Advances in Educational Technology and Psychology (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/aetp.2024.080703
ISSN 2371-9400 Vol. 8 Num. 7

Exploration of the promotion path of the smart elderly care model under the background of fewer children in the elderly

Zihan Hong[a], Jiayi Dong[b], Lina Zhang[c], Lin Zhang[d]

Institute of Psychology, Ningbo University, Ningbo, Zhejiang Province, 315211, China
[a]3245222469@qq.com, [b]3213702595@qq.com, [c]3357496197@qq.com, [d]zhanglin1@nbu.edu.cn

Keywords: Silver hair technology, smart ageing, escort robots, Network of actors, elderly

Abstract: Regarding how to increase the acceptance and promotion scope of the smart elderly care model, this research adopted the questionnaire survey method and randomly selected elderly individuals aged over 60 in Ningbo as the survey subjects. Stratified regression was employed for data analysis. The results indicate that: (1) The majority (68.5%) of the elderly have a relatively high acceptance of companion robots, and this trend decreases with age (B = -0.083, p = 0.048); (2) Openness, initiative, family attitude, community assistance, and corporate donations can all significantly and positively predict the acceptance of companion robots by the elderly. (3) Taking companion robots as an example, the smart elderly care industry has a promising development outlook. In the future, it is necessary to boost the construction of smart elderly care in China from two perspectives: precisely positioning user profiles to develop more age-appropriate intelligent machines and integrating "family-community-enterprise" resources to construct an actor network for the smart elderly care model.

1. Introduction

In recent years, China's population development has faced significant changes, with "aging with few children" becoming the norm. The National Health Commission predicts that China will enter the stage of severe aging around 2035, experiencing rapid transition from "initial aging" to "severe aging" within 50 years, heading towards super aging[1]. To address this, the State Council issued the "14th Five Year Plan for the Development of National Aging Industry and Elderly Care Service System," pointing out issues like unbalanced development and the need for technological innovation in elderly care services. In this context, smart elderly care has gained attention[2]. Since 2013, scholars have explored smart pension models, creating "Internet" services for different elderly care scenarios[3]. This shift toward smart elderly care and technology is key for the industry's future and calls for more research and optimization.

Among smart elderly care products, elderly care robots stand out. These companion robots, as information-based medical products, help with companionship, daily tasks, mental health, and social confidence[4-5]. They also ease the burden on caregivers, showing broad application potential. However, the market for elderly care robots still faces challenges. Despite several

products, user experience often fails to meet expectations, as they overlook the unique needs of the elderly[6-7], leading to low acceptance rates. Therefore, understanding elderly acceptance is crucial to improving the product and promoting AI in elderly care.

Research mainly focuses on product-related factors influencing robot acceptance. Xu Liying reviewed studies on robot acceptance, summarizing factors like robot characteristics, capabilities, demographics, psychology, and human-robot interaction. They concluded that these factors are more manageable for designers and manufacturers[8]. However, examining individual, family, and social factors can reveal practical needs and opportunities for developing companion robots. Jiang Mengdie's research expands on this by considering individual and social factors, calling for policies that encourage elderly use of assistive technologies to foster an inclusive society[9].

In conclusion, developing intelligent companion robots requires a deep understanding of elderly acceptance and its influencing factors. A survey was conducted among individuals aged 60 and above to examine their acceptance and the factors at play. Based on the results, recommendations were made to improve acceptance and product design.

2. Method

2.1. Subjects

This survey was conducted online, randomly distributed to the elderly, and collected 600 responses. After screening out 155 invalid responses, 445 valid ones were retained, with an effectiveness rate of 74.16%. The demographic breakdown of the sample is shown in Table 1. Males make up 55.73%, slightly more than females; the majority (64.94%) are aged 60-65; 76.85% have urban household registration; 57.98% self-reported as in sub-health.

