

Faculty of Applied and Creative Arts

Design Thinking for Age-Friendly Furniture in Chinese Nursing Homes: Addressing Physiological and Behavioral Characteristics of the Elderly

Zhang Yun

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Design Thinking for Age-Friendly Furniture in Chinese Nursing Homes: Addressing Physiological and Behavioral Characteristics of the Elderly

Zhang Yun

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



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Signature

Name: ZhangYun

Matric No.: 20010009

Faculty of Applied and Creative Arts

Universiti Malaysia Sarawak

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ABSTRACT

This research aims to explore the method of addressing the design challenges of age-friendly furniture by optimizing product functionality and implementing innovative design to meet the diverse needs of the elderly in nursing homes in China. Therefore, this research analyse the physiological and behavioral characteristics of the elderly in nursing homes in China, to explore their existing problems and user requirements, to propose the attributes, elements, principles and methods of age-friendly furniture design, and finally to verify the feasibility and effectiveness of the proposed research questions and objectives through design practice. In order to fulfil the objectives of this research and address the research questions, a combination of qualitative and quantitative research methods was utilized to summarise, gather, and analyse the research data, as well as to identify the principal issues and solutions of the research program. This research applies various research techniques, including literature analysis, questionnaires, and interviews, in conjunction with direct observation of specific objects, to conduct a thorough investigation into the current state of furniture usage, design requirements, and physiological and behavioral characteristics of the elderly residing in nursing homes. On this basis, the study analyses the existing problems and causes, design attributes and focal points, as well as user requirements, in relation to the development of age-friendly furniture designs for nursing homes. Furthermore, two brainstorming design workshops are organized to identify keywords, functional hierarchy models, design features, and design concepts for age-friendly furniture design. By analysing the data obtained from the research and conducting a systematic study, this study summarizes seven major user requirements and six major design elements. Subsequently, it proposes seven design principles and a range of design methods tailor to the physiological and behavioral characteristics of the elderly in nursing homes in China.

The study proceeds to implement and validate the proposed design principles and methods. Additionally, it highlights the limitations of design practice, future work, and recommendations. Finally, the design practice and validation are executed.

Keywords: China, nursing home, elderly, age-friendly, furniture design

Penyelidikan tentang Pemikiran Reka Bentuk Perabot Mesra Penuaan Rumah Penjagaan Berdasarkan Ciri-ciri Fisiologi dan Tingkah Laku untuk Warga Emas di China

ABSTRAK

Penyelidikan ini bertujuan untuk meneroka cara menangani cabaran reka bentuk perabot mesra penuaan dengan mengoptimumkan fungsi produk dan melaksanakan reka bentuk yang inovatif, bagi memenuhi pelbagai keperluan individu warga emas di rumah jagaan warga emas China. Oleh itu, objektif penyelidikan ini adalah untuk menganalisis ciri-ciri fisiologi dan tingkah laku warga tua di rumah jagaan kejururawatan China, untuk meneroka masalah sedia ada dan keperluan pengguna, untuk mencadangkan sifat, elemen, prinsip dan kaedah reka bentuk perabot mesra penuaan, dan akhirnya untuk mengesahkan kebolehlaksanaan dan kesahihan cadangan soalan dan objektif kajian dengan melaksanakan amalan reka bentuk. Penyelidikan ini menggunakan pelbagai teknik penyelidikan, termasuk analisis literatur, soal selidik, dan temu bual, bersama-sama dengan pemerhatian langsung objek tertentu, untuk menjalankan penyiasatan menyeluruh ke atas keadaan semasa penggunaan perabot, keperluan reka bentuk, dan ciri fisiologi dan tingkah laku individu warga tua yang tinggal di rumah jagaan. Berdasarkan asas ini, kajian menganalisis masalah dan punca sedia ada, sifat reka bentuk dan titik fokus, serta keperluan pengguna, berkaitan dengan pembangunan reka bentuk perabot mesra penuaan untuk rumah jagaan. Tambahan pula, tiga bengkel reka bentuk sumbangsaran telah dianjurkan untuk mengenal pasti kata kunci, model hierarki berfungsi, ciri reka bentuk dan konsep reka bentuk untuk reka bentuk perabot mesra penuaan. Dengan menganalisis data yang diperoleh daripada penyelidikan dan menjalankan kajian yang sistematik, kertas kerja ini merumuskan tujuh keperluan pengguna dan enam elemen reka bentuk. Selepas itu, ia mencadangkan tujuh prinsip reka bentuk dan pelbagai kaedah reka bentuk yang

