

A Study on the Development Path of Smart Retirement Based on SWOT-PEST Analysis: The Integration Strategy of Technology Empowerment and Social Service

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Abstract: As China's aging population continues to deepen, the traditional old-age service model is difficult to meet the growing, diversified, and professional needs. As a new paradigm of technology empowerment and social service integration, smart old-age has become a key path to meet the challenges of aging. This paper uses the SWOT-PEST analysis model to systematically analyze the internal advantages and disadvantages, external opportunities and challenges of China's smart old-age development from four dimensions: politics, economy, society, and technology. The study found that smart pension has significant advantages in improving service efficiency and optimizing resource allocation, but it also faces internal shortcomings such as insufficient aging and unclear business models. At the same time, policy dividends and technological development provide good opportunities for smart pension, while the digital divide and lagging ethical supervision constitute the main external challenges. On this basis, this paper constructs SO, ST, WO, and WT strategic combinations, and puts forward development paths such as integrated platform construction, aging design promotion, government-enterprise coordination and standardization promotion, in order to provide theoretical references and practical guidance for the perfection and innovation of China's intelligent pension system.

Keywords: Smart elderly care; SWOT-PEST analysis; Technology empowerment; Social services; Integration strategy

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1. Introduction

1.1. Background

According to data from the National Bureau of Statistics, as of the end of 2023, the population aged 60 and above in China has reached 297 million, accounting for 21.1% of the total population. Among them, the population

aged 65 and above is 217 million, accounting for 15.4% of the total population, indicating that China has entered a deeply aging society ^[1]. The aging process presents typical characteristics of huge scale, rapid speed, and aging before becoming rich, which has a profound impact on the sustainable development of the economy and society. Accompanying this is the rapid expansion of the disabled and semi disabled elderly population, which has exceeded 44 million people and caused heavy caregiving and economic pressure on families and society. According to the China Aging Science Research Center, by 2030, the elderly disabled population in China will account for 57% of the total disabled population. Without effective prevention and control measures, this proportion will exceed 70% by 2050 ^[2]. In this context, the traditional family and institutional elderly care models that rely on human resources face practical challenges such as uneven distribution of resources, low service efficiency, and insufficient professional care capabilities. According to data from the Ministry of Civil Affairs, there are only about 500000 professional elderly care workers in China. Faced with over 44 million disabled elderly people, there is a talent gap of up to 6 million ^[3], which is difficult to meet the increasingly diverse and multi-level elderly care service needs of the elderly ^[4].

Smart Elder Care, as an innovative model to address the challenges of aging, integrates modern information technologies such as the Internet of Things, big data, artificial intelligence, and 5G to integrate social resources and service providers, and build a real-time, efficient, and accurate intelligent elderly care service system ^[5]. This model not only represents an application upgrade at the technical level, but also a systematic transformation of elderly care services from “traditional human dependence” to “smart humanistic integration.” It has strategic significance for improving the quality of elderly care services, optimizing resource allocation, and promoting the upgrading of the elderly care industry. The *2023 Research Report on China’s Smart Elderly Care Industry* shows that the market size of China’s smart elderly care has reached 6.2 trillion yuan in 2022, and is expected to exceed 10 trillion yuan by 2025, with a compound annual growth rate of over 20% ^[6], demonstrating enormous market potential and development space. On a global scale, smart elderly care has become a common strategy to actively address population aging. Smith *et al.* pointed out that technology has the potential to completely change the path of achieving healthy aging, promoting the shift of elderly care services from passive disease treatment to active health management and life support ^[7]. In the “14th Five-Year Plan” National Plan for the Development of the Aged Care and the Elderly Care Service System, China also clearly proposed the key tasks of “vigorously developing the silver economy” and “promoting the Internet plus+elderly care service,” which provided clear policy guidance and institutional protection for the development of smart elderly care ^[8].

However, while technology research and development are rapidly advancing and the policy environment is continuously optimized, smart elderly care still faces the dilemma of integrating technology and services in the actual implementation process. On the one hand, a large number of intelligent devices and systems are still in the demonstration stage and have not been effectively integrated into daily care processes, resulting in a practical disconnect of “technology but no service” ^[9]. On the other hand, issues such as the digital divide, data security, ethical regulations, and the sustainability of business models severely constrain its large-scale and inclusive development ^[10]. Therefore, how to systematically identify and seize the opportunities brought by technological empowerment, and effectively respond to the multidimensional challenges in its integration with social services, has become a core issue in promoting the high-quality development of smart elderly care in China.

