Journal of Artificial Intelligence Practice (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/jaip.2025.080307
ISSN 2371-8412 Vol. 8 Num. 3

Empirical Study on AI Empowering Urban Home-Based Elderly Care

Yiwei Zhang

School of Statistics, Renmin Universtiy of China, Beijing, China

Keywords: Artificial Intelligence, Home Based Elderly Care, Technology Cognition Theory, Psychological Needs

Abstract: The rapid development of Artificial Intelligence (AI) is profoundly transforming lifestyles worldwide. With the accelerated aging of China population, challenges in elderly care services have become increasingly prominent, underscoring the urgent need for effective technology-enabled solutions. In this context, investigating how AI can effectively enhance home-based elderly care services holds substantial theoretical and practical significance. This study develops a research model of AI-enabled home-based elderly care grounded in Iceberg Theory and Technology Cognition Theory. Drawing on a survey of 300 elderly individuals and their adult children in Shenzhen China. the research thoroughly examines the intrinsic relationship between elderly care needs and AI technology applications. The findings offer both a theoretical foundation and practical guidance for leveraging AI to optimize urban home-based elderly care services, ultimately contributing to the improvement of elderly individuals' quality of life.

1. Introduction

1.1 Research Background and Significance

Global population aging has emerged as one of the foremost challenges confronting human society in the 21st century. As a developing country experiencing rapid demographic aging alongside a substantial elderly population, China faces particularly acute challenges in the domain of elder care. Key issues include the reduction of family size, increased caregiver burdens and associated economic pressures, as well as a pronounced imbalance between the supply and demand of community-based elderly care services. In 2022, fifteen governmental agencies, including the National Health Commission, Ministry of Education, and Ministry of Industry and Information Technology, jointly promulgated the "14th Five-Year Plan for Healthy Aging."[1] This plan underscores the imperative to leverage advanced information technologies—such as the Internet of Things and big data analytics—to innovate care service models and enhance the quality and efficiency of intelligent health services for older adults. Moreover, several major cities, including Beijing and Shanghai, have undertaken pilot programs deploying smart wristbands, health monitoring systems, and remote medical services within communities, aiming to improve the safety and convenience of home-based elder care.

Compared to countries such as Japan and the United States, where the aging process commenced

earlier and related product development has reached a mature stage, China application of artificial intelligence in elderly care remains in its nascent phase. Key challenges include inadequate standardization of elderly-related data, high costs associated with AI devices and services, underdeveloped commercialization models, and a deficiency in innovation that aligns with the specific needs of older adults. In this context, investigating methods to enhance the effectiveness of AI technologies in home-based elderly care holds substantial practical significance. Urban areas—characterized by rapid population aging, abundant technological resources, and robust policy support—constitute ideal platforms for researching AI-driven elderly care solutions. Such localized research can expedite technology validation and generate both scientific evidence and practical insights to inform broader implementation efforts..

1.2 Research Methods and Innovations

This study, based on cognitive models and Iceberg Theory, deeply analyzes elderly people's cognitive behaviors regarding AI products and the deep motivations behind their multi-level home-based care needs. Using a multivariate variable system and interdisciplinary methods, a structural equation model (SEM) of AI application, multi-level needs, and home satisfaction is established. The empirical analysis explores key driving factors and mediation mechanisms of AI empowerment in home elderly care, aiming to provide scientific references and policy recommendations for governments and communities to promote AI products in elder-friendly construction.

2. Current Situation of Urban Home-Based Elderly Care in China

2.1 Aging and Home-Based Care

China is experiencing one of the fastest rates of population aging in the world. According to United Nations data from 2019, China transitioned from an aging society—defined as a population with over 7% aged 65 and above in 2000—to a moderately aging society (14%) by 2021, achieving this shift within just 20 years. In contrast, countries such as France and Sweden spent 115 and 85 years respectively for the similar demographic transition. Research report (Ren, 2024) [2]states that the proportion of elderly individuals in China will reach 21% by 20235, marking its entrance into a heavily aging society.

The “9073” elderly care model proposed in China to address the challenge of rapid aging. It states approximately 90% of elderly individuals opting for home-based care, 7% utilizing community care services, and only 3% receiving institutional care. The Director of the National Bureau of Statistics has emphasized the social dilemma of “getting old before getting rich,” highlighting that many elderly people are unable to afford the costs associated with institutional care. Furthermore, there is a strong preference among the elderly to remain in familiar home environments where they can maintain family connections and personal autonomy.

