hotel service robots, the focus should be put on the ease of use of hotel service robots, including whether elderly customers can easily operate them. At the same time, hotel service robots and their related facilities should also be fully equipped to meet the service needs of consumers so that, while having a good technology experience, elderly consumers can also obtain the required hotel or tourism-related services quickly. Therefore, the perceived usefulness must be considered; after all, it has a profound impact on the user's technical acceptance. As Sung and Jeon [86] pointed out in their study on the influence of customers' use of robot baristas, perceived usefulness and other factors affect the acceptance intention of robot baristas.

From the perspective of environmental psychology, Scheutz et al. [87] explored the possibility of different social robots encouraging people to conduct sustainable behaviors in hypothetical scenarios, such as dishwashing or cooking in the home kitchen, enterprise or

home energy monitoring, laundromat and cafeteria. The machines in these situations need to have a certain social sensibility. However, social interaction involves a multi-dimensional system, including users' knowledge, emotions and interaction environment [88]. Our research shows that empathy had an impact on users' intention to use hotel service robots, which extends previous studies. It shows that users' intention to use robots for hotel services depends not only on the acceptance of technology itself or technological innovation [6] but also on robots' consideration of users' emotional mechanisms. Therefore, in the subsequent research, development and design of hotel service robots, designers should center on elderly users, make empathy the focus and explore the dimensions of intelligent perception and intelligent interaction methods to improve their empathy. As a result, when service robots interact with the users, they can detect the users' expressions, infer and perceive the users' emotions and then make corresponding feedback according to the users' emotional states [40] to provide users with services that meet their current states or needs. Therefore, as a robot providing hotel services, it is necessary to fully consider the emotions of users and the emotional contact features presented in the human–computer interaction process [88]. Only when the interaction between the hotel robot and the elderly customers is endowed with the most delicate and perceptual emotional contact can the elderly users perceive and experience the emotional interaction experience of the hotel robot and stimulate their interest and intention in the use of the hotel robot. In order to make the interaction between hotel robots and elderly customers a more emotional contact experience, we can try to express the robot shape and its anthropomorphic design as well as color design. As shown in the research of Kuster et al. [89], in comparison with the shape of the robots, the humanoid reactions of robots more significantly affect the perception of thinking, and this process is considered to play an important role in caring. In addition, the exploration of empathy in robot anthropomorphic design is also a feasible path. As Leite et al. [90] pointed out, personification increases the dimension of emotion and perception empathy for human–computer interaction and achieves higher social acceptance and more positive and lasting social interaction. In some human–computer interaction studies, it is found that empathy and other emotional mechanisms are related to robot design and the degree of personification that people give them. For example, Riek, Rabinowitch, Chakrabarti and Robinson [54] explored whether the degree of personification in robot appearance can affect people's empathy for robots. The results show that people's empathy for humanoid robots is higher than that for robots whose appearance is more like that of machines. In addition, the research of Okita [91] integrated the elements of robots and animals. The results show that strong empathy is triggered by using animal robots as social agents. At the same time, because of its strong expressiveness, product color design can become one of the means of shaping enterprises and products [92]. Hotel robot designers can make full use of the emotional semantics of product colors and other information connotations to strengthen the emotional attributes of robot products and to enrich their human–machine emotional contact. Therefore, hotel service robot developers should make full use of the effect of empathy on users' technical behavior intentions and then design hotel robots full of empathy characteristics to provide hotel customers with considerate services and care and to apply social bots to increase social interaction between customers and hotels.

This study showed the indirect impact of perceived trust on the intention to use through perceived usefulness and perceived ease of use. This illustrates that elderly customers believe that the more reliable the hotel service robots are, the more likely they are to choose to use service robots. The results also further confirm the important influence of trust factors on the intent of elderly customers to use robot technology. However, the non-significant effect of trust on usage intention in this study is different from the results of previous studies [62], which may be due to the difference in the study subjects and may also be due to the fact that elderly customers still pay more attention to the practicability and operability of robot products. Only when the product is useful and easy to use will senior customers consider further use. Our research confirmed the impact of perceived trust on the intention to use hotel service robots, indicating that elderly customers believe

that the services provided by hotel service robots need to be reliable and credible. To a certain extent, customers trust robots, which may be because their service needs are not urgent or their requirements are relatively low. When elderly customers encounter an emergency, they may still expect human attendants to provide services. Therefore, when using robots to provide services, hotel managers should focus on protecting consumers' personal safety, property safety and information security, ensuring the safety and reliability of robot products and services. Hotel managers should humanize the trust issue, which may arise when robots provide services, and safeguard the interests of elderly customers. In addition, our research also shows that perceived trust directly affected users' perception on the usefulness and ease of use of robots. This shows that, when elderly customers trust robots, they will also have a more positive perception of robots. Therefore, robot researchers and developers must strive to enhance the trust that robots bring to users; otherwise, it will affect users' cognition of robots, create cognitive biases toward robots and then affect their intention to use robots.

The research results show that elderly consumers' perceived value of hotel service robots positively impacted their intention to use them, indicating that elderly consumers believe that the higher the benefits and values brought to them by using service robots in hotels, the stronger their intent to choose to use robots in hotels for service. These results further illustrate the important impact of perceived value on the technology adoption intentions of elderly consumers. Our research results are similar to those of Yang et al. [93] on internet acceptance and use, that is, perceived value plays an important role in internet user acceptance. As Belanche et al. [94] pointed out, robot attendants with artificial intelligence can identify the names of tourists in time and take the initiative to greet them, promoting tourists' positive feelings about the services they provide. This virtually increases the users' favorable impression of the robots and generates the emotional value perception of being respected during the service process. When a service robot smiles and interacts with users politely, users will feel that the service robot is kind and friendly [95]. In addition, AI robots may speak multiple languages, even local dialects, which may reduce the communication difficulties caused by human attendants in language communication, making customers feel more comfortable [31] and more valuable with robot services. Therefore, robot designers and hotel managers should focus on designing and planning the use of hotel service robots based on the value interests of users so that users can feel that it is worthwhile to use robots to provide services in hotels. Only in this way can we enhance users' intention to use hotel service robots and promote the continuous and extensive application of robots in hotels and other fields.