disesuaikan dengan ciri fisiologi dan tingkah laku individu warga emas di rumah jagaan orang China. Kertas kerja ini meneruskan untuk melaksanakan dan mengesahkan prinsip dan kaedah reka bentuk yang dicadangkan. Selain itu, ia menyerlahkan batasan, kerja masa depan dan cadangan amalan reka bentuk. Akhirnya, amalan reka bentuk dan pengesahan dilaksanakan.

Kata kunci: *China, rumah pengasuh, orang tua, ramah tua, reka bentuk perabot*

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
CNBS	China National Bureau Statistics
CNKI	China National Knowledge Infrastructure
F	Female
M	Male
Q	Questionnaire
RMB	Ren Min Bi
RQ	Research Question
RO	Research Objective
UN	United Nations
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 General Introduction

This research centres on examining the correlation between the elderly population and the utilization of furniture in the design of nursing home spaces. With a fundamental understanding of China's increasingly prominent ageing population problem, the objective of this research is to provide furniture products that suit the needs and preferences of China's elderly. By conducting a thorough investigation and analysis of the psychological, physiological, and behavioral characteristics of the elderly, this research aims to explore the various elements, principles, methods, and design approaches that can be implemented in the creation of age-friendly furniture for China nursing homes.

This research aims to discover, investigate, develop, and design ageing furniture in nursing home in China. This chapter outlines the background of the research, the problem statement, the research questions, the research objectives, the significance of the study, the scope of the research, the limitations, and the research framework.

1.2 Research Background

The ageing of China's population and the growth of the elderly care industry have necessitated a higher requirements for the design and research of age-friendly furniture in nursing homes. However, current furniture manufacturers and designers often overlook the unique characteristics of elderly residents in nursing homes, resulting in a limited number of truly "age-friendly" furniture products. Given the physiological and behavioral changes that occur with age, there is an urgent need for design to enhance interaction and

communication between the elderly and their living furnishings. Therefore, it is crucial to develop and design age-friendly furniture that aligns with the physiological and behavioral characteristics of the elderly population in nursing homes.

1.2.1 The Current Situation and Trend of Ageing Population in China

The guidebook aims to assist postgraduate research students in writing their final thesis. This can be achieved through the following objectives:

Based on data from the Seventh National Population Census and the United Nations World Population Prospects 2022, an analysis of population ageing trends in China reveals that the country is currently experiencing a rapid development of population ageing, with this process expected to accelerate in the future, leading to an increasingly aged society (Dong, 2022).

China officially entered an aged society in the year 2000. From 1982 to 2020, the proportion of the elderly population aged 60 and above in China has drastically increased from 7.62% to 18.7%, accounting for a population of approximately 264,019,000. Similarly, the proportion of the elderly population aged 65 and above has risen significantly from 4.91% to 13.5%, with a population of approximately 190,635,000 (CNBS, 2019). According to the population projections in the United Nations World Population Prospects 2022, the number of individuals aged 60 and above in China is expected to surpass 500 million by 2050, constituting 38.81% of the total population. Additionally, the proportion of the population aged 80 and above is projected to exceed 10 % (UN, 2022).

Currently, China’s fertility rate has declined to a level below replacement, while

life expectancy and mortality rates align closely with those observed in developed nations. It is evident that the initial phase of the 21st century will witness the most rapid period of population ageing in China. Consequently, the living conditions of the elderly, the establishment of elderly care facilities, and the development of products tailored to the needs of the ageing population have garnered significant attention from various stakeholders.