Table 1: Basic information of the survey sample of the elderly.

variable	classification	number of people	percentage
sex	man	248	55.73%
	female	197	44.27%
age	60-65 Years old	289	64.94%
	66-70 Years old	96	21.57%
	over 71 years old	60	13.48%
household registration	rural area	103	23.15%
	urban area	342	76.85%
health level	healthy state	29	6.51%
	sub-health state	258	57.98%
	disease state	158	35.50%

2.2. Questionnaires

2.2.1. Survey on the Acceptance of Accompanying Robot

The questionnaire was developed based on the Technology Acceptance Model (TAM)[10], focusing on the elderly's attitude and intention toward using companion robots. Acceptance consists

of three dimensions: value identification, emotional identification, and intention to use, with 9 items in total. A five-point scale was used, with higher scores indicating higher acceptance. Cronbach's alpha coefficient was 0.833.

2.2.2. Investigation of Factors Influencing the Acceptance of Accompanying Robots

This study examined factors from three perspectives: psychological characteristics, family, and society, based on Jiang Mengdie's classification. Sociodemographic factors included age, gender, registered residence, health level, and socio-economic status (SES), with 7 items in total. SES was scored based on education, occupation, and income, with higher scores reflecting higher status[9].

Openness, reflecting familiarity with new technologies, was assessed with two items: proficiency in using smartphones and understanding of companion robots, using a five-point scale. Higher scores indicated greater openness. Initiative, measuring the elderly's social engagement, was assessed by the question: "Do you actively participate in community activities?" Family attitude was measured by: "Would you use a companion robot if your family strongly supported it?" Higher scores indicated greater willingness under family support. The impact of community assistance, corporate donations, and government subsidies was assessed with three questions on willingness to use robots under these conditions, each using a five-point scale.

2.3. Data Processing

SPSS 25.0 was used for data analysis. Categorical variables were assigned values, and independent sample t-tests and ANOVA were used to explore differences in acceptance among different groups. Hierarchical regression was used to examine the impact of sociodemographic characteristics (age, gender, household registration, health level, SES), openness, initiative, family attitude, community help, corporate donations, and government subsidies on robot acceptance. A p-value of <0.05 was considered statistically significant.

3. Conclusions

3.1. Elderly Acceptance of Companion Robots

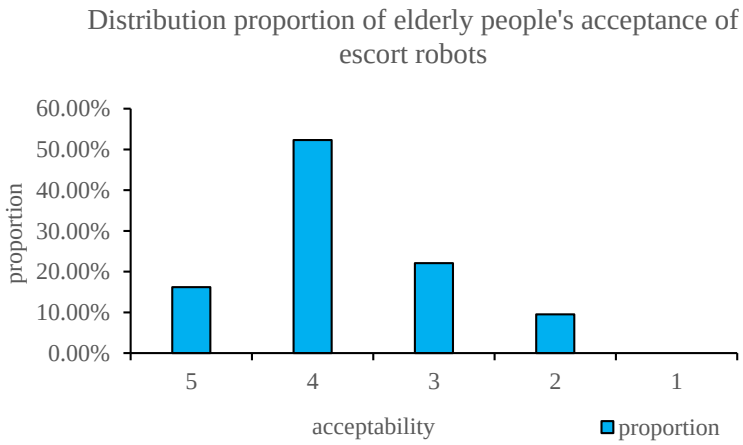

Figure 1: Distribution proportion of elderly people's acceptance of escort robots.

The acceptance status of elderly people towards companion robots is shown in Figure 1. The average acceptance score of the elderly (n=222) is 30.15 ± 7.07. Among them, 16.2% of the elderly accept and 52.3% relatively accept companion robots, while only 9.5% do not accept, and no one

strongly rejects them. These results indicate that most elderly people (68.5%) hold an open and inclusive attitude, with a high intention to use companion robots, suggesting a positive prospect for the future development of China's companion robot industry.

