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Research on Product Demand Mining and Development of the Silver Economy Market Based on AI Analysis

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Abstract: The accelerated aging of the population has promoted the silver economy to become a new engine of economic growth, while a persistent structural mismatch between supply and demand remains a core bottleneck for the high-quality development of related industries. Relying on the advantages of artificial intelligence (AI) in big data processing, user profiling, and demand forecasting, this paper systematically constructs a whole-process framework of "data acquisition–AI modeling–demand analysis–product development–iterative optimization" for the silver economy market. Within this framework, heterogeneous data from elderly users are integrated and modeled to identify latent, diversified, and personalized needs that are often overlooked by traditional survey-based approaches. The study further combines segmented application scenarios in health management, aging-friendly smart products, and spiritual and cultural consumption to explore concrete paths for AI-enabled demand mining and product innovation. Empirical and conceptual analyses indicate that AI technology can effectively break the limitations of conventional demand identification, enhance the precision of market segmentation, and support rapid product iteration based on real-time feedback. The findings suggest that AI facilitates a transformation of the silver economy from a predominantly "supply-oriented" to a genuinely "demand-oriented" development paradigm, thereby providing robust technical support and methodological guidance for the sustainable and high-quality development of silver economy industries.

Keywords: silver economy; artificial intelligence; demand mining; aging-friendly product development; health management; smart eldercare; market segmentation

1 Introduction

1.1 Research background

China entered the stage of moderate aging in 2021. By 2025, the proportion of elderly individuals aged 60 and above is projected to reach 23.0%, while those aged 65 and above will account for 15.9%. It is anticipated that the country will enter the stage of deep aging around 2030. Compared to developed nations, China's aging process has progressed at an exceptionally rapid pace, completing the transition from aging to deep aging in approximately 25 years. This is significantly faster than the transitions observed in other countries, such as France and the United States, which took 115 years and 60 years, respectively. The accelerated pace of aging leaves limited time for societal adaptation and system preparation, creating substantial challenges in areas such as pension security, medical services, and the provision of care for the elderly [1, 2].

Simultaneously, the silver economy has been expanding at a remarkable rate, with its size projected to reach 8.3 trillion yuan in 2024, accounting for 6% of the nation's GDP. By 2025, it is expected to exceed 9 trillion yuan, and by 2030, it may surpass 25 trillion yuan. Despite this growth, the market faces a pronounced imbalance between supply and demand. On the supply side, there are only around 2,000 types of independently developed elderly products available, which is far fewer than the global total of approximately 60,000 types [3, 4]. Moreover, many of these products are concentrated in the low-end segment and lack diversity. On the demand side, the consumption patterns

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of the new elderly generation have shifted from basic survival needs to a focus on development and enjoyment. There is a growing demand for products related to health management, intelligent technology, spiritual enrichment, and other advanced services [2]. Traditional methods of demand analysis, which often rely on small sample research, are inefficient and lack precision, making it difficult to address the diverse and hierarchical needs of the elderly population. The integration of AI technology offers a promising solution to overcome these challenges and enhance the efficiency and accuracy of demand analysis.

1.2 Research significance

1.2.1 Theoretical significance

The theoretical framework for utilizing artificial intelligence technology to facilitate the demand identification and development of products within the silver economy is established [3, 5]. This approach enhances the interdisciplinary integration of aging economics and technological innovation theories, addressing the limitations of traditional demand identification methods in handling extensive data and performing precise analyses [6]. Furthermore, it introduces a novel technical perspective and methodological foundation, offering valuable insights and tools for advancing research in this domain [3].

1.2.2 Practical significance

To provide practical guidance for enterprises related to the silver economy, it is essential to help them accurately identify the genuine needs of the elderly demographic, enabling the development of products tailored to their usage habits and consumption preferences. This approach not only enhances market competitiveness but also serves as a valuable reference for governmental efforts in formulating industrial policies and improving the market environment [7]. Such measures contribute to fostering the refined and high-quality advancement of the silver economy, ensuring sustainable and inclusive growth [6, 8].