1.2.2 New Perspective On the Elderly Population

a) The Concept of Well Being for Elderly

Treating the elderly as a problem is rife with negative connotations. This results in older people often finding themselves in a passive role when implementting designed interventions that encounter difficulties in achieving sustainable well-being for the elderly. To foster new aspects of design for the ageing population and allow the elderly to enjoy their old age, it is necessary to have a new understanding of the nature of happiness and well-being.

Well-being is closely associated with the concepts of happiness and welfare, although there are notable distinctions between them. In contemporary psychological research, the English equivalent of well-being is derived from the compound term Well-being, reflecting Western views of human existence. Happiness means both subjective and objective happiness. It encompasses both “the happiness that human beings derive from the fulfilment of their needs and the pleasure that individuals derive from being able to realize their values,” and can be expressed in terms of objective counterparts and quality of life. The design process should focus on the design object’s potential to regulate happiness-enhancing behaviors rather than materialistic attributes. On the one hand, this is an

intrinsic requirement for human beings, reflecting the nature of happiness, and on the other hand, it is also an objective requirement of social development.

b) The Evolvement Concept of Ageing

In 1983, Robert Butler, a distinguished American geriatrician and the first director of the national institute on ageing, first proposed the concept of productive ageing. Later, the concept of healthy ageing was introduced at the world health assembly in 1987. It was a confrontation with ageism, and it was proposed as an attempt to transform older persons from a social burden to a potentially productive one.

The concept and strategy of active ageing evolved from the ideas of successful ageing, productive ageing, and healthy ageing, and endeavours to convey an inclusive concept that transcends mere health. In 1999, the European Union organized a conference on the topic of "active ageing" to explore this concept, and initially proposed a policy framework for active ageing.

It was not until 2002 that the concept of "active ageing" was formally introduced at the Second United Nations World Assembly on Ageing, which took place in Madrid. In that same year, the World Health Organization (WHO) published the report "Active ageing: A Policy Framework," wherein the concept of active ageing was explicitly defined as "the process by which the three dimensions of health, participation, and security may be optimized in old age to enhance quality of life (WHO, 2002)." Consequently, the concept of active ageing has been established as the policy framework and guiding principle for the international community in addressing the challenges of ageing in the modern era.

The conceptualisation and interpretation of well-being focuses on the "well-doing" element of happiness, which is shared by the concept of active ageing promoted by the

international community. Therefore, it is possible to establish a correlation between well-being in old age and active ageing and to build a positive view of well-being in old age from the perspective of active ageing. An important function of design is to enhance the active participation of older people themselves and to strengthen their self-management of their own lives. There is also a need for designers to understand the positive changes of ageing and to actively play a constructive role in designing on this basis.

In the World Report on Ageing and Health, published in 2015, the World Health Organization (WHO, 2015) presented a fresh articulation of healthy ageing. The new concept of healthy ageing incorporates elements of active ageing. On June 12, 2019, the World Health Organization officially drafted the Decade of Action for Healthy Ageing 2020 - 2030 (WHO, 2019).

c) The Design Demand for Ageing Population

The phenomenon of an increasing ageing population has always been regarded as a "social issue". The social implications of population ageing are directly manifested in the creation of human settlements. The physical, psychological, and behavioral abilities of the elderly are diminishing, thus weakening their adaptability to their surroundings and increasing their reliance on others. This is evident in their desire for safety and comfort. Simultaneously, they are psychologically disconnected from society and susceptible to negative emotions such as frustration, loneliness, and feelings of loss. Consequently, it is imperative to establish positive spaces or products that can compensate and support them.

In view of China's rapid ageing process and the challenge of facing the "old before rich" dilemma, Western developed nations are insufficiently prepared to address the ageing problem during this adaptation period. As a result, the current theoretical and practical

aspects of nursing home furniture design are not in line with international standards and fail to fully meet the actual needs of the elderly. This contradiction has become increasingly apparent. With a deeper understanding of the ageing problem, China is increasingly aware of the importance of the elderly living environment and its implications for the social economy.