3.2. Acceptance of Companion Robots by Different Types of Elderly Groups

Table 2: Comparison of acceptance differences among different types of elderly groups.

		n	*M*	*SD*	*p*
Sex	Male	248	30.19	7.15	0.928
	Female	197	30.1	7	
Household Registration	Rural area	103	29.77	6.29	0.664
	Urban area	342	30.26	7.3	
Age	60-65Years old	289	31.02	7.11	0.02
	66-70 Years old	96	29.3	7.08	
	over 71 Years old	60	27.32	6.1	
Health Level	Healthy state	29	26.1	6.81	0.083
	Sub-health state	258	30.52	6.35	
	Disease state	158	30.27	8.03	
Socioeconomic Status	Low	121	28.88	7.07	0.209
	Middle	204	30.32	7.04	
	High	120	31.13	7.06	

As shown in tablet 2, independent sample t-tests showed no significant gender or household registration differences in robot acceptance ($p > 0.05$). A one-way ANOVA revealed significant age-related differences in acceptance ($F(2,219) = 3.95$, $p = 0.02$). The acceptance rate was higher for those aged 60-65 ($M = 31.02$, $SD = 7.11$) compared to those 71+ ($M = 27.32$, $SD = 6.10$), $p = 0.009$. No significant differences were found based on health or socio-economic status.

3.3. Factors Affecting the Acceptance of Elderly People Towards Companion Robots

3.3.1. Relevant Analysis

Table 3: Correlation matrix table of Individual factors, Social factors, and Acceptance.

Indicator variable	Openness	Initiative	Family attitude	Community assistance	Community assistance	Government subsidies
Openness	1					
Initiative	.346**	1				
Family attitude	0.118	.300**	1			
Community assistance	0.069	.355**	.643**	1		
Community assistance	.200**	.315**	.638**	.595**	1	
Government subsidies	.206**	.372**	.703**	.678**	.690**	1
Acceptance	.292**	.451**	.691**	.688**	.646**	.665**
Note: ** $p < 0.01$.						

Acceptance was positively correlated with openness ($r = 0.292$), initiative ($r = 0.451$), family

attitude (r = 0.691), community assistance (r = 0.688), corporate donations (r = 0.646), and government subsidies (r = 0.665), indicating that openness, initiative, and social support (family, community, business, government) positively impact the elderly's acceptance of companion robots.

3.3.2. Hierarchical Regression Analysis

Table 4: Hierarchical regression analysis of demographic characteristics, individual and social factors' degree of acceptance.

		Model 1				**Model 2**				**Model 3**			
	Grouping Variable	*SE*	*B* (95%CI)	*t*	*p*	*SE*	*B* (95%CI)	*t*	*p*	*SE*	*B* (95%CI)	*t*	*p*
	Constant	3.41	(22.83, 36.26)	8.67	0.000	3.50	(11.67, 25.47)	5.31	0.000	2.57	(-2.40, 7.72)	1.04	0.301
Demographic characteristics	Sex	0.96	0.016 (-1.66, 2.11)	0.23	0.816	0.85	0.066 (-0.75, 2.62)	1.10	0.274	0.58	0.03 (-0.73, 1.57)	0.72	0.473
	Registered residence	1.21	-0.012 (-2.59, 2.19)	-0.16	0.870	1.08	-0.023 (-2.51, 1.75)	-0.35	0.725	0.74	-0.045 (-2.20, 0.69)	-1.03	0.305
	Age	0.67	-0.167 (-2.95, -0.31)	-2.44	0.016	0.60	-0.174 (-2.87, -0.52)	-2.85	0.005	0.41	-0.083 (-1.62, -0.01)	-1.99	0.048
	Health level	0.82	0.044 (-1.09, 2.16)	0.65	0.518	0.73	0.004 (-1.40, 1.49)	0.06	0.952	0.50	0.019 (-0.74, 1.21)	0.47	0.639
	Socio-economic status	0.70	0.096 (-0.46, 2.30)	1.31	0.191	0.63	0.011 (-1.13, 1.35)	0.17	0.865	0.43	-0.048 (-1.30, 0.38)	-1.09	0.277
Psychological characteristics	Openness					0.45	0.137 (0.07, 1.83)	2.13	0.034	0.30	0.15 (0.44, 1.64)	3.43	0.001
	Initiative					0.67	0.409 (2.95, 5.57)	6.40	0.000	0.48	0.143 (0.54, 2.44)	3.09	0.002
Family	Family attitude									0.45	0.296 (1.27, 3.03)	4.82	0.000
Society	Community help									0.45	0.306 (1.41, 3.18)	5.13	0.000
	Corporate donations									0.40	0.162 (0.31, 1.88)	2.76	0.006
	Government subsidies									0.48	0.052 (-0.59, 1.32)	0.76	0.451
	R^2	0.045				0.258				0.672			
	Adjust R^2	0.023				0.233				0.655			
	F value	2.037				10.608				39.199			
	$\triangle R^2$	0.045				0.213				0.415			
	△ F value	2.037				30.639				66.504			
Dependent variable: Total acceptance score													