1.3 Research status at home and abroad

The aging process in foreign countries began earlier, leading to the development of various theories and practices addressing the needs of aging populations [9]. For instance, one perspective highlights the concept of a three-dimensional industry chain within the silver economy, encompassing standard industries, related industries, and derivative industries. Additionally, it has been observed that the consumption patterns of elderly individuals in certain regions are closely tied to their annual income levels, revealing untapped opportunities for innovation in markets that are otherwise considered saturated. Countries such as the United States and Japan have made significant advancements by integrating artificial intelligence and Internet of Things technologies into areas like intelligent care and telemedicine. These efforts have resulted in the creation of mature and well-defined product forms, showcasing the potential of technology to address the challenges associated with aging populations.

Research within the domestic context has primarily concentrated on exploring the developmental trajectory of the silver economy and addressing the imbalance between supply and demand. A significant focus has been placed on the socialization and industrialization of institutional pension services, emphasizing the need to enhance service accessibility and efficiency. Furthermore, efforts have been directed toward identifying and addressing the individual needs of elderly populations from the supply side, aiming to create more tailored and effective solutions [4, 10]. While recent studies have begun to explore the role of artificial intelligence in empowering the silver economy, much of this research remains confined to isolated scenarios. There is a notable lack of comprehensive studies that systematically investigate AI-driven requirements mining and the end-to-end process of product development [11, 12]. This paper seeks to address this gap by providing a more holistic perspective on leveraging AI technologies to meet the evolving demands of aging populations [13].

2 The market development status and demand characteristics of silver hair economy

2.1 Current situation of market development

China's silver economy has entered a new stage characterized by coordinated efforts between governmental initiatives and market-driven forces, with policy incentives continuing to stimulate growth [14]. The market has experienced a compound growth rate exceeding 10% from 2019 to 2023, outpacing the national economic growth during the same period. The industrial structure reflects a diversified segmentation pattern, with health maintenance, functional food, and tourism leading as primary areas of demand, collectively accounting for approximately 70%. Secondary areas, including sports and entertainment, financial products, and home aging solutions, represent 30% to 50% of demand [11]. Emerging sectors such as smart products, education, and training form the third tier, showcasing gradual demand potential. Despite these advancements, challenges persist on the supply side, including product uniformity, insufficient adaptation to aging needs, and a notable gap in high-end service offerings, which require targeted improvements to fully unlock market potential.

2.2 Demand characteristics analysis

2.2.1 Demand stratification is significant

Based on age and varying consumption capabilities, the population can be categorized into three distinct groups. Individuals aged 55 to 64, often referred to as "silver-haired young people," exhibit a strong interest in health supplements and self-driven travel, showcasing notable consumption vitality. Those aged 65 to 74, termed "silver-haired middle age," prioritize comfortable home living and meticulous personal care [4]. Meanwhile, the "silver-haired elderly" group, comprising individuals over 75 years old, primarily focuses on essential medical services and end-of-life care. Additionally, the market can be segmented into basic livelihood needs, accounting for 79%, and quality-driven consumption, representing 21%. Notably, the quality-driven segment contributes significantly to overall market growth, driving 74% of consumption and emerging as a pivotal force in economic expansion.

2.2.2 Transformation of consumption concept to quality

A significant portion, 58.3%, of the silver-haired demographic prioritized meeting their own needs above all else, while 21.8% emphasized maintaining a balance across generations. Notably, traditional consumption patterns accounted for less than 20% of preferences. The market witnessed a remarkable surge in the sales of smart small household appliances, health care devices, and medical beauty products [1]. Additionally, health-monitoring smart bracelets and watches experienced extraordinary growth, with sales increasing by 200% and 350%, respectively, reflecting evolving consumer priorities [3, 13].