Consequently, home-based care not only addresses the individual needs of the elderly but also aligns with the preferences of families and policy priorities, positioning it as the predominant form of elderly care in China. The familiarity of the home setting combined with active family participation reinforces home care as the preferred option. Moreover, it constitutes a critical focus within the national elderly care policy framework..

2.2 Challenges of Urban Home-Based Care

However, the rapid decline in family size coupled with an increasing proportion of urban

empty-nest and solitary elderly has generated significant challenges for home-based elderly care. The average household size in China has decreased remarkably from 4.41 persons in 1982 to 2.62 persons in 2020. Consequently, many family members experience dual pressures arising from both employment responsibilities and caregiving duties, adversely affecting their quality of life. The prevalence of multi-generational households has diminished, while the number of empty-nest and solitary elderly individuals has risen, contributing to escalating mental health concerns among the elderly population.

Despite governmental efforts manifested through multiple policy initiatives and increased investments aimed at enhancing the elder-friendliness of home environments and expanding community support networks, a persistent imbalance between the supply of and demand for elderly care services remains. The shortage of professional caregivers and medical resources continues to impede the ability to meet the diverse and complex care needs of the elderly. Furthermore, the utilization of community care services remains relatively low, evidencing a substantial gap between actual eldercare needs and the existing support infrastructure..

2.3 Urban Elderly Care Needs Analysis

Aging individuals living at home face increasing challenges as their physical functions decline and social networks diminish, resulting in diverse and complex service needs. According to the China Home-Based Elderly Care Survey Report by SFC group[3], key service demands can be categorized as follows:

Basic daily care: including nutrition support, elder-friendly housing modifications, and household facility maintenance.

Medical care: encompassing health monitoring, rehabilitation nursing, and home-based medical visits.

Psychological comfort: comprising mental health counseling and cultural or recreational activities.

Different age cohorts display distinct care priorities. Recently retired individuals around the age of 60 tend to emphasize psychological comfort needs, those aged 70 and above have heightened requirements for basic daily care, while individuals over 80 prioritize rehabilitation and medical services. Notably, health management needs remain relatively consistent across age groups, due largely to objective declines in physical capability coupled with concerns regarding loss of autonomy and maintenance of dignity in quality of life.

Drawing on Satir's Iceberg Theory, these visible care needs are manifestations of deeper emotional and psychological desires. Although health management represents a prominent apparent requirement, it fundamentally reflects underlying needs for respect (including a desire to avoid being stigmatized as 'patients'), security, a sense of value (particularly fear of becoming a burden on family), and autonomy (the ability to maintain control over one's own life).

In this context, artificial intelligence (AI) technologies—utilizing data perception and intelligent analysis within home-based elderly care scenarios—offer promising solutions. These technologies provide services such as continuous health monitoring and intelligent companionship, which support elderly individuals in maintaining independence and enhancing health security. Consequently, AI integration has the potential to improve both the quality of life and the sense of personal value for older adults receiving care at home..

3. AI Applications in Urban Home-Based Elderly Care

3.1 Current status of Domestic and international research

Artificial Intelligence (AI) refers to systems capable of perceiving data, performing cognitive analysis, and making autonomous decisions through techniques such as machine learning and natural language processing (Russell & Norvig, 2020) [4]. In the context of home-based elderly care, key AI applications encompass:

- Home safety services: real-time monitoring and alerting of health abnormalities to ensure the safety of elderly individuals remotely.
- Remote medical and personalized nursing services: addressing diverse health needs through tailored interventions.
- Intelligent companionship: mitigating loneliness and providing psychological support through AI-driven interaction.
- Home life care: including home automation and robotic assistance to support housework and physical care.

Internationally, countries with earlier aging processes, such as Japan and various European nations, have had a longer history of exploring AI-enabled home-based elderly care, with diverse and extensive technological applications. Japan's Pepper robot provides companionship, dialogue, and entertainment for the elderly, helping to alleviate feelings of loneliness. Germany primarily utilizes technologies such as telemedicine and mobile health to deliver efficient medical services to the elderly, aiming to enhance their ability for self-care through technological means. Sweden focuses on building digital healthcare systems and promoting community-based intelligent pilot projects that support rehabilitation training and social participation for the elderly. The Netherlands implements comprehensive management of elderly living environments through remote monitoring and smart home technologies. The United States has developed remote health management solutions encompassing wearable devices and telehealth platforms, accelerating their adoption during the pandemic. Several U.S. cities have also launched smart home elderly care pilot programs, collaborating with technology companies and communities to deeply integrate AI technologies into health terminal devices.