6. Conclusions

6.1. Conclusions

As a potentially effective solution to alleviate problems, such as labor shortages, hotel service robots have gained much attention. However, little is known about the factors that affect elderly customers' intention to use robots for hotel services. Based on the technology acceptance model and service quality theory, this study explored the impact of perceived trust, perceived value, perceived usefulness and perceived ease of use in the perception dimension and the impact of empathy in the emotional dimension on the intention to use of elderly customers. In addition, a hotel service robot acceptance model was constructed and demonstrated in this study. The results found that empathy, perceived value, perceived usefulness and perceived ease of use had direct and positive effects on behavioral intentions. Perceived ease of use has a positive effect on perceived usefulness. Perceived trust positively affects perceived ease of use and perceived usefulness, which in turn affects behavioral intentions. This research further expanded the technology acceptance model, enriched the user behavior research theory of hotel service robots and can serve as a reference for designers, managers, decisionmakers and marketing promotions related to hotel service robots.

6.2. Contribution

Against the backdrop of the COVID-19 pandemic and an aging population, the hotel industry is in urgent need of technological change to cope with uncertainties, such as labor shortages and outbreaks. Robots provide a new path for hotel service innovation. Currently, user behavior research for hotel smart technology is still poorly understood [19]. To our knowledge, this is the first study to investigate older customers' intentions to use hospitality robots. Therefore, this study has certain theoretical and practical significance.

The theoretical implications of this study: Firstly, from the perspective of perception and emotion, this study explored the relationship between perceived value, perceived trust, perceived usefulness, perceived ease-of-use, empathy and the elderly customers' intention to use service robots. This provides a more targeted theoretical reference for the subsequent design and marketing promotion of hotel service robots. In particular, this study showed that empathy was also an effective factor in predicting user behaviors. This will provide more thinking for the research and development of smart technology in hospitality service industries, such as hotels that adhere to the customer first. However, in the era of intelligent human–computer interaction, it is extremely necessary to fully consider the emotional needs of users and to build emotional contact channels between robots and elderly users. Therefore, the exploration of the emotional dimension of empathy in the research highlights the value of this research. Then, although the technology acceptance model is widely used to explain the user's technology acceptance, because it does not fully consider more exogenous variables, the model cannot be applied to more technology acceptance studies [25], which is a limitation. Therefore, this research took hotel service robots as the research objects, integrated the theoretical literature, such as the technology acceptance model and service quality theory, and constructed the elderly hotel service robot acceptance model. While further expanding the technology acceptance model, it also provided a theoretical basis for the emerging technology research of the current hospitality service industry, such as hotels, and enriched the hotel industry user research theory. Then, targeting hotels and other tourism industries, the research model this study proposed has been confirmed by the subjects of Chinese elderly customers, which has not only enriched the application field of the technology acceptance model but also provided a reference to other researchers to understand the hotel robot-related behaviors intention of Chinese elderly customers. Finally, the theoretically based hotel service robot scale for the elderly proposed in this study has been validated by this study, and the scale can provide a reference for the acceptance measurement of hotel robots and the formulation of other intelligent technology scales for the elderly.

The practical implications of this study: This study revealed the antecedents that affected elderly customers' intention to use hotel service robots, namely perceived value, perceived trust, perceived usefulness, perceived ease of use and empathy, which provides valuable insights for robot research and development designers and hotel practitioners and managers. The finding is of great significance to promote better applications and development of service robots in the hospitality industry. The developers of hotel service robots must ensure the functions of robots, provide users with practical functions, improve the value of users and enhance their intention to use. The research and development personnel should ensure that the service provided by robots is reliable and credible. The usefulness and ease of use of its products can be enhanced through the design of human–computer interfaces, such as voices and postures. Then, the findings of the positive effect of the empathy factor on the behavioral intention in this study provide thinking for the emotional design of hotel service robots. For example, on the basis of practicality and ease of use, hotel service robots try to achieve an interactive experience with more emotional experience and humanistic care, enhance the love and interest of elderly users in robots, and enhance their use intentions. Therefore, to promote the application of service robots in the hotel industry, all parties need to work together to enrich hotel service robot products, improve user-friendly services, highlight the value advantages of robot applications for hotels and users, and improve customers' intention to use hotel service robots.

6.3. Limitations and Future Directions

Although valuable conclusions have been drawn from this study, some limitations still exist. For example, the sample of this study is only for the elderly in China, which may limit the applicability and promotion of the results and models of this study in other age groups or elderly groups with other cultural backgrounds. At the same time, because the research subjects are a single group, this study cannot examine the influence of other potential factors, such as different ages. Therefore, it is valuable to consider the impacts of other age groups and their related factors on the adoption of hotel robot technology to expand the model proposed in this study in the future. In addition, although the hotel service robot acceptance model constructed and demonstrated in this study has a certain theoretical basis, the effectiveness of this model in other fields requires further verification. Therefore, the model needs to be tested subsequently, including the demonstration in different research objects and application fields, to further test and expand the model and provide more scientific theory for subsequent practical research.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and the ethical application for this study was approved by the Academic Committee of Guangdong Ocean University.

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