Research on Age-Friendly Design of Smart Home in the Context of Home-Based Elderly Care Mode

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Abstract: With the acceleration of the global ageing process, home-based elderly care has gradually become one of the important methods of caring for the elderly. The application of smart home technology is an important means to improve the quality of life for the elderly, and research on its age-friendly design is of considerable importance. This paper utilizes the home-based elderly care mode as its research context and systematically investigates the relationship between smart home and home-based elderly care. It provides an in-depth discussion on the principles and strategies of age-friendly design for smart home, explores the challenges faced by the elderly-friendly design of smart home in the context of home-based elderly care from three perspectives: technology, economy and society, and proposes corresponding solutions. It aims to provide useful references for the practical application and promotion of the age-friendly design of smart home.

Keywords: Home-Based Elderly Care Mode; Smart Home; Age-Friendly Design; Principles and Strategies

1. Introduction

The 2023 Chinese Government Work Report proposed to development of community and home-based elderly care services and the promotion of high-quality development of home and community care services. In May, the Ministry of Civil Affairs and the Ministry of Finance issued a notice on the implementation of the project to enhance home and community-based elderly care services. They identified 50 project areas, including Changping District in Beijing, as demonstration sites for building home-based elderly care mode, encouraging localities to explore various aspects actively, such as the construction of facilities, the cultivation of institutions, the training of talents and service innovation, in order to create a replicable and scalable mode of professionalized and socialized home-based elderly care services [1]. The emergence of this mode reflects not only the growing demand for comfortable and convenient living environments for the elderly, but also the increased social and family concern for the quality of life of the elderly.

Currently, the situation of home care for the elderly is showing a trend towards personalization, specialization, standardization as well as higher quality of service. On the one hand, the level of intelligence will be further improved, and the smart home products will be more popular and personalized, which will be able to better meet the special needs of the elderly; on the other hand, the home care services will be more specialized, standardized and the quality of the services will be further improved; Additionally, the government and the various sectors of society will pay more attention to the development of the home care mode and introduce more policies and measures to provide the elderly with higher quality home care services [2].

2. Definition and Characteristics of Home-based Elderly Care Mode

Home-based elderly care is a mode in which the elderly spend their twilight years in their own homes. It emphasizes the family as the core and the community as the backbone, and through the integration of various social resources, comprehensive and multi-level services are provided to the elderly. Compared with traditional institutional care, this mode pays more attention to the personalized needs and quality of life of the elderly, and aims to enable the elderly to spend their twilight years in a familiar and comfortable environment [3]. With the rise of this mode globally, particularly in some developed countries and regions, it has become one of the mainstream methods of elderly care. The advantages of Home-based elderly care mode are obvious. Firstly, it has been demonstrated that the aforementioned

environment is conducive to the psychological needs of the elderly population. For a considerable number of elderly individuals, the family home represents a place of long-term residence, replete with memories and emotional attachments. The act of growing older within the confines of a family unit has been demonstrated to engender feelings of affection and a sense of belonging, which has been shown to have a mitigating effect on the prevalence of psychological problems such as loneliness and depression in the elderly. Secondly, the home-based elderly care mode has the advantage of cost-effectiveness. Compared with institutional care, the financial outlay for home-based elderly care is comparatively lower, thereby reducing the economic burden on the elderly and their families. At the same time, the constant improvement of community services has gradually improved the quality of home-based elderly care services, so that the elderly can enjoy convenient and professional services at home [4].

The home-based elderly care mode also faces a number of challenges. Firstly, as older persons grow older, their physical functions and cognitive abilities gradually decline, placing higher demands on the adaptability and safety of the home environment [5]. This necessitates adaptation of the home environment to address the unique requirements of elderly individuals. Furthermore, the promotion and popularisation of the home-based elderly care mode is a collective responsibility that demands the concerted efforts of all sectors of society. The current challenges include the paucity of services, suboptimal quality of services, and a shortage of service personnel in some areas, which impede the development of the home-based elderly care mode. To surmount these challenges, it is imperative for all stakeholders, encompassing the government, communities, enterprises and social organisations, to engage collectively, thereby engendering a symbiotic relationship. The government should increase policy support and financial investment in home care services to promote the improvement and development of the home care service system. Local communities, too, are called upon to leverage their own strengths, integrating diverse resources to offer customised services tailored to the needs of the elderly. Enterprises, for their part, should proactively develop and promote smart home products and services that are suitable for the elderly, with a view to enhancing their quality of life and sense of well-being. Concurrently, social organisations must enhance their care and assistance for the elderly, fostering a societal environment characterised by respect for the elderly.