The 2014 Blue Book of Ageing Industry Report on the Development of China's Ageing Industry explicitly states that the ageing real estate industry and ageing service industry are the cornerstones of ageing industry development. These sectors fall within the purview of national scientific and technological innovation and will become important components of the national macroeconomic operation (Wu & Dang, 2014). With the support of government policies and private capital investment, China's elderly care environment construction will experience a peak of development. Therefore, the research and implementation of age-friendly product design in nursing homes should seize this opportunity to provide scientific and rational recommendations to the industry, so that the elderly can enjoy a more comfortable, healthy, and pleasant environment.

The design demand for the ageing population is rooted in the growing recognition of the need for products that accommodate age-related physical, cognitive, and emotional changes. The design needs of the elderly population are a complex and important topic that requires a combination of factors.

1.2.3 The Challenges in Designing Furniture for the Elderly

The investigation on the ageing furniture for China nursing homes is still in the preliminary stage. Applying scientific method that combines empirical research and design to the construction of China nursing homes has also encountered various challenges.

a) The Lack of Design Research in Furniture Design for Elderly

The lack of research in furniture design specifically targeting the elderly has been noted by various scholars and professionals. While there has been an increasing demand for age-friendly designs, the gap between need and dedicated research in the area remains significant.There has been relatively little research on furniture design for the elderly.

Existing research on the design of furniture for the elderly often does not adequately take into account the special physiological and psychological needs of the elderly. For example, size designs are mostly derived from foreign standards or based on Chinese adult size projections, and there is a lack of normative measurements and templates for the elderly population. In addition, some studies have shown that research on furniture design for the elderly in China is mostly superficial, and in-depth research on the functionality and styling design of bedroom furniture is particularly scarce.

This study calls for more interdisciplinary work to address the physical and cognitive limitations of older adults through better-designed furniture. Furniture design for the elderly requires the integration of knowledge from multiple disciplines, such as geriatrics, ergonomics and psychology. However, existing research is often limited to a single discipline and lacks comprehensive interdisciplinary research. For example, in functional design, it fails to fully integrate the physiological characteristics of the elderly for targeted design.

b) The separation between research practice and design creation

The disconnection between research and design remains an ongoing issue in the realm of age-friendly furniture (Zhang, 2023). Designers often only have a superficial understanding of the positive impacts that typical healthcare furniture can have on an

individual. However, due to the limited scope of theoretical research that provides specific recommendations for nursing home furniture design, many interiors in elderly care facilities are still designed based on the designers' intuition.

Ideally, the research practice and design creation of age-friendly furniture should be closely linked and mutually reinforcing. In practice, however, there may indeed be some separation between the two. Although there have been some research attempts to design furniture products suitable for older adults, these designs often lack extensive market validation and practical application, which prevents the practicality and comfort of the products from being fully validated and improved. The opinions and needs of older persons are often ignored or underestimated in the design process. This leads to the design of products that may deviate from the actual needs of older persons and fail to truly meet their lifestyle needs. In addition, there are technical bottlenecks and cost consideration limitations. In some cases, although design teams have innovative ideas and concepts, these ideas may not be translated into actual products due to limitations such as technical bottlenecks or cost considerations (Zhou et al., 2020). It is determined through scientific user research that the design scale of elderly furniture used in the daily life of the elderly is not aligned with the operational behavior of the elderly (Shi & Zhang, 2023). Consequently, furniture designs targeting the China's elderly needs still cannot fully meet their actual needs.

In conclusion, the separation between research practice and design creation of age-friendly furniture is a problem that needs attention. By strengthening cross-disciplinary cooperation, in-depth research on market demand, technological innovation and cost

control, as well as focusing on user experience, this problem can be effectively solved and the development of the furniture for the elderly industry can be promoted.

c) The Neglects of Attending to Elderly Needs Among Furniture Manufacture and Design

Most furniture available on the market lacks an age-friendly concept, and the exclusivity and market positioning of furniture for the elderly remain unclear and ambiguous. Most geriatric furniture functions similarly to furniture for young adults, and has not been designed from the perspective of older adults. Additionally, furniture manufacturers lack an understanding of the distinct needs and desires of the elderly in nursing homes, resulting in existing furniture products that fail to meet the daily needs of elderly consumers. These factors contribute to the background of the research conducted in this study.