1.2. Method introduction

To systematically analyze the complex situations faced in the development of smart elderly care, this article

introduces the SWOT-PEST composite analysis model, which structurally identifies and comprehensively analyzes the internal advantages and disadvantages, external opportunities and challenges of smart elderly care development from four macro dimensions: politics, economy, society, and technology.

The SWOT analysis method was proposed by Learned *et al.* in the 1960s and is a classic tool used in the field of strategic management to systematically evaluate the development trend of objects ^[11]. It provides a comprehensive basis for strategic formulation through a comprehensive analysis of four elements: internal strengths, internal weaknesses, external opportunities, and external threats. Combining this model with the PEST analysis framework can help break through the limitations of a single dimension and achieve a multi-level and systematic deconstruction of the development environment for smart elderly care.

The SWOT-PEST analysis framework constructed in this study mainly focuses on two major factors: internal and external supplementation. Internal factors mainly refer to the attributes and conditions that the research and application subjects of smart elderly care technology can control and optimize, including its advantages and disadvantages in service efficiency, technology integration, talent support, and other aspects; External factors mainly refer to the macro environmental factors faced by the development of smart elderly care, including opportunities and challenges in policy orientation, market demand, technological evolution, social cognition, and other aspects.

Through element sorting and cross-analysis, this study will further construct four strategic combinations: SO (Strength-Opportunity), ST (Strength-Threat), WO (Weakness-Opportunity), and WT (Weakness-Threat), providing systematic and actionable decision-making references for the path selection and policy design of smart elderly care in China.

1.3. Literature review

Scholars at home and abroad have explored the integration of smart elderly care technology and social services from multiple perspectives, such as technological efficiency, social acceptance, and policy environment, laying an important foundation for this study. However, existing research still has the limitation of “clear differentiation and insufficient integration,” and it is urgent to achieve theoretical sorting and strategic improvement through a systematic analysis framework.

In terms of technological efficiency, most research focuses on the “internal advantages” of smart elderly care. Tian *et al.* had shown through empirical research that using an AIoT-based intelligent warning system can improve the recognition accuracy of unexpected events such as falls in the elderly to over 95%, and shorten the response time from several hours in traditional modes to less than 3 minutes ^[12]. Appel *et al.* found that virtual reality and social robot technology have positive effects in alleviating elderly loneliness and enhancing cognitive function ^[13]. This type of research fully demonstrates the potential value of technology applications, but it is mostly limited to idealized scenarios and lacks attention to the adaptability and sustainability of technology integration into real service environments.

In terms of obstacles to technology promotion, scholars have focused on analyzing the “internal disadvantages” and “external challenges” of smart elderly care. According to a survey by Liang *et al.*, over 65% of elderly people believe that the current smart devices on the market are “too complex to operate,” and in elderly care institutions that have deployed smart systems, the cost of data exchange due to inconsistent system interfaces accounts for 15–20% of the total investment ^[9]. Friemel emphasized that the digital divide not only stems from access barriers but also manifests as social exclusion at the skill and utility level, which constrains the inclusive

development of technology^[10]. In addition, risks such as data privacy, algorithmic ethics, and regulatory lag have also attracted widespread academic attention^[14]. This type of research deeply reveals the practical obstacles in the implementation of technology, but mostly focuses on problem identification, and there is a relative lack of exploration on how to systematically resolve risks through strategic integration.

In terms of the external environment, research is mostly scattered in policy interpretation and market forecasting. The “14th Five-Year Plan for the Development of National Aging Industry and Elderly Care Service System” is regarded as a key policy opportunity to promote the development of smart elderly care^[8]; Cheng *et al.* analyzed from a cost-benefit perspective that the initial investment for a medium-sized institutional smart elderly care system is about 1–3 million yuan, with annual operation and maintenance costs ranging from 200,000 to 500,000 yuan. Nearly 70% of elderly care institutions stated that it is difficult to cover these costs through service fees^[15]. However, these studies are often disconnected from the analysis of technical ontology defects and service implementation challenges, and fail to effectively build a strategic bridge from macro opportunities to micro practices.

In summary, existing research has accumulated rich knowledge in the technological advantages, application challenges, and policy opportunities of smart elderly care, but there are still significant shortcomings in systematic integration and strategic construction. This study aims to incorporate the dispersed research results into a unified logical system by introducing the SWOT-PEST analysis framework, achieving a leap from “current situation description” to “strategic planning,” and providing a comprehensive, hierarchical, and operable path reference for the integrated development of smart elderly care.