Compared to these countries, China research and application of AI in elderly care commenced more recently. Nevertheless, the Chinese government places significant emphasis on this area through policies such as the "14th Five-Year Plan for Aging Development" and the "Smart Healthy Aging Industry Action Plan," which promote the integration of AI with internet technologies. Market participants focus on developing wearable devices to monitor elderly health and detect abnormalities, while leading companies like Huawei and Tencent have introduced intelligent robots that provide voice reminders, facilitate communication, and offer psychological companionship. Additionally, smart speakers such as those by Tmall serve to alleviate loneliness.

Despite strong government leadership, significant enterprise investment, and active community pilot programs, actual adoption rates of AI-enabled elderly care remain low. Empirical studies, including experiments conducted in the United Kingdom, suggest that remote care systems exert limited influence on health outcomes or service utilization; furthermore, remote monitoring has not shown clear evidence of cost reduction or improvement in quality of life. A 2022 report from Beijing indicated that although smart service devices covered 90% of communities, fewer than 15% of elderly residents consistently engaged with these technologies throughout the year.

Furthermore, the 2023 White Paper on China Smart Healthcare Industry reported an annual production exceeding 1.55 million smart aging devices[5]; however, household penetration remains below 3%. A substantial proportion of these devices remain unused or are stored after delivery, with

active household user rates constituting less than 10% of total sales, highlighting significant challenges in both user adoption and sustained engagement.

3.2 Main Challenges

AI applications in home-based elderly care face multifaceted challenges, including immature technology, low user acceptance, high costs, and insufficient institutional support. From a technical perspective, many products lack elder-friendly designs and involve complex operations, thereby reducing ease of use. Research consistently identifies usability as a critical factor influencing elderly users' acceptance of technology. On the supply side, shortages of professional talent and the absence of standardized service protocols constrain improvements in service quality. Additionally, high costs impede the large-scale adoption of AI-enabled elderly care solutions.

The Invisible Guardianship – Silver Tech Blue Book 2022[6] revealed that approximately 70% of smart care products emphasize monitoring functions; however, the capacity for effective post-alert medical response remains inadequate, diminishing the overall value of these products. Existing studies mostly concentrate on functional adaptation and daily care needs but lack a comprehensive theoretical framework linking elderly individuals' technology cognition to their deeper psychological and social needs. Empirical evidence underscores that systemic policy support and coordinated management are essential to optimizing the integration of smart medical and elderly care services.

Moreover, ethical concerns related to technological intervention remain underexplored. While smart technologies offer convenience, they may undermine the autonomy of elderly users and generate complex socio-psychological consequences.

Within this context, the present study uniquely integrates Technology Cognition Theory and Iceberg Theory, drawing on over twenty in-depth interviews with elderly residents across six communities in Shenzhen and data from 300 offline and online questionnaires. This approach analyzes the mechanisms underlying cognitive formation and the multi-layered needs of elderly users. The study systematically examines key factors influencing AI empowerment in home elderly care and explores its mechanisms, with a particular focus on the multidimensional impacts on elderly individuals' technological autonomy, social participation, and self-efficacy. The objective is to provide both theoretical and empirical evidence to inform the development of people-centered smart elderly care service systems.

4. Theoretical Framework and Hypotheses

4.1 Technology Cognition and Its Role in Home Elderly Care

Technology cognition refers to individuals' mental representation and processing of technology systems. Tenenbaum and Land (2009)[7] argued that users' mental models of technology shape their understanding and usage patterns, emphasizing that cognition of technical functions together with value judgments jointly influence adoption behavior.

In the context of home elderly care, elderly individuals' cognition toward AI products operates through two pathways:

Usability cognition: the evaluation of whether the technology meets explicit needs, such as the accuracy of health monitoring and the speed of emergency response.

Psychological cognition: the perception of whether the technology satisfies implicit psychological needs, including the preservation of autonomy and dignity.

With physical decline, elderly users develop increasing health management needs, and their perception of AI devices as "enhancement tools" can increase their willingness to adopt such

technologies. A 2023 Wanqing Health Tech survey [8]reported that 55% of elderly individuals use digital health technologies, with usage rates for health applications and smart wristbands reaching 45% and 30%, respectively. Studies based on the Technology Acceptance Model (TAM) highlight that attitudes towards technology depend not only on perceived usefulness and ease of use but also on social contextual factors such as culture and societal cognition.