A stratified regression analysis was conducted with sociodemographic characteristics, openness,

proactivity, family attitudes, community assistance, corporate donations, and government subsidies as independent variables, and the total acceptance score of elderly people towards companion robots as the dependent variable. The study used the enter stratified regression analysis method to explore whether these factors significantly predict the acceptance of companion robots among the elderly. Three regression models were set up, with variables included in turn as follows: in model 1, sociodemographic characteristics including age, gender, registered residence, health level, and socio-economic status were included as control variables; secondly, psychological characteristics including openness and proactivity were added to Model 2 to examine their impact on elderly acceptance; finally, family and social factors, such as family attitudes, community assistance, corporate donations, and government subsidies, were included in Model 3 to examine their impact on acceptance.

The regression results of demographic characteristics, openness, proactivity, family attitude, community assistance, corporate donations, and government subsidies on the acceptance of elderly care robots are shown in Table 4. It can be seen that Model 1 has R^2=0.045, meaning that gender, registered residence, age, health level, and socio-economic status can explain only 4.5% of the total acceptance score. Among them, only age (B=-0.167, t=-2.44, p=0.016) had a significant negative predictive effect on the acceptance of companion robots, indicating that as age increases, the elderly are less likely to accept companion robots. In Model 2, after adding openness and proactivity, the R^2 is 0.258, with F (7,214) =10.608, p<0.01, showing that incorporating psychological features (openness and proactivity) increased the explanatory power by 21.3%. Among them, openness (B=0.137, t=2.13, p=0.034) and proactivity (B=0.409, t=6.40, p<0.01) significantly positively predicted acceptance, indicating that higher proactivity and openness are associated with higher acceptance of companion robots. In Model 3, after adding family attitude, community assistance, corporate donations, and government subsidies, the R^2increased to 0.672, and F (11,210)=39.199, p<0.01, indicating that including these family and social factors increased the explanatory power by 41.4%. Specifically, family attitude (B=0.296, t=4.82, p<0.01), community assistance (B=0.306, t=5.13, p<0.01), and corporate donations (B=0.162, t=2.76, p=0.006) have a significant positive predictive effect on the acceptance of caregiving robots. This indicates that, with family support for using caregiving robots, community assistance, and corporate donations, elderly people are more likely to have a higher acceptance attitude towards caregiving robots.

4. Discussion

4.1. The Impact of Age Factor on the Acceptance Level of Elderly People towards Companion Robots

A survey was conducted using the questionnaire method to investigate the acceptance of elderly people towards companion robots, as well as the sociological, psychological, family, and social factors affecting their acceptance. Research shows that elderly people (68.5%) are generally more accepting of companion robots. Further analysis revealed a negative correlation between age and acceptance, consistent with the findings of Heerink et al. and Giuliani et al., that older adults are more willing to adapt to the inconvenience of not using robots compared to using them[11-12]. The decline in physiological abilities may be the main reason. Research indicates that due to the loss of brain cells and degeneration of the nervous system, elderly people's ability to learn and accept new things decreases, requiring more cognitive effort and energy[13]. As people age, they put in more effort to learn new products, which may reduce their acceptance of companion robots. However, due to physical decline or the need for emotional companionship, older people may actually need the help of companion robots more.