2.2.3 Deep integration of online and offline scenes

A significant portion of the elderly population, approximately 60.7%, engages with mobile phones for more than three hours daily, demonstrating a growing familiarity with digital platforms. Their participation in online shopping has reached levels comparable to younger demographics, highlighting a shift in consumer behavior. Short videos and community groups have emerged as pivotal channels for consumption, reflecting the increasing influence of digital media [6]. Despite this, offline consumption remains dominant, accounting for over 70% of total activity. The integration of online and offline modes has become a prevailing trend, driven by a 25% rise in demand for instant and convenient services, underscoring the evolving expectations of modern consumers.

2.2.4 The rise of spiritual and emotional needs

The proportion of spiritual and emotional consumption is projected to grow significantly, increasing from 24% to 35% by 2035. This trend is driving the rapid emergence of innovative industries such as geriatric research, cultural tourism, and the integration of artificial intelligence into companionship services [9]. Furthermore, the

market for smart toys and AI-driven companionship robots is anticipated to experience exponential growth, with sales expected to surge by over 2,000% and 200%, respectively, reflecting a profound shift in consumer priorities and technological advancements [10].

3 Application mechanism of AI analysis in product demand mining of silver economy

3.1 Multi-source data acquisition and integration

A comprehensive data source system is established to encompass multi-dimensional datasets, including consumption data derived from e-commerce transactions and offline purchasing activities, behavior data obtained from smart device usage logs and application operation records, health data sourced from wearable technology and physical examination results, and social data gathered from social media interactions and questionnaire responses [1, 2]. These datasets undergo meticulous cleaning and desensitization processes to ensure the formation of standardized, high-quality data sets, which serve as a robust foundation for subsequent analytical endeavors [3, 9].

3.2 AI modeling and requirements analysis

3.2.1 User profile construction

Clustering algorithms, such as K-Means, are employed to develop detailed hierarchical profiles encompassing categories like "health regimen," "rehabilitation nursing," and "quality enjoyment." These profiles are constructed based on factors including consumption capacity, lifestyle patterns, and overall health conditions [1]. This approach enables a comprehensive understanding of the primary needs and latent preferences of diverse population groups, facilitating targeted strategies to address their specific requirements effectively [5].

3.2.2 Requirements identification and classification

Natural language processing technology was utilized to conduct sentiment analysis and extract keywords from unstructured data, enabling the identification of user satisfaction levels, complaints, and expectations regarding existing products [2]. By integrating this approach with association rule algorithms, deeper insights into the interconnections among product requirements were uncovered. This analysis serves as a foundational framework for guiding the development and optimization of product combinations, ensuring alignment with user needs and market demands [2, 7].

3.2.3 Demand trend forecast

Using advanced time series analysis models, including LSTM, and integrating historical data, demographic shifts, and policy dynamics, the projected trajectory of demand across specific sectors is systematically analyzed [3]. This approach enables enterprises to strategically plan and optimize their research and development efforts, ensuring alignment with anticipated market needs and fostering innovation in targeted areas [10].

3.3 Application advantages of AI analysis

Compared with traditional models, AI analysis demonstrates significantly higher accuracy and surpasses the constraints associated with small sample sizes [5]. It enhances operational efficiency through automated data processing, thereby reducing the time required for data mining. Additionally, it identifies latent demands, offering valuable insights for driving product innovation. By enabling dynamic optimization, it continuously monitors evolving requirements and provides actionable guidance for iterative product development and refinement, ensuring sustained relevance and adaptability.

4 Product development strategy of silver economy based on AI analysis

4.1 Precision product development: personalized adaptation based on user portraits

Customized products tailored to diverse user groups are essential for addressing the needs of the aging population. For health and wellness groups, smart wearable devices

can be designed with advanced monitoring capabilities and medication reminder functions to promote proactive health management. Rehabilitation-focused innovations may include the development of exoskeleton robots and sensorless fall detection systems, enhancing mobility and safety [7]. For individuals seeking quality-of-life improvements, intelligent small appliances can be optimized with features such as voice control and large-character displays to ensure ease of use. Emotional companion solutions can be enhanced by upgrading AI companion robots with advanced natural language processing and emotion recognition technologies, fostering meaningful interactions and emotional support.