2. SWOT-PEST analysis of smart elderly care development

2.1. Internal strengths

2.1.1. Precision and intelligent leap in service efficiency

Smart elderly care technology achieves dynamic perception and intelligent response to the health status, behavior patterns, and life needs of the elderly through data-driven and algorithmic analysis, promoting the transformation of elderly care services from “experience judgment” to “precise decision-making.” For example, an intelligent monitoring system based on multi-source sensors can identify abnormal deviations in daily activities such as living, eating, and toileting for the elderly, achieving early warning and proactive intervention for risks such as falls and sudden illnesses. Empirical research has shown that using an AIoT-based intelligent warning system can improve the accuracy of identifying unexpected events, such as falls in the elderly, to over 95%, and shorten the response time from several hours in traditional modes to less than 3 minutes^[12].

2.1.2. Optimization of care resources and alleviation of human burden

Faced with the global problem of a shortage of professional nursing staff, smart elderly care technology effectively reduces the physical and mental burden of frontline caregivers through automated processes and auxiliary tools. Intelligent robots can assist in completing repetitive physical tasks such as item handling and relocation care. The intelligent management platform can automate administrative tasks such as scheduling and drug management, allowing nursing staff to devote more energy to humanistic care and professional services. Research has shown that in nursing homes equipped with automated devices such as intelligent nursing beds and medication delivery robots, the average time spent by nursing staff handling repetitive physical labor has been reduced by 30%^[16].

2.1.3. Spatial and temporal extension of service accessibility

Smart elderly care utilizes advanced information technology to break the limitations of traditional elderly care services in terms of time and space. In terms of the time dimension, intelligent health monitoring devices can achieve real-time monitoring of the physical condition of elderly people 24 hours a day without interruption. For example, wearable devices can continuously record data such as heart rate, blood pressure, and sleep quality of elderly people, and transmit this information to remote medical platforms in a timely manner. Medical staff can view this data at any time, and once any abnormal situation is detected, they can quickly respond and provide timely medical advice or intervention measures for the elderly, ensuring their health and safety even during non-working hours such as at night.

In terms of spatial dimension, remote medical services enable elderly people in remote areas or with limited mobility to enjoy high-quality medical resources. Through video consultations, elderly people can have face-to-face communication with experts from big cities at home and receive professional diagnoses and treatment plans. In addition, the online elderly care service platform integrates various elderly care service resources, such as home care services, rehabilitation care, cultural entertainment, etc. Elderly people can easily book and enjoy these services through their mobile phones or computers, without being limited by geographical location. Moreover, smart elderly care also promotes the sharing and collaboration of elderly care services. Elderly care institutions and service providers in different regions can optimize resource allocation and collaborate on services through information-sharing platforms. For example, when there is a shortage of beds in elderly care institutions in a certain region, elderly people in need can be referred to institutions with available beds in other regions through the platform, which improves the utilization efficiency of elderly care resources and further expands the accessibility of services. The characteristic of time and space extension allows more elderly people to enjoy personalized and diversified elderly care services at the appropriate time and place, improving their quality of life and happiness. Especially for rural, remote areas, and elderly people with limited mobility, smart elderly care technology relies on remote medical care, online consultation, and intelligent terminals to break through geographical barriers and time limitations, enabling high-quality medical and care resources to cover a wider range of people. A meta-analysis on remote chronic disease management showed that elderly hypertensive patients who use remote monitoring and management have an 18% higher rate of blood pressure control compliance than those in the conventional care group, and a relatively lower readmission rate of 21%^[17].

2.1.4. Improvement of autonomy and quality of life in the elderly population

Smart elderly care technology not only focuses on safety and health, but also emphasizes functional compensation and environmental control to support elderly people in maintaining their independent living ability and social participation. For example, smart home systems, voice interaction devices, and cognitive assistance tools can help elderly people independently complete environmental regulation, information acquisition, and daily activities, enhancing their self-efficacy and life dignity^[9]. The application of this technology greatly enhances the autonomy of the elderly population, bringing more convenience and choices to their daily lives. The intelligent home appliance control system enables elderly people to easily control household appliances such as turning on and off lights, adjusting air conditioning temperature, and controlling curtain opening and closing through voice or mobile applications, without the need for manual operation as before. This allows them to independently manage their home environment and meet their living needs even if they have difficulty moving around.