Research has noted that care robots sometimes raise concerns regarding the weakening of family responsibility and emotional alienation. For instance, media reports in Hong Kong warn that replacing human care with robots may exacerbate loneliness and family estrangement. Similarly, the Guangdong Civil Affairs Department pointed out that, despite policy-driven enthusiasm and investment, elderly care robots have encountered lukewarm acceptance, partly due to ethical concerns related to family dynamics.

These insights align with the Iceberg Model's emphasis on underlying needs for autonomy, suggesting that technology cognition must address both explicit functional layers and implicit psychological layers. Elderly individuals desire to independently manage their lives with AI support but do not want to live in isolation. The transition into later life often involves stressors such as loss of social roles and routine changes, which can result in negative emotions that affect subjective well-being and acceptance of AI technologies.

Integrating these perspectives, perceived usefulness directly enhances both satisfaction and adoption of technology. TAM further posits that external variables, including family cognition, influence perceived ease of use and usefulness, thereby promoting utilization. Family cognition can alleviate anxiety towards technology and improve acceptance, highlighting the important role of family perceptions in AI application. Based on this, following two hypotheses are proposed.

H1: AI application positively affects home care satisfaction.

H2: Family cognition positively affects AI application.

4.2 Iceberg Theory and Home Care Needs

Drawing on Satir's Iceberg Theory[9], home care needs comprise a dual structure consisting of explicit functional needs and implicit psychological value needs. Explicit needs relate to the adaptability of AI functions, while implicit needs pertain to ethical boundaries that ensure the preservation of elderly autonomy.

Family social support influences technology use through emotional recognition and compensatory mechanisms, providing psychological safety that enhances satisfaction with care services. Accordingly, the third and fourth hypotheses are proposed:

H3: Family social support positively affects AI application.

H4: Family social support positively affects home care satisfaction.

Value perception, as a core latent variable reflecting elderly individuals' implicit needs, exhibits a "double-edged sword" effect: moderate technological assistance (e.g., self-managed health monitoring) strengthens self-efficacy, whereas excessive replacement of traditional roles (e.g., fully automated care) may provoke anxiety related to role marginalization. Thus, the fifth hypothesis is proposed:

H5: Value perception moderates the relationship between AI application and home care satisfaction.

4.3 Research model

The study builds a "dual-core drive-layered regulation" model as Figure1.

- Technology cognition drive core: with family cognition and social support as exogenous variables, mediated by AI application degree to impact home care satisfaction.

• Demand level regulation core: with value perception as cross-layer moderator adjusting AI application-satisfaction relation.

This framework of Figure 1 highlights interaction between tech cognition and elderly deep needs, emphasizing focusing on elderly psychological value feelings to improve both elderly care service quality and satisfaction.

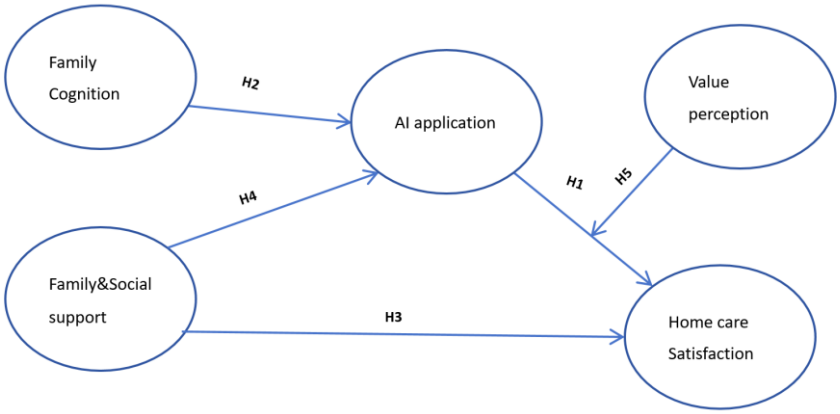

Figure1 Dual-core drive-layered regulation model.

Ovals means variables including AI application, Family Cognition, Family and Social Support , Value perception and Home care satisfaction. The Arrows with H-labels stands for 5 Hypothesized Relationships.