4.2 Scenarized product innovation: integrated solution based on requirement correlation

The construction of scenario-oriented product ecosystems emphasizes the integration of home care environments through advanced technologies such as seamless monitoring, intelligent response systems, and specialized services [2]. This approach connects intelligent detection devices with community service centers to create a cohesive operational framework. In the health management domain, a comprehensive cycle encompassing prevention, diagnosis, and rehabilitation is established. Data is gathered via smart devices, analyzed for risk assessment using artificial intelligence, and linked to relevant medical resources to ensure effective care delivery. Additionally, in the realm of spiritual consumption, innovative solutions such as combining artificial intelligence-driven educational agents with offline activities are developed to enhance user engagement and experiential value [12].

4.3 Aging technology optimization: product experience upgrading based on behavior analysis

Optimized product aging design focuses on enhancing usability through simplified interfaces and streamlined operational processes, incorporating features such as voice control and a one-button call function to improve accessibility [8]. Personalized adaptations leverage behavior data to automatically adjust screen brightness and provide stepwise guidance tailored to user needs. Advanced artificial intelligence systems are employed to establish robust security measures, including enhanced misoperation detection, proactive fraud prevention mechanisms, and comprehensive privacy safeguards, ensuring a safer and more user-friendly experience [9].

4.4 Dynamic product iteration: continuous optimization based on real-time feedback

A closed-loop iterative mechanism was established, wherein product usage data and user feedback were systematically collected in real time [6]. Advanced AI algorithms were employed to identify areas for improvement with precision, ensuring that high-frequency complaints and usability barriers were addressed promptly. Proactive measures were taken to predict future demands, enabling the early development of new functionalities. Additionally, core users were actively engaged in testing phases, fostering a continuous cycle of research, feedback, and optimization that enhanced overall product performance and user satisfaction.

5 Case study: Application of AI in the development of silver-hair health management products

5.1 Case structure diagram

The diagram presented in Figure 1 demonstrates the structural organization and data flow within the primary functional modules of the application. This design emphasizes modularity, ensuring that each layer operates independently while facilitating seamless integration [1, 12]. By adopting this approach, the system achieves enhanced scalability, allowing for future expansions, and improved maintainability, enabling efficient updates and troubleshooting [10]. The clear separation of responsibilities across layers further optimizes operational efficiency and supports long-term adaptability in dynamic environments.