Intelligent health management devices provide strong support for the autonomous management of elderly

people's health. These devices can monitor the health indicators of elderly people in real time, such as heart rate, blood pressure, blood sugar, etc., and synchronize the data to mobile applications or cloud platforms. Elderly people can check their health data at any time to understand their own health status. At the same time, the system can also provide personalized health advice for the elderly based on data analysis, such as a reasonable diet, moderate exercise, etc. If abnormal health indicators are detected, the device will promptly issue an alarm and automatically contact family members or medical staff to ensure that the elderly can receive timely medical assistance. This health management approach enables elderly people to take a more proactive approach to their health and enhances their ability to cope with health issues.

In terms of social interaction, smart elderly care technology has broken down communication barriers between the elderly and the outside world, expanding their social circle. Video calling software allows elderly people to have face-to-face communication with distant family and friends anytime, anywhere, sharing their daily experiences and alleviating their sense of loneliness. Online social platforms provide opportunities for elderly people to meet like-minded friends. They can participate in various interest groups such as calligraphy, painting, photography, etc., and communicate and learn with other elderly people to enrich their spiritual life.

In addition, smart elderly care services also provide more cultural and entertainment options for the elderly. Online education platforms provide rich learning resources for the elderly, who can choose courses based on their interests and hobbies, such as music appreciation, historical culture, health care, etc., continuously improving their knowledge level and cultural literacy. Online libraries and video platforms enable elderly people to easily access various books, movies, TV dramas, etc., meeting their entertainment needs.

Through these technological means, smart elderly care has enhanced the autonomy of the elderly population, enriched their spiritual and cultural life, enabled them to actively participate in social activities, and significantly improved their quality of life, allowing them to maintain health, happiness, and dignity in their later years.

2.2. Internal weaknesses

2.2.1. Technology adapted to aging and insufficient system integration

Currently, many intelligent elderly care products are still dominated by “technology-driven approaches,” lacking a deep understanding of the cognitive characteristics, operating habits, and real needs of elderly users, resulting in complex interfaces, cumbersome interactions, and high learning costs. A survey shows that over 65% of elderly people believe that the current smart devices on the market are “too complicated to operate.” At the same time, different devices, systems, and platforms form “data islands” due to inconsistent standards and closed interfaces, hindering information sharing and service collaboration. In elderly care institutions that have deployed smart systems, the cost of data exchange due to inconsistent system interfaces accounts for 15–20% of the total investment^[9].

The insufficient adaptability to aging and low system integration of this technology greatly limit the effectiveness and promotion of smart elderly care services. For the elderly, complex operations make it difficult for them to truly enjoy the convenience brought by smart devices, and many smart elderly care products can only be idle, unable to play their due role. For example, some intelligent health monitoring devices, although equipped with advanced functions, cannot be used independently by the elderly due to their complex operation, which makes the devices that could have protected the health of the elderly meaningless.

The problem of “data silos” also seriously affects the synergy and efficiency of elderly care services. The inability to share data between different systems results in healthcare workers, elderly care service providers,

and others being unable to fully understand the situation of the elderly, making it difficult to provide them with accurate and personalized services. For example, when elderly people seek medical treatment, due to the lack of data exchange between the hospital system and the elderly care institution system, doctors may not be able to obtain timely health data of the elderly in the elderly care institution, thereby affecting the accuracy of diagnosis and treatment.

In addition, the aging of technology and insufficient system integration have also increased the cost of elderly care services. On the one hand, in order to enable elderly people to use complex smart devices, additional manpower needs to be invested in training and guidance; On the other hand, solving the problem of “data silos” requires significant investment in system upgrades and interface development, which undoubtedly increases the burden on elderly care institutions and society.

2.2.2. High costs and unclear business models

The research and development, deployment, and operation of smart elderly care technology require a large amount of capital investment, and the initial and ongoing costs of smart hardware, cloud platforms, and network services pose economic pressure on ordinary households and elderly care institutions. The initial investment for a medium-sized institutional smart elderly care system is about 1–3 million yuan, with annual operation and maintenance costs ranging from 200,000 to 500,000 yuan. In addition, it is difficult to quantify the value of services and incorporate them into the existing payment system. Nearly 70% of elderly care institutions indicate that it is difficult to rely on service fees to cover these costs, and the market’s ability to generate revenue is weak, which hinders the sustainable development of the industry^[15].