3. The Concept of Smart Home and Its Role in Home-Based Elderly Care Mode

Smart home, as a product of the combination of modern information technology and traditional home, refers to the interconnection and intelligent control of home equipment through the Internet of Things, cloud computing, big data and other technical means. It is with the help of various types of sensors and actuators, real-time perception of the state of the home environment and user needs, and then through the central controller or cloud platform for data analysis and processing, and ultimately achieve intelligent control of home equipment. For example, the temperature sensor senses the indoor temperature and automatically adjusts the operation status of air conditioning to maintain a constant indoor temperature; the light sensor senses the indoor light intensity and automatically adjusts the degree of opening and closing of curtains to create a comfortable visual environment [6].

Under the field of home-based elderly care mode, the application of smart home technology can be multifaceted. Firstly, it can achieve health monitoring and early warning for the elderly. Through wearable devices or built-in sensors at home, real-time collection of the elderly's heart rate, blood pressure, etc. . Once abnormalities are detected, alarm messages are immediately sent to family members or medical institutions to ensure that the elderly receive timely assistance. Secondly, it can improve the quality of life of the elderly. Through intelligent control of home equipment, such as lighting, music, TV, etc. The home environment is automatically adjusted according to the preferences and habits of the elderly, so that they can enjoy a more personalised and comfortable home life. In addition, smart home can also enhance the sense of security of the elderly. Through intelligent door locks, surveillance cameras and other equipment, real-time monitoring of home security conditions, to prevent accidents, to protect the home security of the elderly, to create a better life for the elderly in their twilight years.

4. Smart Home Age-friendly Design Strategy

With the increase of age, the elderly will experience a series of changes in physiology and psychology, and these changes directly affect their needs and expectations for the living environment. Consequently, in the context of smart home ageing design, it is imperative to comprehensively consider the physiological, psychological and usage habits of the elderly, in conjunction with the characteristics of smart home technology. This comprehensive approach facilitates the formulation of specific design strategies and methodologies.

4.1 User-Centred Design

In the process of developing products or services for older persons, it is imperative to possess a profound comprehension of their particular requirements and daily habits. Given the potential decline in visual acuity, auditory perception and operational skills that occurs with age, it is essential to simplify the operational process and ensure that it is intuitive and straightforward to comprehend during the design stage. Specifically, this can be achieved by increasing the size of fonts and icons to enhance visual readability, providing clear voice prompts to facilitate auditory comprehension, and employing interface elements that are easily identifiable and straightforward to operate, thereby significantly enhancing the ease of use for elderly individuals. Simultaneously, in consideration of the potential memory impairment experienced by the elderly, the design process should minimise the number of operational steps requiring memorisation, employing intelligent default settings and intuitive icons instead of complex text descriptions. This approach ensures that older individuals can effortlessly initiate and continue utilising the system with ease.

4.2 Safety and Comfort Considerations

Safety and comfort are at the core of smart home design for ageing. It should be ensured that all equipment complies with relevant safety standards and designs that may cause harm to older persons should be avoided [7]. For example, the power cords of electrical equipment should be avoided to be too long to prevent the elderly from tripping over. In addition, the use of equipment should be as comfortable as possible, such as the adjustment of the colour temperature and brightness of lights and the setting of air-conditioning temperatures, all of which should be based on the comfort of older persons.

4.3 Ease of Use and Accessibility Enhancements

The fundamental principles of age-friendly smart home design emphasise the importance of ease of use and accessibility. It is acknowledged that older people may be unfamiliar with new technologies; therefore, it is essential to provide intuitive and easy-to-use user interfaces, as well as simple and clear operating instructions. Simultaneously, the devices must be highly accessible, enabling seniors to readily access and control smart home devices, irrespective of their location within the home.

4.4 Automation and Intelligence in Smart Home

Using the automation and intelligent technology of smart home, we can provide a more convenient and comfortable living environment for the elderly. For example, by setting up automated scenarios, environmental adjustments such as lighting and temperature are automatically made at specific times. At the same time, through intelligent data analysis, we can predict the living habits of the elderly and thus provide more personalised services.

4.5 Integration of Health Management and Emergency Response Systems

Smart home systems can integrate health management and emergency response functions to cope with unexpected situations that the elderly may encounter. For example, by monitoring the health status of the elderly through devices such as smart bracelets and smart mattresses, the smart home system can automatically contact medical institutions or family members in case of abnormalities. Meanwhile, by setting up emergency buttons or voice recognition systems, the elderly can quickly seek help in case of emergency.

