

Research on Product Design System and Market Growth Strategies for New Intelligent Elderly-Care Robots

Kairan Shen *

International Department of Beijing No80 High school, China

* Corresponding Author Email: qweRdfty123456@outlook.com

Abstract. In the context of a quickly paced world of aging, intelligent elderly-care robots as a technology that is vital to overcome the servicing gap in relation to elderly-care services are enjoying new opportunities and challenges like never before. Based on an analysis of the current aging population and market demand, and integrating product innovation theory with commercialization promotion pathways, this paper systematically explores the product design system and market growth strategies for intelligent elderly-care robots. The study points out that current products suffer from core issues such as a disconnect between technology and demand, poor user experience, and low market penetration. It proposes a dual-track innovation system centered on "emotional interaction" and "physiological personalized services." By constructing a tiered product architecture (Tier 1–Tier 3) combined with the MVP development model, the usability, accessibility, and user acceptance of the products are significantly enhanced. Furthermore, market promotion strategies are proposed from perspectives such as policy coordination, ecological cooperation, experiential marketing, and new media communication, providing theoretical support and practical references for the widespread adoption and sustainable development of intelligent elderly-care robots.

Keywords: intelligent elderly-care robots; product design; aging population; emotional interaction; market strategy.

1. Introduction

In the contemporary world, the planet is experiencing a serious shift in population composition to the aging population. According to United Nations statistics, the number of elderly people who are 65 years and older will constitute 16 percent of the global total by 2050 and China is projected to have more over 400 million aged people indicating a much higher aging rate than the rest of the world [1]. Intelligent elderly-care robots are slowly gaining relevance to fill the existing disparity in elderly care, along with the increasing percentage of seniors living alone, changing family forms and more limited care resources, to enhance the quality of life of the elderly. A report by Boston Consulting Group (BCG, 2023) asserts that the elderly service robot market in the world was 22 billion dollars in 2023 and that the compound growth rate is also at 23.5, which shows that the market has a good growth momentum [2]. Nonetheless, the penetration rate of such products in the market is yet to reach 7% marking a noticeable diversity between the functionality of the products and the real needs of the elderly customers with much to be done regarding the user experience and social acceptance [3]. According to the background of the aging society, the current paper would dwell on product innovation and market expansion by the intelligent elderly-care robots, a systematic examination of their development history, central problems, and potential remedies would be conducted. It is also sought to improve the effectiveness of application and social awareness of these products by building a user-based product design system and sustainable business promotion system and avail actionable solutions and decision-making guidelines to the related business and government departments.

2. Similar Ideas and Approach to Research.

Product Innovation Product innovation is a methodical approach of creating or advancing the current product functions to satisfy market demands and it involves goods and services among other fields. It may be broadly categorized into two (possessing disruptive technological breakthroughs and incremental functional optimizations). Intelligent elderly-care robot product innovation, besides the

hardware performance boost and technological functionality breakthrough, focuses on customer-centered emotional and personalized design, which touches upon various fronts such as interactive experience, service situations, and psychological companionship.

Commercialization Promotion The proliferation of commercialization is a marketing approach the essence of which is to market products or services to the target audience using a variety of methods and channels to increase the impact of the brand, increase market share, and stimulate sales growth. When promoting the commercialization of intelligent elderly-care robots, when developing a more efficient marketing strategy, one should take into consideration aspects like the product adaptation to the elderly, its recognition and acceptance in the market and the policy approval.

3. Development Status and Existing problems of Intelligent Elderly-Care Robots

Robotics technology dates back to the 1960s, where it was actively used most often in industrial production and the army, where the goal is to replace human labor with high-intensity and high-precision or dangerous work. The development of research on rehabilitation robots also accumulated gradually in this respect. As the global conditions settled down and social problems like an ageing population started to take centre stage in the 1990s, commercial organizations started to realise the massive market potential in the elderly care services [4]. At the beginning of the 21st century, as the technologies of artificial intelligence, the Internet of Things, and big data were rapidly created, the elderly-care robots were gradually endowed with new functions, like emotional contact, intelligent perception, and remote care, and some countries are already introducing some products of this kind [5]. At present, the smart old-age-care robot market is experiencing the stage of active growth, and first of all it is creating a relatively complete industrial ecosystem. Rudimentary functional devices like health monitoring, medication reminders and remote calling have been implemented gradually in nursing facilities and home settings [6].