Due to high costs and unclear business models, the smart elderly care industry has encountered a dilemma in its development process. From a market perspective, high costs have deterred many potential customers, making it difficult for ordinary families to afford the cost of smart elderly care products and services. This has led to difficulty in fully unleashing market demand. Although there is a demand for introducing smart elderly care technology in elderly care institutions, the high cost and difficulty in achieving profitability make them hesitant and even choose to give up when promoting smart elderly care projects.

In terms of business models, there is currently no mature, clear, and sustainable model formed. The existing charging model is single and mainly relies on service fees. However, due to the difficulty in quantifying the value of services, the charging lacks a reasonable basis and is difficult to gain customer recognition. At the same time, there is a lack of diversified profit channels and insufficient exploration of the potential value of the smart elderly care industry. For example, the large amount of elderly health data collected has not been effectively developed and utilized, and has not been transformed into commercial value.

This situation also affects the innovation and development momentum of the industry. Enterprises invest a large amount of funds in research and development, but due to the difficulty in achieving profitability through a reasonable business model, their R&D enthusiasm is frustrated, and their innovation capabilities are suppressed. Over time, the smart elderly care industry will find it difficult to achieve technological upgrades and optimize services, and cannot meet the increasingly diverse needs of the elderly.

2.2.3. Interdisciplinary talent shortage and skill gap

The deep integration of smart elderly care urgently requires composite professionals who are both knowledgeable in technology research and development and familiar with elderly care. However, in the current education system

and career paths, the cultivation and reserve of such talents are clearly insufficient, leading to the prominent phenomenon of “two skins” in technology and services, which restricts the overall effectiveness^[18].

In the field of technology research and development, due to the lack of professional knowledge of elderly care, R&D personnel find it difficult to accurately grasp the actual needs and usage scenarios of the elderly. The products developed may be out of touch with the needs of the elderly in terms of functional design, operational convenience, and other aspects. For example, although some intelligent elderly care devices have advanced technological functions, the operating interface is too complex, making it difficult for elderly people with relatively weak cognitive and operational abilities to master and use, resulting in a significant reduction in the practicality of the product.

In terms of elderly care services, nursing staff often lack the necessary technical skills, making it difficult to fully utilize smart elderly care technology to improve service quality and efficiency. They may not be proficient in operating smart devices and systems, and may not be able to timely and accurately obtain and analyze relevant data, thereby affecting their judgment and response to the health status and needs of the elderly. For example, when using intelligent health monitoring systems, nursing staff may not be able to correctly interpret monitoring data, and may not be able to detect abnormal changes in elderly health indicators in a timely manner, which delays the diagnosis and treatment of diseases.

Meanwhile, the shortage of interdisciplinary talents also hinders the promotion and application of smart elderly care technology. Due to the lack of professional talents for technical training and guidance, the acceptance and recognition of smart elderly care technology by nursing homes and the elderly are low, making it difficult for new technologies to be widely applied in practical scenarios. Moreover, in the implementation process of smart elderly care projects, due to the lack of composite talents who understand both technology and management, there may be problems in the planning, organization, and coordination of the project, which may affect the smooth progress of the project and the achievement of expected results.

2.2.4. Technical reliability and responsibility risks

As an emerging field, the reliability of smart elderly care technology faces many challenges, especially for intelligent systems related to the safety and health of the elderly, whose stability and accuracy are crucial. Frequent false positives or omissions may trigger a crisis of user trust, and the responsibility definition and legal traceability mechanism for adverse events caused by technical failures are not yet perfect, increasing application risks and social concerns^[14].

The hardware quality of some intelligent elderly care devices varies greatly, and there may be malfunctions or unstable performance. For example, smart health monitoring wristbands may have inaccurate data, leading to misjudgments of the health status of elderly people. If medical staff diagnose and treat based on incorrect data, it may have a serious impact on the health of elderly people.

In terms of software systems, there are also vulnerabilities and security risks. The smart elderly care service platform stores a large amount of personal information and health data of the elderly. Once it is hacked or leaked, it not only violates the privacy of the elderly but may also lead to risks such as fraud. In addition, if the software system is not updated and maintained in a timely manner, it may affect the normal use of its functions, reducing the quality and efficiency of services.