5. Data Analysis and Hypothesis Testing

5.1 Questionnaire and data collection

To test the five hypotheses proposed above, this study designed a structured survey questionnaire focused on the application of artificial intelligence in home elderly care and its related influencing factors. The survey covered six districts in Shenzhen, involving over 20 interviews with elderly individuals and distribution of a total of 300 questionnaires. Of these, 150 were offline questionnaires targeted mainly at people aged 50 and above, while the other 150 were conducted online, primarily targeting family members and individuals under 60, ensuring multi-level and multi-perspective data collection. The questionnaire covered five core dimensions:

The multidimensional data collected through this questionnaire will be analyzed using structural equation modeling to verify the hypothesized relationships among variables and to deeply explore the practical role and impact mechanisms of AI technology in the context of home elderly care.300 questionnaires distributed, 255 valid (85% effective rate). Age distribution: under 50 years 56.4%, 51-60 years 20.3%, 61-75 years 16.9%, above 75 years 6.4%.

5.2 Path Analysis and Hypothesis Testing

Using Smart-PLS 4.0, PLS - SEM Path Analysis Results of Factors Influencing Home Care Satisfaction is as Figure 2, which indicates below:

● AI application has a positive effect on home care satisfaction (path coefficient = 0.164, t = 2.177, $p < 0.01$), confirming H1. Although the effect size is small, this suggests that technology contributes to partial improvement in satisfaction but is not the primary determinant.

● Family cognition positively influences AI application (coefficient = 0.209, t = 4.049, $p < 0.01$), supporting H2. However, the moderate effect size (< 0.3) indicates that cognition represents only

one of several factors driving technology adoption.

- Family and social support exert a strong positive influence on AI application (coefficient = 0.594, t = 12.552, p < 0.01), confirming H3. Adequate social support significantly boosts technology adoption.
- Family and community support also positively impacts home care satisfaction (coefficient = 0.348, t = 12.552, p < 0.01), supporting H4. Such support provides elderly individuals with psychological comfort and security, which are crucial for meeting latent needs.
- The moderating effect of value perception on the relationship between AI application and home care satisfaction was weak and not statistically significant (coefficient = 0.001), thus H5 was not supported. This outcome may be attributed to the relative immaturity of the technology and challenges in quantifying complex psychological constructs.

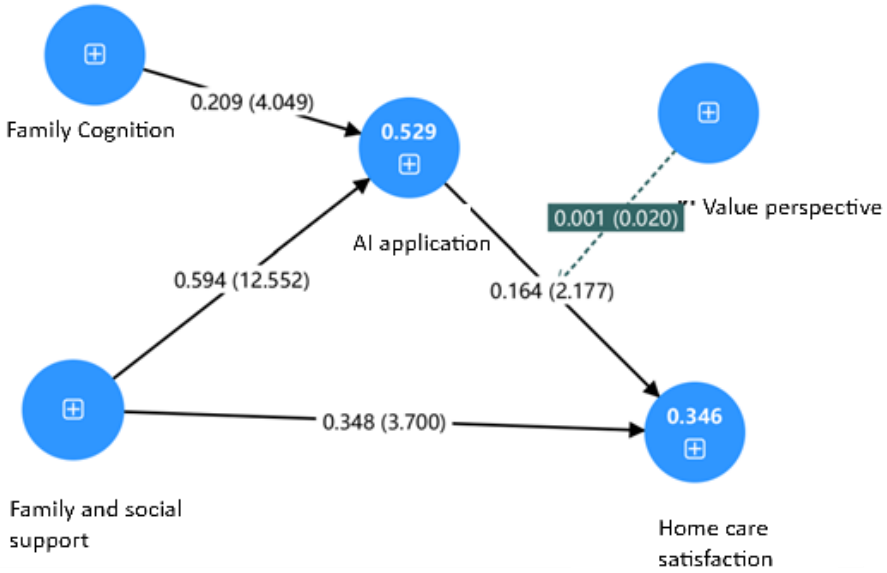

Figure2 PLS - SEM Path Analysis Results of Factors Influencing Home Care Satisfaction

6. Discussion of Results

Overall, the results confirm that family cognition and social support significantly influence AI application and empowerment in home elderly care. Family and community support emerge as key drivers: functional support reduces technical anxiety and facilitates technology use, while emotional support enhances willingness to adopt. A positive community technology atmosphere further promotes individual adoption behaviors. The moderate effect of family cognition on AI use reveals a "conversion gap" between cognition and actual adoption—family members' understanding remains focused on functional aspects, with limited awareness of emotional and privacy risks, leading to discrepancies between expectations and reality.

Variations in family members' technological understanding result in fragmented cognition levels, hindering the formation of consistent adoption attitudes. This underscores the need for emotional resonance and customized intergenerational approaches to foster shared acceptance.

The limited impact of AI on home care satisfaction reflects current product adaptation challenges and suboptimal user experiences. Concerns over elderly identity and autonomy also diminish positive perceptions of technology's effects on daily life.