3.1. Design Principles

The learning load and the perceived complexity of use among the elderly end users is minimized by simplifying the voice interaction process, implementing graphical interfaces, and incorporating multi-modal feedback (like voice, tactile and visual) with the age-friendly design concept at its center [7]. Meanwhile, safety is taken into consideration in the product lifecycle, with several mechanisms involved, including fall-prevention alerts, emergency response, data encryption, and privacy protection, designed in a systematic security (safeguard system).

Tier 1: Minimal Safety Surveillance Type deals with high-need functions like fall detector, medication alert, and emergency calls. It is not cumbersome and easy to use particularly among elderly individuals and those with low self-care skills.

Tier 2: Mobile Assistance and Companion Type incorporates voice social interaction, memory assistance, cognitive training and entertainment interaction features on the foundation of safety monitoring, to increase mental health and social engagement of users.

Tier 3: AI Care Partner incorporates more advanced features including health data analysis, remote medical access, and custom service suggestions, which are focused on transitioning to an "intelligent elderly care" rather than just an "assistive tool" to a target audience of high-end users in communities and institutions.

The MVP (Minimum Viable Product) development model will allow enterprises to rapidly iterate and address user feedback, and will result in a reduction in the overall product cost by as much as 60 percent via constant optimization [8]. When combined with natural language processing and multi-modal emotion recognition technology, the accuracy of language interaction has risen to 77 percent when the modules of emotion computing are introduced [9]. The massive simplification of interaction design and guidance system based on context and one-click operation make the average period of independent learning of users aged over 70 years to be less than 15 minutes, and this is a huge success

in making products easier to use and enhance the user experience. Several policies like Smart Elderly Care Action Plan and Artificial Intelligence Elderly Care Experimental Base have also helped in giving solid backing to product development and promotion [10]. With technology integration and interdisciplinary collaboration, some major companies have first succeeded in implementing robots in various applications like fall prevention, chronic disease treatment, and daily companionship and showed good exemplary results and market opportunities.

3.2. Existing Problems

Although the market potential is huge, current products still have significant contradictions in multiple core dimensions, specifically manifested in the following aspects:

3.2.1 Gap Between Existing Functions and Age-Friendly Needs

In the pursuit of technological advancement, elderly-care robots often neglect the actual acceptance ability of elderly users, leading to a significant disconnect in practical use. Many products are complex to operate with unfriendly interfaces, resulting in high learning and usage thresholds for the elderly [11]. As some smart products are primarily designed based on the interaction logic of normal adults, they fail to fully consider the degenerative characteristics of the elderly in terms of cognition and perception, causing practical interaction difficulties. For example, voice systems have weak recognition capabilities for dialects or ambiguous phrases, screen buttons are too small to press easily, and metallic appearances and complex interfaces can easily make the elderly feel cold, fearful, or distrustful, leading to resistance to use. Although there are many functions, their practicality is low, and the usage rate of integrated high-frequency functions is low, failing to address the real pain points of users. A survey by the China Aging Association shows that only 23% of the elderly are willing to actively use such products, mainly due to concerns about operational complexity and fear of malfunction. Care robots deployed in communities are often left unused because users "don't know how to use them or dare not use them," fully reflecting the shortcomings of current products in age-friendly design and function simplification.

3.2.2 Commercialization Process Still Faces Significant Challenges

There is still a lack of good synergy between the commercial value and social benefits of intelligent elderly-care robots [12]. The overall product cost is high, pricing is expensive, making it difficult for ordinary families to afford, and there is also a lack of sustained and stable service and content ecosystem support. High-end models typically cost between 500,000 and 1 million yuan, while even basic functional models require 20,000 to 30,000 yuan, significantly exceeding the affordability of average families. Core components such as precision servos and high-precision sensors mostly rely on imports, keeping manufacturing costs high. The service network coverage is insufficient, especially in remote areas where professional maintenance teams are lacking, leading to slow response to failures. Additionally, the interoperability between devices and medical information systems is low, creating "information silos." Imperfect payment mechanisms, lack of relevant insurance coverage, and insufficient content updates and personalized services further affect users' long-term willingness to use. Currently, models such as leasing and sharing, medical insurance access, and ecological cooperation are needed to break through these bottlenecks.