5. Challenges and Solutions for Age-Friendly Design of Smart Home

5.1 Technical Challenges and Solutions

In the process of designing smart home for the elderly, technological challenges are a part of the process that cannot be ignored. These challenges are mainly related to the complexity and

compatibility of the technology, as well as the acceptance of the technology by the elderly. Smart home systems integrate a variety of advanced technologies, such as the Internet of Things, big data and artificial intelligence, which makes the design and implementation of the system quite complex. To solve these problems, designers need to have a profound understanding of the characteristics and application scenarios of these technologies to ensure that the system can operate stably and efficiently. Compatibility of smart home devices is also an issue that needs to be addressed [8]. Currently, there is a wide range of smart home products on the market, but there are often compatibility problems between devices of different brands and mode, which causes great inconvenience for the elderly. To address this issue, the industry should develop a unified standard for smart home devices to improve interoperability between devices, thereby reducing the difficulty of use for the elderly. In addition, the acceptance of new technologies by the elderly is generally low, which is also a major challenge for designing smart home for ageing. To overcome this challenge, designers need to fully consider the cognitive characteristics and operation habits of the elderly, and design smart home interfaces and operation methods that are easy to use and compatible with the elderly. At the same time, all sectors of society should strengthen technical education and popularisation for the elderly to improve their technical literacy and confidence.

In addition to the aforementioned solutions, the level of smart home age-friendly design can be further enhanced by introducing intelligent assistants and optimising voice recognition technology [9]. To illustrate this point, intelligent assistants can facilitate the control of domestic devices and the access to life information by elderly with greater convenience. Moreover, optimised voice recognition technology can enhance the accuracy of voice commands, thereby improving the efficiency of system interactions.

5.2 Economic Challenges and Solutions

The promotion and application of age-friendly design in the smart home faces several economic challenges. The first is the cost of the product. Smart home devices tend to be more expensive to develop and produce than traditional home devices. This is mainly due to the integration of high-tech elements, multi-functional integration and more complex production processes. These higher costs are ultimately passed on to consumers, resulting in relatively high retail prices for smart home products. This is undoubtedly a considerable burden for families with limited financial resources. The installation and maintenance costs of smart home systems should not be overlooked. In order to ensure the stable operation of the system, professional technicians may be required to carry out regular inspections and updates, and this part of the cost will also increase the user's cost of use [10]. At the same time, the rapid updating of smart home technology may require older people to update their equipment, which will undoubtedly add to their financial pressures.

In order to address the economic challenges faced by this demographic, the following solutions are proposed. Primarily, governments and relevant organisations can provide subsidies or tax incentives to reduce the purchase cost of smart home products, thereby encouraging more older people to use smart home devices. Secondly, the manufacturing sector of smart home products can be encouraged to reduce production costs through technological innovation and optimisation of production processes, thereby reducing the selling price.

5.3 Social Challenges and Solutions

In the process of designing smart home for ageing, challenges at the societal level cannot be ignored. These challenges are mainly in the areas of social acceptance, privacy protection, and digital divide. To address these challenges, this study proposes a series of targeted solutions. Regarding the issue of social acceptance, older people and their family members may hold scepticism or resistance towards smart home technologies. This is mainly due to the lack of understanding of the new technology, the complexity of operation, and the impact on traditional living habits [11]. In order to improve social acceptance, on the one hand, it is necessary to strengthen the popularisation and publicity of smart home technology, and show the convenience and practicality of smart home to the elderly and their family members through online and offline channels. On the other hand, the design of smart home products should give full consideration to the use habits and psychological needs of the elderly, and strive for simplicity and ease of use to reduce the threshold of operation.

Privacy protection constitutes a further important theme in the realm of smart home age-friendly design [12]. The utilisation of smart home products can give rise to concerns among the elderly regarding the potential for leakage or misuse of personal information. To address this issue, it is recommended that smart home systems adopt advanced encryption technologies and privacy protection measures to ensure the security of user data. In addition, governments and companies must strengthen regulation and establish strict privacy protection policies and regulations to ensure a secure environment for elderly individuals to utilise smart home technologies.

The digital divide is a pertinent issue that must be addressed in the context of smart home age-friendly design [13]. The level of economic development and the distribution of educational resources are factors that may result in some older persons facing barriers to accessing and using digital technologies. In order to address this issue, it is essential for governments and all sectors of society to collaborate in providing inclusive digital technology training and support. This will assist older people in crossing the technological threshold and enjoying the convenience of smart home.

6. Conclusions

At a time when home-based elderly care mode is gradually becoming mainstream, the importance of smart home age-friendly design is becoming more and more prominent. In the face of the special needs of the elderly group, this paper discusses in depth the physiological function changes, psychological and emotional needs of the elderly and the various challenges they encounter in the actual living through meticulous analysis. Combined with the current rapid development of intelligent technology, we are committed to building a comfortable, safe and intelligent home care environment for the elderly. Such a design can not only effectively improve the quality of life of the elderly, so that they can enjoy their twilight years in a familiar environment, but also lay a solid foundation for the sustainable development of the home care mode. With the accelerated pace of the ageing society, smart home age-friendly design will undoubtedly become an important trend in the field of home care in the future, to provide the elderly with more intimate and comprehensive services, so that the elderly have a sense of

nourishment, a sense of dependence, a sense of joy, the beautiful vision of the elderly become a reality.

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