In terms of responsibility definition, when there are problems with smart elderly care technology that result in damage to the rights and interests of the elderly, the responsible parties are often difficult to clarify. Manufacturers

of smart devices, developers of software systems, providers of elderly care services, and other parties may shift responsibilities among themselves. For example, when a smart elderly care device malfunctions and causes a safety accident, manufacturers may attribute the responsibility to software system problems, while software developers may believe that it is caused by hardware defects in the device itself. This ambiguous responsibility makes it difficult to effectively protect the legitimate rights and interests of the elderly.

At present, the laws and regulations regarding smart elderly care technology are not yet perfect, and there is a lack of clear industry standards and norms. This leads to a lack of basis in handling liability disputes and increases the difficulty of judicial practice. Moreover, due to the continuous development and innovation of smart elderly care technology, new problems and risks continue to emerge, and the update speed of laws and regulations often cannot keep up with the pace of technological development, further exacerbating the uncertainty of liability risks.

2.3. External opportunities

2.3.1. Continuous empowerment and strategic guidance of national policies

In recent years, from the “14th Five-Year Plan” for the development of the national elderly care industry and the elderly care service system to the pilot and special subsidy policies for smart elderly care in various regions, the national level has created a favorable environment for the development of smart elderly care through institutional design and resource investment. During the 14th Five-Year Plan period, the China Development Bank announced that it will allocate a total of 100 billion yuan in special loans for elderly care services to support the construction of elderly care service systems, including smart elderly care^[19]. In particular, “Internet plus elderly care service” and “silver economy” and other strategic orientations provide clear direction and policy endorsement for industrial innovation^[8].

2.3.2. Expansion and demand upgrade of the elderly consumer market

The large and rapidly growing elderly population in our country is driving the formation of a diversified and multi-level elderly care service consumption market. Compared with the past, the education level and consumption ability of the new generation of elderly people have generally improved. A survey by the China Association on Aging shows that 56% of the “post-60” new generation of elderly people are willing to spend more than 3000 yuan on smart products that they are interested in^[20], showing stronger openness and willingness to purchase technology products and services that improve their quality of life, providing a broad market space for smart elderly care.

2.3.3. Maturity of basic technologies and acceleration of fusion innovation

The rapid development and cost reduction of underlying technologies such as artificial intelligence, big data, and cloud computing provide strong support for the iteration and platform construction of smart elderly care products. As of August 2023, China has built over 2.93 million 5G base stations, covering all urban areas of prefecture-level cities^[21]. The high-speed and low-latency characteristics of 5G networks ensure the high-speed transmission of real-time data, and AI algorithms improve the accuracy of behavior recognition and risk prediction, jointly promoting the transition of smart elderly care from “single point application” to “system integration”^[12].

2.3.4. Social awareness enhancement and digital adaptation driven by the epidemic

With the deepening of media publicity and market education, the concept of “technology empowering elderly care” is gradually taking root in people’s hearts. During COVID-19, the popularity of digital services such as

telemedicine and online shopping objectively improved the whole society's acceptance of an intelligent lifestyle and laid a social psychological foundation for the promotion of intelligent elderly care services ^[7].

2.4. External threats

2.4.1. The digital divide exacerbates the risk of social exclusion

The development of smart elderly care faces a severe digital access, usage, and efficiency gap. According to the report of China Internet Network Information Center (CNNIC), as of June 2023, the number of non-Internet users in China is 362 million, of which 41.6% are elderly people aged 60 and above, making them the main “offline” population ^[22]. Some elderly people are excluded from digital services due to economic conditions, cognitive abilities, and skill deficiencies; Even with access conditions, there are significant differences in the actual effects of using technology to improve well-being, which may lead to new forms of social inequality ^[10].

2.4.2. Regulatory lag and incomplete standard system

The rapid iteration of smart elderly care technology exceeds the update speed of existing laws and industry standards, and there are regulatory gaps in areas such as data ownership, privacy protection, product liability, and service quality assessment. Academic literature analysis points out that in the field of smart elderly care, there are fewer than 10 national mandatory standards directly related to data privacy and security, far behind the iteration speed of technology, leading to ambiguous areas in regulatory practice ^[14]. The lack of standards leads to a mixed market, uneven product quality, and affects the standardized development of the industry.

2.4.3. Ethical dilemmas and insufficient public trust

Continuous monitoring, data collection, and algorithmic decision-making have raised ethical concerns such as privacy erosion, limited autonomy, and algorithmic discrimination. If the concerns of the general public, especially the elderly, about these issues are not effectively addressed, they can easily escalate into a crisis of technological trust, fundamentally hindering the implementation of technology ^[23].