3.3. Inadequate Response to the Emotional Needs of the Elderly

Existing products mostly focus on basic care functions, paying insufficient attention to deep psychological needs such as emotional companionship, cognitive training, and social participation, resulting in low user stickiness during actual promotion and difficulty in forming sustained use [13]. Many robots can only execute preset commands, unable to engage in warm, deep-level communication or provide truly personalized spiritual comfort. The interaction content is repetitive and monotonous, making it difficult to alleviate the loneliness and social alienation of the elderly. After the initial novelty wears off, elderly users tend to set the products aside, indicating that these robots have not truly integrated into their daily lives to become indispensable companions. This

reflects insufficient research on geriatric psychology and behavioral habits during the initial product development phase, failing to translate technological advantages into lasting emotional connections and user dependence.

4. Countermeasures and Suggestion for Promoting Market Growth

4.1. Product Design Should Focus on the Actual Usage Needs of the Elderly

Discourage age-inducing changes in products, streamline working interfaces, natural interaction strategies, and remove laborious authentication. It is advisable to apply neutral color like beige as the primary color and as auxiliary colors most of the time in warm low-saturation colors like light yellow, forming a certain contrast with the surrounding environment, which will constitute the elderly to distinguish the boundaries of the object clearly and minimize the risk of collision. The smart applications must have interaction methods that are easy to use and understand with clear prompts and capable of adapting depending on the cognitive capacity of the user. The controllers should be in the same functionality as the furniture and the situation of their use and the operational steps should be as minimal as possible to avoid misuse. The system must be able to be compatible with dialect recognition and have an optimal rate of speech. The interfaces should be displayed in big font and contrast colors, with the main functions being possible by means of one-click access so that the elderly can use it with ease without intricate training. Improve emotional interaction capabilities, combine multi-modes emotion computing theories to get emotion perception and feedback, and include cognitive exercise and memory assistance modules. Through the multi-source analysis of the voice, text and facial expression, accurately understanding the emotional state and personal qualities of the user, and integrating emotion computing and emotion encoding technology, to give dynamic responses focused on care and comfort. Simultaneously, incorporate entertaining capabilities like cognitive training games and social coaching to make the elderly keep their brains occupied, enhance their cognitive and social skills, and in this way, offer them a more positive and warm experience of emotional companionship.

4.2. Strengthen Technology Research and Development and Standard System Construction

Increase efforts in technology R&D and integrated application, enhance the device's ability to perceive the environment and make autonomous judgments, strengthen data security and privacy protection, and promote system integration with smart homes and medical health platforms. Introduce large AI models and multi-sensor fusion technology to enable robots to accurately recognize the behavior, posture, and emotions of the elderly, achieving high-precision obstacle avoidance and real-time risk response. At the same time, establish sound data encryption and anonymization mechanisms to ensure the security of health data transmission locally and in the cloud, and through standardized protocols, collaborate with smart home devices to achieve automatic adjustment of lights, air conditioning, etc., and share key physical sign data with medical platforms to support timely warnings and remote diagnosis and treatment, ultimately building a safe, intelligent, and interconnected elderly service ecosystem.

Improve standards and the industrial ecosystem, actively participate in and refine domestic and international standards for elderly-care robots, and build a multi-stakeholder collaborative industrial system. The international standard IEC 63310 "Performance criteria for robots used in active assisted living in interconnected home environments," led by China, has provided a systematic basis for product design, production, testing, and certification, covering core requirements such as usability, reliability, accessibility, energy management, health monitoring, emergency response, and communication support [14]. This standard not only provides clear development guidelines and a stable production framework for manufacturers, helping the industry chain achieve refined management and efficient resource integration, but also supports domestic products and services to go global by promoting the alignment of Chinese and foreign smart elderly-care industries and technical standards. In the future, the standard system should be continuously improved, and the

forces of government, enterprises, scientific research, and medical care should be coordinated to jointly build a full industry chain ecosystem covering technology R&D, product application, market promotion, and after-sales service, enhancing overall competitiveness and sustainable development capabilities.