The strong path coefficients for family and community support highlight their critical role in fulfilling elderly individuals' needs for belonging and respect, thereby enhancing overall home life

satisfaction. Traditional family-centered care, supported by social networks, reinforces cultural identity and social value.

The hypothesized moderation effect of value perception was not supported, likely due to its paradoxical nature: moderate technological assistance boosts self-efficacy and a sense of control, whereas excessive reliance on technology can provoke role loss and psychological alienation, offsetting positive effects. Moreover, measurement difficulties, along with cultural and individual differences, complicate value perception as a latent variable. Future research should employ mixed methods and more nuanced metrics to better capture its internal and external drivers as well as its temporal dynamics.

7. Conclusion

This study innovatively integrates Technology Cognition and Iceberg theories to reveal how elderly cognitive barriers and multi-level needs shape AI adoption and home care satisfaction. By analyzing the interconnected roles of cognitive processes, social support, and psychological needs, the study establishes a comprehensive framework for understanding AI adoption among urban elderly populations.

The findings underscore the crucial role of family and community support in facilitating AI use and enhancing elderly well-being. While improving AI usability remains important, embedding technology within comprehensive social support systems and family education is key to effective smart elderly care. Moreover, balancing elderly autonomy and emotional needs can prevent negative impacts of excessive technology reliance. Additionally, this research highlights the importance of protecting elderly autonomy and psychological health. It calls for careful attention to the balance between technological assistance and the preservation of seniors' independence and social roles, to avoid risks of psychological alienation that can arise from excessive reliance on technology.

Despite its contributions, the study is limited by its sample, which mainly covers an urban setting and lacks representation from rural and culturally diverse groups. The complexity of value perception and its measurement also surfaced as a challenge, showing that future studies need better ways to measure these factors. Expanding research to include broader populations and refining multidimensional scales for psychological factors are recommended for a more robust theoretical and practical understanding.

In conclusion, this study not only enriches the theoretical landscape of smart elderly care but also provides practical guidance for technology developers, service providers, and government-led community management. By fostering a holistic approach—one that combines technological innovation with social and emotional support—we can promote more effective, ethical, and satisfying models of elderly care in an aging society.

References

[1]The Central People's Government of the People's Republic of China, 2022. Notice on the Issuance of the '14th Five-Year Plan' for Healthy Aging. Available at: https://www.gov. cn/zhengce/zhengceku/2022-03/01/content_5676342. htm [Accessed 24 May 2025].

[2] Ren, Z., et al., 2024. China Aging Research Report 2024. Available at: https: //www. caoss. org. cn/UploadFile/pic/20229281791192316. pdf [Accessed 24 May 2025].

[3] SFC Group. White Paper on the Development Trend of Home-Based Elderly Care in China Available at: https://daneenon.com/wp-content/uploads/2022/09/%E3%80%8A%E4%B8%AD%E5%9B%BD%E5%B1%85%E5%AE%B6%E5%85%BB%E8%80%81%E5%8F%91%E5%B1%95%E8%B6%8B%E5%8A%BF%E7%99%BD%E7%9A%AE%E4%B9%A6%E3%80%8B.pdf [Accessed 24 May 2025].

[4] Russell, S.J. and Norvig, P., 2020. Artificial Intelligence: A Modern Approach. 4th ed. Pearson.

[5] Zhu, Y., Li, Z. and Jiao, G., 2023. National Smart Elderly Care Industry Development Report . Available at:

https://www.pishu.com.cn/skwx_ps/ps/literature?SiteID=14&ID=15824763 [Accessed 24 May 2025].
[6] Tencent and Silver Tech, 2022. Invisible Guardians: Silver Tech Blue Book 2022 [online]. Available at: https://13115299.s21i.faiusr.com/61/1/ABUIABA9GAAg1JjvoAYo1PTz2gI.pdf [Accessed 24 May 2025].
[7] Tenenbaum, G. and Land, W.M., 2009. Mental Representations as an Underlying Mechanism for Human Performance. Progress in Brain Research, 174, pp.251–252.
[8] Wanqing Health Technology, 2023. 2023 Research Report of Wanqing Health Technology [online]. Available at: https://www.sgpjbg.com/baogao/614631.html [Accessed 24 May 2025].
[9] Satir, V., Banmen, J., Gerber, J. and Gomori, M., 1991. The Satir Model: Family Therapy and Beyond. Palo Alto, CA: Science and Behavior Books.