4.2. The Impact of Openness and Proactivity on the Acceptance of Elderly People towards Companion Robots

This study found that initiative and openness significantly positively predict elderly people's acceptance of companion robots. The initiative of elderly individuals, which reflects their participation in social activities, may relate to their self-efficacy. Latikka et al. found a strong correlation between self-efficacy and robot acceptance[14]. Elderly people with high self-efficacy are more confident, proactive in social participation, and more willing to use new products. In contrast, those with low self-efficacy feel insecure and less willing to engage with new things. Additionally, the openness of elderly people also positively predicts their acceptance of companion robots, possibly due to their personal innovativeness. Agarwal et al. defined personal innovativeness as the willingness to try new technologies[15],which has been shown to significantly impact robot acceptance[16]. Older adults with higher personal innovation are more familiar with and open to new technologies, leading to greater acceptance of companion robots. This suggests that the positive impact of individual innovation on robot acceptance may have cross-cultural stability.

4.3. The Impact of Family and Society on the Acceptance of Elderly People towards Companion Robots

Family attitudes, corporate donations, and community assistance significantly predict elderly people's acceptance of companion robots. Research shows that with aging, individuals' thinking abilities change[17], and trust increases with age[18]. They are more inclined to positive emotional reactions and are highly influenced by the surrounding environment[19]. For elderly people, determining the value of companion robots depends on the information and evaluation from their social environment. Family support increases financial confidence and mental courage, making them more willing to learn about companion robots. In the consumption context, elderly people often rely on packaging and marketing methods for judgments. Donating robot products to enterprises for discounted sales can reduce elderly people's vigilance and improve their acceptance of companion robots. Community assistance means that companion robots gain recognition from an authoritative environment, reducing elderly resistance. Providing volunteer support in the community also helps alleviate technological anxiety. In summary, from a social perspective, creating a favorable product promotion and application atmosphere can effectively enhance elderly people's acceptance of companion robots.

4.4. Limitations of the Research

This study draws on Jiang Mengdie's classification of factors influencing elderly assistive technology acceptance, examining the impact of age, gender, health level, socio-economic status, openness, initiative, family attitude, community help, corporate donations, and government subsidies on elderly care robots' acceptance[9]. The research shows that age, openness, proactivity, family attitude, community assistance, and corporate donations all affect elderly people's acceptance. This provides empirical support for promoting the companion robot industry from individual, family, and societal perspectives. However, this study has limitations due to a small sample size and a lack of exploration into the positive impact of family and social factors on elderly people's exposure to and experimentation with new technologies. Further research is needed to analyze whether family or society plays a greater role in improving elderly people's acceptance of intelligent technology.

5. Suggestions

5.1. Accurate Positioning and Refinement of Product User Profiles

Before designing and developing companion robot products, the user profile of the target product should be refined. On the premise of considering a suitable age group for users, research on the target age group of elderly people should be conducted to understand their physiological and psychological characteristics. Based on real needs, product design and R&D should aim to meet the diverse needs of the elderly through product visualization. Additionally, this study found a positive impact of openness and proactivity on elderly care robots' acceptance. Therefore, in addition to considering age, the target elderly users' familiarity, understanding, and enthusiasm for new technologies should also be addressed. Product development and promotion should first research and evaluate the elderly with high openness and initiative to obtain authentic and effective feedback. Secondly, elderly users with high openness and initiative can be selected through questionnaires or app quizzes for precise product marketing. Furthermore, the "potential user circle" of elderly people with positive social attributes can be leveraged for a chain-like product promotion effect, expanding the companion robot's visibility in their social circle.

5.2. Collaborate with the Three Forces of "Family, Enterprise, and Society" to Construct a Network of Actors for Smart Elderly Care Models

5.2.1. Design an Intelligent Elderly Care Digital Image that is Friendly and Caring

The promotion of intelligent elderly care is not yet widely accepted, with nearly one-third of people still having "no understanding" of it. Based on the dynamic timeline model, future users will pay more attention to digital society promotion and experience. Enterprises should design approachable digital faces and App-based digital butlers to fit elderly people's desire for a "humanistic companion" style. Age-appropriate digital IP images can increase interest, understanding, and the social visibility of intelligent elderly care AI.