4.3. Promote Business Model Innovation

Innovate business models, expand leasing services, and explore multiple paths such as government subsidies and cooperation with insurance. Use "leasing instead of purchasing" to reduce the economic burden on the elderly of using high-end equipment. For example, exoskeleton robots have been promoted through leasing in many elderly care institutions; the government can reduce user cost pressure through measures such as procurement subsidies, issuing consumption vouchers, and tax reductions; simultaneously introduce an insurance mechanism to cover risks such as equipment failure, maintenance, and accidental liability, building a trinity (inclusive service system) of "leasing-subsidy-insurance" to enhance market acceptance and commercial sustainability.

5. Conclusion

The creation of intelligent elderly-care robots is not purely a technical problem but also a systematic project that deals with social, cultural, ethical and policy aspects. According to the actual requirements of the users, the proposed paper offers a product design system with the focus on emotional interaction and physiological personalized services and multi-level collaborative market promotion strategies that should contribute greatly to the practicality of the products and their competitiveness on the market. Frontier technologies including emotion computing, health big data, cross-platform services, and generative artificial intelligence are some of the technologies that should be further developed in the future to create a more humanized, intelligent, and sustainable elderly health ecosystem. Meanwhile, the social construction of social identity, the established ethical standards, and the role of the educational system should be reinforced in order to support the so-called technology-assisted elderly care between the idea and the mass application of the solution, and it is possible to create the real collaborative management and the development of a growing population of the ageing population.

References

- [1] United Nations. World Population Ageing 2020 Highlights[R]. New York: United Nations, 2020.
- [2] Boston Consulting Group. The Global Silver Economy Report 2023[R]. Boston: BCG, 2023.
- [3] Smith J, Brown A. Elderly Acceptance of Assistive Robots: A Cross-Cultural Study[J]. International Journal of Social Robotics, 2021, 13(2): 245-259.
- [4] Kotler P, Armstrong G. Principles of Marketing (7th Edition) [M]. Beijing: Tsinghua University Press, 2000.
- [5] Chen M, Liu Y. Research on Emotional Interaction in Age-Friendly Intelligent Product Design[J]. Journal of Mechanical Design, 2021, 38(8): 120-125.
- [6] Ries E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses[M]. New York: Crown Business, 2011.
- [7] Norman D A. The Design of Everyday Things: Revised and Expanded Edition[M]. New York: Basic Books, 2013.
- [8] Zhang H, Li M. Analysis of the Development History and Trends of Elderly Service Robot Technology[J]. Robot Technology and Application, 2020(4): 12-18.
- [9] Liu Z, Wang P. Application Progress of Artificial Intelligence in Elderly Care[J]. Acta Automatica Sinica, 2021, 47(6): 1234-1245.
- [10] Chen X, Yang L. Evaluation of the Application Effect of Intelligent Elderly Care Robots in Nursing Institutions[J]. Chinese Journal of Gerontology, 2022, 42(15): 3782-3785.

- [11] Wang J, Li H. Research on Design Principles of Elderly Service Robots Based on User Experience[J]. Packaging Engineering, 2020, 41(10): 145-150.
- [12] Ministry of Industry and Information Technology. Smart Health and Elderly Care Industry Development Action Plan (2021-2025) [EB/OL]. (2021-08-20). <http://www.miit.gov.cn>
- [13] China Aging Association. Survey Report on the Use of Intelligent Technology by the Elderly[R]. Beijing: China Aging Association, 2022.
- [14] International Electrotechnical Commission. IEC 63310 Performance criteria for robots used in active assisted living in interconnected home environments[S]. Geneva: IEC, 2022.