2.4.4. Path dependence and transformation resistance of the traditional service system

The existing elderly care service system has strong inertia in organizational structure, workflow, and interest pattern, which poses structural obstacles to the introduction of new technologies. A sampling survey shows that only about 23.6% of elderly care institutions have achieved a high level of integration and intelligence of medical care and elderly care, which is far from the goal of achieving an 80% integration rate of medical care and elderly care by 2035 proposed in the National Medium- and Long-Term Plan for Actively Responding to Population Aging ^[3]. Some institutions lack reform motivation due to high initial investment and difficulty in employee training; Frontline personnel may also develop resistance and delay the overall transformation process due to concerns about job replacement ^[23].

3. Smart elderly care development strategy combination based on SWOT-PEST matrix

Based on the aforementioned SWOT-PEST analysis, a strategic action matrix will be further constructed to systematically integrate the four elements of strengths, weaknesses, opportunities, and challenges, forming a strategic combination with clear policy implications and practical directions. This matrix covers four typical

strategic orientations: SO strategy (relying on internal strengths to capture external opportunities), ST strategy (utilizing one's own strengths to address external threats), WO strategy (leveraging external opportunities to address internal weaknesses), and WT strategy (by avoiding threats and overcoming one's own weaknesses). This framework provides a systematic path selection basis for strategic decision-making in differentiated contexts, enhancing the policy applicability and practical operability of research.

3.1. SO strategy: Leveraging strengths and seizing opportunities

As the most forward-looking and enterprising strategic orientation, the core of the SO strategy (Strength-Opportunity Strategy) lies in fully activating the internal advantages of smart elderly care technology, accurately connecting with external development opportunities, and achieving the coordinated expansion of technology application depth and market coverage breadth. The specific implementation path includes:

3.1.1. Building an integrated and inclusive smart elderly care service platform

Based on the advantages of core technologies such as artificial intelligence, 5G communication, and big data, we will build an integrated platform that covers multidimensional functions such as safety monitoring, health management, life services, and spiritual comfort, and promote the systematic upgrade of elderly care services from "single point intelligence" to "global collaboration." This measure helps to align with the national smart elderly care policy orientation and the continuously expanding market demand, achieving a structural transformation of service models.

3.1.2. Developing a demand-oriented aging-friendly intelligent product system

Develop intelligent terminals and VR/AR immersive applications with easy-to-use and function-focused features to meet the diverse needs of active elderly groups in social participation, lifelong learning, and health promotion. By enhancing the empowering effect of technology on the autonomy of the elderly, seizing the favorable opportunity of the new generation of elderly people's consumption ability improvement and social cognitive shift, and fully unleashing the endogenous potential of the "silver economy."

3.2. ST strategy: Utilizing strengths and avoiding threats

The ST strategy (Strength-Threat Strategy) focuses on effectively utilizing technological advantages to address structural challenges in complex and ever-changing external environments. Its core logic is to transform core technological capabilities into systematic defense and adaptation mechanisms to mitigate external risks and maintain development resilience. The specific path includes:

3.2.1. Strengthening aging-friendly design and digital inclusion system

Actively leveraging the core advantages of smart elderly care technology in human-computer interaction optimization and personalized customization of functions, to systematically address the social exclusion risks brought about by the digital divide. By developing and promoting aging-friendly design standards, we will focus on optimizing features such as voice interaction, one-click operation, and interface simplification; Simultaneously building a collaborative "digital feedback" support network among communities, families, and public welfare organizations to enhance the elderly's ability to accept and use technology.

3.2.2. Building a privacy enhancement and trustworthy governance framework

Relying on technological research and system integration capabilities, we are able to address external threats such as data security and ethical governance. Widely adopting privacy computing technologies such as federated learning and differential privacy in the platform to achieve “data available but invisible”; Simultaneously establish a data authorization and usage mechanism that users can understand and control, enhancing technical credibility and social acceptance.

3.3. WO strategy: Leveraging opportunities to overcome weaknesses

The WO strategy (Weakness-Opportunity Strategy), as a typical turnaround strategy, aims to systematically identify and utilize external opportunities, effectively address internal capacity gaps, optimize resource allocation, and achieve structural transformation and capability leap. The specific implementation path includes:

3.3.1. Deepening the mechanism of government enterprise collaboration and innovating business models

Actively connect with the dividends and financial support of smart elderly care policies at the national and local levels, effectively resolving development bottlenecks such as high initial investment and unclear business models. By participating in pilot demonstration projects, seeking special subsidies, expanding public-private partnerships (PPP) and other mechanisms, we aim to promote the connection between smart elderly care services and payment systems such as long-term care insurance, and build a financially sustainable business model.