A survey of on-line communities and forums where designers are active reveals that designers also hold negative stereotypes about ageing design. Many designers believe that products for ageing should be characterized by large fonts and loud sounds, and that designs should focus on facilitating mobility, given the difficulties that come with ageing. To some extent, these two perspectives reflect the prevailing concept of design for ageing.

In recent years, a new economic term “silver hair economy” has emerged, meaning that the ageing of the population has contributed to the creation of a new consumer market. However, in the Chinese furniture market, there are few furniture products designed for the elderly. The research on elderly furniture is not in-depth, including unprofessional design and single style and function of furniture. The special characteristics of the elderly in the use of furniture and the real needs of the elderly are not considered. From the Shanghai

international furniture exhibition in recent years, we can find that most of the furniture enterprises and designers do not target the behavioural habits of the elderly, physiological characteristics of the research and product development, and vaguely believe that the traditional solid wood furniture is the furniture for the elderly, and does not really take into account the elderly on the furniture of the special needs. The design often stays on the surface of the conceptualisation, without really standing in the perspective of the elderly to think about the problem and feel the design, which is not in line with the actual needs of the elderly for furniture products, and the market positioning is not accurate enough. Design teams may rely too much on their own expertise and experience and neglect in-depth research and understanding of the elderly population, which may result in product designs that deviate from market demand and fail to truly meet the needs of the elderly in terms of usage (Dong et al., 2020).

In terms of the furniture market, China's research and development of elderly furniture is a small number of enterprises, accounting for a small proportion of the entire furniture market. From the designer's point of view, some designers confuse the concept of age-friendly furniture with old furniture or old-fashioned furniture, and the design and research of elderly furniture products are not deep enough, not professional enough, with serious plagiarism and low overall level. This is where the space of this thesis research lies.

This study examines the current situation and challenges surrounding the use of age-friendly furniture in China nursing homes, within the context of an increasingly pressing backdrop of an ageing society. This study takes the age-friendly furniture in China nursing homes as the research object, focusing on the deeper design connotation behind the

age-friendly furniture, i.e. the relationship between the physiological and behavioral characteristics of the elderly in nursing homes and the furniture.

1.3 Problem Statement

Throughout the analysis of background study, it was found that the increasing ageing population presents significant social challenges, particularly in the design and creation of living environments for the elderly. The elderly's diminishing physical, psychological, and behavioural abilities result in heightened dependence on others and a need for safety and comfort. They often feel socially disconnected and prone to negative emotions. China faces a unique dilemma with its rapid ageing process, influenced by economic constraints. The current nursing home furniture design does not align with international standards or adequately meet the elderly's needs. Rapid economic development and a focus on quick results in China have hindered establishing a robust research foundation before the design phase. Consequently, the furniture design for elderly care often emphasizes appearance and commercial appeal over functionality and empirical research.

This disconnection between research and design results in nursing home furniture that does not cater to the elderly's specific needs. Many designers have superficial understandings and hold stereotypes about age-friendly design, leading to products that do not meet the practical needs of elderly consumers. Hence, addressing these issues through empirical research and integrating it with design practices is essential for creating effective, age-friendly furniture. To bridge the gap between the current design practices and the needs of the elderly, it is crucial to conduct comprehensive research on age-friendly furniture based on the physiological and behavioral characteristics of the elderly. This

approach will lead to scientifically and rationally designed products that enhance the comfort, health, and well-being of the elderly in nursing homes. By focusing on empirical research and fostering a better understanding among designers, China can improve the elderly care environment, aligning with international standards and addressing the unique challenges posed by its rapidly ageing population.

An important motivation behind the research question posed in this study is the underlying assumption that both older individuals and society as a whole will benefit from the implementation of age-friendly furniture. Such a furniture not only supports and enhances their well-being but also enables them to maintain an independent lifestyle for as long as possible. Consequently, society as a whole stands to gain from the design products of age-friendly furniture, as they can alleviate the social pressures associated with ageing.