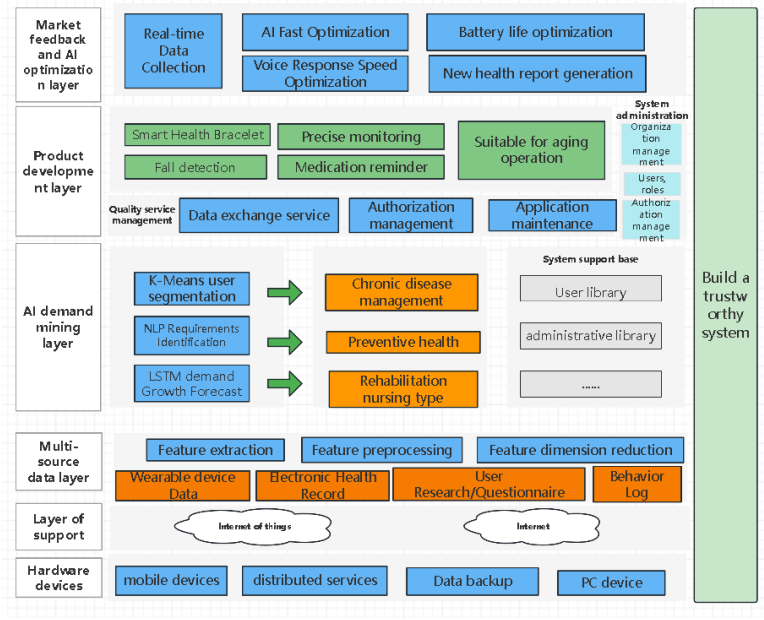

Figure 1 Application Architecture diagram

5.2 Description of the architecture diagram

The architecture diagram leverages the comprehensive capabilities of artificial intelligence technology to facilitate the core operational logic [12, 14]. It systematically outlines the practical pathway for a technology enterprise in developing a silver health management product. This process is categorized into three essential implementation phases: identifying and analyzing user needs, designing and developing the product, and gathering market feedback to refine the offering. Ultimately, the process culminates in evaluating the effectiveness and verifying the value generated by the implementation outcomes [12].

5.2.1 Requirements mining phase

This stage serves as the foundational step in product development. It begins with the integration of diverse data sources, including health-related metrics, consumption patterns, and behavioral data pertaining to the elderly population. Advanced analytical techniques and multi-class artificial intelligence algorithms are then employed to accurately identify and predict user needs [9, 13]. Furthermore, the application of the long short-term memory (LSTM) time series model facilitates precise quantitative forecasting of demand trends, offering valuable and reliable guidance for the strategic direction of product development efforts [13].

5.2.2 Product development stage

Building upon the findings from the demand analysis phase, the focus was placed on addressing the primary challenges in health management faced by the silver-haired demographic [10]. The resulting core product is a multi-functional intelligent health bracelet, designed to cater to the diverse needs of this group. Specifically, it integrates three essential health features: precise health monitoring, timely medication reminders, and advanced fall detection capabilities. These functionalities are meticulously tailored to align with the technical requirements and practical usability preferences of elderly users, ensuring both effectiveness and accessibility in their daily lives [13].

5.2.3 Market feedback stage

A sophisticated AI-driven dynamic iteration mechanism is established to collect comprehensive product market usage data and subjective user feedback in real time through advanced AI technology [8]. By analyzing the data to identify product-related issues and uncover latent user needs, the optimization process addresses both functional and experiential aspects of the product [5]. Additionally, an AI-generated health report

feature is integrated, ensuring the product evolves to align with the practical and evolving requirements of elderly users, thereby enhancing its relevance and usability in this demographic.

5.3 Implementation effect

The product development effect is evaluated through two primary dimensions: market sales and user satisfaction. This approach validates the practical implementation of an AI-driven development model tailored for the silver economy. It highlights the significant role of AI technology in facilitating the entire process, including demand identification, product development, and iterative improvement of silver economy products [2, 6]. Furthermore, this methodology offers a replicable framework that can serve as a practical reference for advancing the development of similar products within this sector, ensuring broader applicability and innovation.

6 Safeguard Measures and prospects

6.1 Safeguard measures

6.1.1 Data security

A comprehensive security management system is designed to oversee the entire data life cycle associated with the application of artificial intelligence in the silver economy. Sensitive data, including information related to elderly health, identity, and consumption patterns, is managed through hierarchical and classified controls to ensure robust protection. Advanced technical measures such as end-to-end encryption, hierarchical authority control, and privacy desensitization are employed to establish clear boundaries for data access and operation by personnel. The principle of "minimum necessary and express consent" is strictly adhered to, ensuring that data is utilized only with explicit authorization from elderly users. Additionally, user-friendly mechanisms are provided for authorization withdrawal and data deletion to empower individuals in managing their personal information. A proactive approach is adopted through the establishment of early warning systems and regular audits to identify and address vulnerabilities promptly, thereby preventing data leakage and misuse while safeguarding privacy and security.