3.3.2. Promoting interdisciplinary talent cultivation and industry standard co-construction

Grasp the favorable window driven by both market demand growth and policy support, and focus on breaking the constraints of the insufficient supply of compound talents. Encourage universities and enterprises to collaborate in building the “Smart Health Elderly Care” professional direction, and improve the skill enhancement system for in-service personnel; Support industry associations to take the lead in formulating key standards such as product interconnection and data security, in order to enhance the collaborative efficiency and service quality of the entire industry chain.

3.4. WT strategy: Overcoming weaknesses and avoiding threats

The WT strategy (Weakness-Threat Strategy) is positioned as a defensive development path, with the core goal of systematically weakening the constraining effects of internal weaknesses while effectively avoiding potential threats in the external environment, providing strategic guidance for enterprises to achieve stable operations under high-pressure competition and resource constraints.

3.4.1. Focusing on core functions and implementing the minimum feasible product strategy

In response to the practical constraints of insufficient product age adaptability, cost sensitivity, and digital access barriers, we abandon the idea of building a comprehensive system and instead focus on the most frequent and urgent core needs of the elderly population. Focus on developing safety products that are easy to operate and have clear functions, such as fall detection and one click call for help. Quickly verify market acceptance through Minimum Feasible Product (MVP), and continuously optimize product form and service experience through user participation iteration.

3.4.2. Building a collaborative ecosystem and third-party certification system

Faced with multiple challenges such as insufficient reserves of professional talent, technical reliability disputes, and compliance risks, we actively promote cross-institutional cooperation and resource integration. By establishing strategic alliances with traditional elderly care service institutions, third-party testing platforms, and technology ethics assessment organizations, we can jointly build a compliant, controllable, and trustworthy service chain, enhance the market credibility and risk resistance ability of the overall solution.

4. Conclusion and prospects

This article is based on the SWOT-PEST analysis framework, systematically deconstructing the internal and external environment of the development of smart elderly care in China, identifying important opportunities in technology empowerment, policy support, and market demand, while revealing structural challenges such as insufficient aging adaptability, significant digital divide, and shortage of professional talents. On this basis, four differentiated strategic combinations of SO, ST, WO, and WT were studied and constructed, forming a systematic and operable development path system for smart elderly care.

Looking towards the future, China's smart elderly care industry should adhere to the principle of "data-driven and precise policy implementation," with the core concept of "humanistic guidance, technological empowerment, and system integration," and promote the deep integration of policy layout, technological research and development, service innovation, and talent cultivation. Therefore, this article proposes the following suggestions:

Firstly, prioritize the promotion of high-priority strategic initiatives. The focus is on areas such as "aging-friendly design" and "innovation of government enterprise collaboration models." These measures are urgently needed by society and have a certain policy and market foundation, making them easy to form demonstration effects.

Secondly, establish a smart elderly care statistical monitoring and evaluation system. Incorporate core indicators such as service coverage, user satisfaction, and service efficiency improvement rate into the routine statistical scope of the government, build a dynamic data platform, and provide empirical evidence for policy formulation and industry evaluation.

Thirdly, establish a smart elderly care innovation guidance fund. In response to development obstacles such as unclear business models and high initial investment, it is recommended that the government take the lead in jointly establishing a special risk fund with industry leaders, focusing on supporting innovative projects with clear profit models and inclusive value.

Fourthly, improve the mechanism of diversified collaborative governance. Strengthen the guiding role of the government in top-level design, standard specifications, and regulatory safeguards, promote the industry to focus on user experience and sustainable business models, encourage interdisciplinary research and practical evaluation in academia, and jointly build an inclusive, trustworthy, and sustainable smart elderly care new ecosystem.

Through the implementation of the above path, it is expected to build a smart elderly care ecosystem that combines technological empowerment and humanistic care. In the future, we still need to continue to pay attention to technological evolution and changes in demand, dynamically adjust development strategies, promote high-quality development of China's smart elderly care industry, and ultimately achieve the strategic goal of improving the quality of life and social well-being of the elderly.

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