1.4 Research Questions

As the population ages, China's demand for services that cater to the design needs of the elderly is expected to surge. Although the state and local authorities have made gratifying efforts in promoting the design of nursing homes in recent years, the field of age-friendly furniture is still relatively immature and imperfect due to its late start. Not surprisingly, the current designs fall short of effectively meeting the physiological and behavioral characteristics of the elderly. Consequently, it becomes imperative to address the urgent issue of enhancing the design of age-friendly furniture in China nursing homes to better cater to the daily needs of the elderly. In light of this, the present study will focus on the following four key areas:

i. What are physiological and behavioural characteristics of the elderly in nursing homes in China?

ii. What are the existing problems and user requirements of the elderly?

iii. How the attributes, elements, principles and methods of age-friendly furniture design for the elderly can be proposed?

iv. How the feasibility and effectiveness of the proposed research questions and objectives can be established through design practice?

1.5 Research Objectives

The research objectives are as follows:

i. To explore the physiological and behavioural characteristics of the elderly in nursing homes in China.

ii. To analyse the existing problems and user requirements of the elderly.

iii. To propose the attributes, elements, principles and methods of age-friendly furniture design for the elderly.

iv. To verify the feasibility and effectiveness of the proposed research questions and objectives through design practice.

1.6 Research Hypothesis

Despite the increasing need for elderly-friendly furniture, existing designs often fail to address the specific physiological, behavioral, and psychological needs of the ageing population, particularly in nursing homes. This research aims to analyse the physiological and behavioral characteristics of the elderly in nursing homes in China, to explore their existing problems and user requirements, to propose the attributes, elements, principles and methods of age-friendly furniture design, and finally to verify the feasibility and

effectiveness of the proposed research questions and objectives through design practice. So, the following hypotheses are proposed

Hypothesis 1: Furniture designed to accommodate the specific physiological and behavioral characteristics of elderly individuals in China nursing homes will significantly improve their comfort, safety, and overall well-being compared to conventional furniture.

Hypothesis 2: Identifying the existing problems and unmet user requirements in age-friendly furniture designs lead to higher satisfaction and usability among elderly users.

Hypothesis 3: The attributes, elements, principles, and methods of age-friendly furniture design for the elderly can be proposed by considering their physiological and behavioral characteristics, existing problems, and user requirements.

Hypothesis 4: The proposed research questions and objectives, when tested through design practice, will demonstrate the feasibility and effectiveness of age-friendly furniture design in improving the living conditions and quality of life for elderly individuals in nursing homes.

1.7 Significance of Study

The survey reveals that China's research into the design of age-friendly furniture in nursing homes is still in its nascent stage, and numerous challenges remain in the existing age-friendly furniture. This study offers a substantial theoretical foundation and empirical survey data on the design components, principles, and methods of age-friendly furniture in China nursing homes. Additionally, practical design considerations and pathways for implementing age-friendly furniture in nursing homes are presented.

a) Practical Significance

This study focuses on the physiological and behavioral characteristics of the elderly in nursing homes and aims to investigate the issue of designing furniture that is conducive to ageing in such an environment. This research holds significant practical implications for the physical and mental well-being of the elderly population.

It not only presents a substantial theoretical foundation but also offers empirical data obtained from surveys, thus providing valuable insights into the construction of age-friendly furniture in China nursing homes. Furthermore, this study proposes some practical strategies for designing furniture that cater to the needs of the ageing population in nursing homes.

This research endeavours to foster innovation in the elderly furniture industry and facilitate the advancement of "age-friendly" product design in China. Thereby promoting the development of the ageing industry itself and the economic growth of the furniture industry.

b) Social Significance

As China's ageing situation is increasingly dire, it is crucial to investigate and study the design of furniture specifically tailor-made for nursing homes. This research has important social value as it aims to educate and raise awareness about the challenges faced by the elderly in society. Additionally, it serves as a valuable reference for addressing global ageing issue and contributes to the decision-making process.

The development of innovative products catering to the elderly can greatly enhance their comfort and safety, thereby improving their overall quality of life. Moreover, such

products promote independent living and alleviate the burden on family and later life. This positive influence contributes to the harmonious development of society.

To enhance the lives of the elderly, it is imperative to create and provide furniture products that meet their physiological and behavioral needs. By providing a range of options specifically designed for the elderly, their quality of life and self-confidence can be significantly improved.