5.2.2. Building a Complementary Network of Community Actors

To enhance user acceptance, the role of community actor networks is essential. Community centers, families, and children should collaborate to promote intelligent elderly care: by enhancing elderly people's positive cognition of intelligent elderly care AI, creating opportunities for interaction, and establishing a supportive atmosphere. This helps update the elderly's role, making them beneficiaries of the AI elderly care model. By improving the socialization path and enhancing network cohesion, a complementary actor network can be built, where family, community, and enterprises promote each other.

In summary, leveraging the government's role in developing smart elderly care technology and integrating "family-community-enterprise" resources will create a supportive and inclusive social environment, where elderly people can use companion robots with peace of mind and happiness, fostering human-machine trust and advancing China's smart elderly care initiatives.

References

[1] Zhang Haomiao, Tan Hong. Innovative practice and optimization of health care services in smart communities: Based on local experience in Chengdu [J]. Journal of Chengdu University (Social Science Edition), 2024, (06): 15-30.
[2] Zuo Meiyun, Shen Yuanyanhang, Duan Ruirui. Research on Smart Elderly Care: Theoretical Review and Future Opportunities [J]. Population and Society, 2022, 38 (04): 3-14.
[3] Sun Qing, Liu Jiang. A literature review on smart elderly care based on Cite Space knowledge graph [J]. Foreign

Trade and Economic Cooperation, 2024 (6): 42-45.
[4] Cui Kaichang, Liu Chunyan. 2022 Artificial Intelligence Elderly Care Services: Development Model and Implementation Path [J]. Chinese Journal of Gerontology, 42 (08): 2037-2044.
[5] Liu Zongming, Ge Bihui. 2018 Design of elderly home care robot based on QFD [J]. Journal of Graphic Science, 39 (4): 695-699.
[6] Hu Fan. 2019 Research on the Current Status and Countermeasures of Smart Elderly Care Development [J]. Economic Research Guide, (9): 49-50 108.
[7] Xu Liying, Yu Feng. 2020 Factors affecting robot acceptance [J]. Scientific Bulletin, 65 (6): 496-510.
[8] Jiang Mengdie, Li Jiajia, Dai Fumin. 2020 Research progress on the acceptance and influencing factors of assistive technologies among the elderly [J].Nursing Research, 34 (13): 2334-2338.
[9] Davis F D, 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology[J]. Management Information Systems Quarterly, 13(3): 319.
[10] Heerink M., 2011. Exploring the influence of age, gender, education and computer experience on robot acceptance by older adults[J]. In Human-Robot Interaction.
[11] Giuliani M., Scopelliti M., Fornara F., 2005. Elderly people at home: technological help in everyday activities[J]. In Robot and Human Interactive Communication.
[12] Wu Lei, Li Juan, 2021. A review of inclusive design and ethical research on elderly service robots [J]. Packaging Engineering, 42 (8): 20-29.
[13] Latikka R., Turja T., Oksanen A., 2019. Self-efficacy and acceptance of robots[J]. Computers in Human Behavior, 93: 157–163.
[14] Agarwal R., Prasad J., 1998. A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology[J]. Information Systems Research, 9(2): 204–215.
[15] Serenko A., 2008. A model of user adoption of interface agents for email notification[J]. Interacting With Computers, 20(4–5): 461–472.
[16] Ngo E.B., 2001. When Disasters and Age Collide: Reviewing Vulnerability of the Elderly[J]. Natural Hazards Review, 2: 80-89.
[17] Schafer M. H., Koltai J., 2014. Does Embeddedness Protect? Personal Network Density and Vulnerability to Mistreatment Among Older American Adults[J]. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 70(4): 597–606.
[18] Guo Xiuyan, Zhang Jingmin, Zhu Lei, etc, 2007. A Preliminary Study on Age Differences and Confidence Differences in Misleading Information Effect [J]. Applied Psychology, (4):291-296.
[19] Wang Meng, Liu Tingting. Construction of Grassroots Social Governance Community from the Perspective of Actor Network: A Case Study of H Community in Chengyang District, Qingdao City [J]. The Communist Party of China Qingdao Municipal Party School Journal of Qingdao University of Administration, 2024, (04): 94-99.