6.1.2 Technical innovation support

Addressing the practical demands of the silver economy, efforts will be intensified to enhance investment in the research and development of core artificial intelligence technologies. Priority will be given to overcoming critical technical challenges, including advancements in natural language processing, recognition of emotional states in elderly individuals, and precise monitoring of health-related data. Enterprises, academic institutions, and research organizations are encouraged to collaborate in establishing research and development platforms and joint laboratories, fostering cooperative innovation in the creation of aging-related products. To further support these initiatives, the government has allocated a dedicated fund aimed at promoting AI-driven innovation within the silver economy. Financial incentives, such as subsidies for core technology development and product innovation, are being provided. Additionally, tax benefits, including increased deductions for research and development expenditures, are being implemented. Projects demonstrating significant technological advancements are rewarded to invigorate market-driven innovation and stimulate broader industrial progress.

6.1.3 Standard system construction

Driven by the collaboration of various departments, alongside industry associations, leading enterprises, and scientific research institutions, differentiated standards for technology, quality, and services are developed to address the specific needs of the silver economy. These standards focus on areas such as health management and intelligent care. A unified national certification system for aging-related products is established, fostering the growth of third-party certification agencies. Products meeting these standards are awarded exclusive certification marks, and the aging design requirements for AI products

are integrated into the certification framework. A multi-departmental collaborative supervision mechanism is implemented to ensure regular inspections of both online and offline product quality. Efforts are intensified to combat fraudulent advertising and counterfeit products, while corporate credit files are maintained to enforce accountability. Additionally, mechanisms are enhanced to facilitate consumer complaints and safeguard the rights of elderly individuals, ensuring a more secure and trustworthy market environment.

6.1.4 Digital skills are pervasive

A comprehensive training system should be established to connect government entities, community organizations, enterprises, and pension institutions. This system should provide hierarchical and categorized training tailored to elderly groups with varying levels of digital proficiency. The curriculum should include practical topics such as fundamental operations of intelligent devices and strategies for ensuring network security. Training should utilize a blended approach, combining online and offline methods. Offline sessions can be conducted through hands-on practical guidance in community centers and universities for the elderly, while online platforms can offer accessible teaching materials through short videos and live broadcasts. Enterprises should be encouraged to incorporate user-friendly features, such as AI voice guidance and animated demonstrations, into their products, alongside simplified operational modes and remote assistance functionalities. Additionally, public welfare guidance teams, including college students and community workers, should be organized to provide personalized, one-on-one support for elderly users, thereby effectively reducing the digital divide and fostering inclusivity in technology adoption.

6.2 Future prospects

With the continuous advancement of AI technology and the increasing aging of the global population, three significant trends are emerging in the development of products tailored to the silver economy. First, the precision and intelligence of AI algorithms are expected to advance further, enabling real-time identification and dynamic adaptation to the personalized needs of older adults. This will allow for more responsive and tailored solutions that address the diverse requirements of this demographic. Second, the evolution of product offerings is shifting from single-function tools to comprehensive, scenario-based ecosystems. These integrated systems will encompass a wide range of services, including home care, health management, and avenues for fulfilling emotional and recreational needs, thereby creating a holistic support framework. Third, the application of these technologies is anticipated to expand beyond urban centers to rural areas, leveraging AI to reduce service costs and ensure equitable access to innovative solutions. This broader reach will help bridge the gap between different regions, fostering inclusivity and enhancing the overall quality of life for older populations.

Looking ahead, it is imperative to deepen the integration of AI technology with the silver economy to unlock its full potential. Efforts should focus on refining mechanisms for identifying and addressing the needs of older adults, ensuring that technological advancements are paired with a strong emphasis on human-centered design and empathy. By balancing innovation with humanistic care, the silver economy can evolve into a sector that not only meets practical needs but also enriches the lives of older individuals. Furthermore, fostering collaboration across industries and regions will be crucial to driving sustainable growth and ensuring that the benefits of technological progress are widely shared. Future research should explore ways to enhance accessibility, affordability, and inclusivity, paving the way for a high-quality, equitable, and sustainable silver economy that empowers older generations to thrive in an increasingly digital world.

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