1.8 Scope of Research

This research focuses on the promising prospects of China's elderly home furnishing market. By analysing the characteristics and behaviors of the elderly to find out their specific needs, relevant furniture designs can be developed. While drawing on research findings and experiences from other countries, the primary focus of this study is to address the needs of nursing homes in China.

a) Definition of Spatial Scope

The scope of this study primarily covers a range of spaces found in institutional nursing home in China. Based on the living environment, social services, and national conditions of the elderly in China, this study focuses on providing furniture products suitable for them. Although international research results and experiences will be considered, the research problem and results focus primarily on China nursing homes.

b) The Selection of Research Perspective

From a Chinese perspective, this study examines and summarizes the physiological and behavioral characteristics of elderly individuals residing in China nursing homes. Additionally, this study explores the impact of these characteristics on the functional

requirements of furniture that promotes age-friendly environments. By reviewing previous studies, it was determined that the existing research findings and production technology are adequate to support the creation of high-quality furniture products. However, the actual design and utilization of this furniture did not achieve satisfactory results. Therefore, this research analyses and generalizes the physiological and behavioral characteristics of the elderly and subsequently propose corresponding design principles and methods.

c) Selection of Survey Scope

The data collection for this study was conducted in various provinces and regions in China. Questionnaire and interview surveys were conducted to collect information on the lifestyles of selected groups of people living in nursing homes. These surveys employed both quantitative and qualitative research methods, which are fundamental and indispensable in this field. Subsequently, scientific data analysis and design practices are then employed to further study the collected data. The main scope of the study broadly covers the following points:

i. Analysing and generalizing the physiological and behavioral characteristics of older individuals residing in nursing homes.

ii. Exploring the relationship between the elderly and furniture through the amalgamation of scientific, user-friendly, emotional, and intelligent design.

iii. Examining the design attributes, essentials, elements, and requirements of furniture that promotes age-friendly environments from the perspective of the elderly.

iv. Proposing the design principles and methods for the development of furniture that caters to the physiological and behavioral characteristics of the elderly in nursing homes.

v. Implementing and validating design practices.

1.9 Research Limitation

The elderly included in this study are defined as those who reside in elderly care institutions in China, namely nursing homes, nursing centres, community care centres, senior apartments, and hospital care centres. These people can be further categorized into two groups: those with basic self-care abilities and those with mobility impairments, slow responsiveness, advanced age, and depend on assistive devices.

The purpose of nursing home furniture design for the elderly is to cater to the furniture and facilities of nursing home living space, activity area, rest area, rehabilitation area, and medical space. This includes configuring furniture commonly used by the elderly in functional spaces, as well as assistive devices and other necessary facilities and equipment. Furniture and facilities include movable and non-movable furniture and facilities for daily use by seniors, such as tables, chairs, beds, lamps, electrical equipment, and components located in nursing home living spaces and common activity areas.

This research focuses on the general population of older adults with mostly general needs living in nursing homes. Most of these people are in good health and have relatively high mobility. However, there is a lack of research on elderly individuals who are unable to care for themselves. The classification of the elderly is based on the understanding that

they have different degrees of physical decline, resulting in different physical conditions and cannot be generalized.

The cities chosen for this study are representative ageing cities in the eastern coastal region and the central developed region. These cities are chosen due to their significant ageing-related impacts and contradictions arising from development.

The design principles and methods proposed in this study are based on specific principles and practices implemented in the design process. These principles and practices address user needs, design orientation, vision, and goals. The main objective is to solve the problem of "how to do it," which represents the practical implementation of the design process.

Lastly, the relationship between the elderly and furniture design is a broad research category, which is also the focus of this study. In order to differentiate and establish valid research conclusions, this study examines the diverse needs and individual differences in the furniture preferences of the elderly in nursing homes. However, there is room for further subdivision within this category, and future research could provide deeper classification at a more detailed level.

1.10 Structure of the Study

This study is organized into seven chapters. Based on the primary content of the research, this section has formulated a comprehensive research approach, which is visually depicted in Figure 1.1.

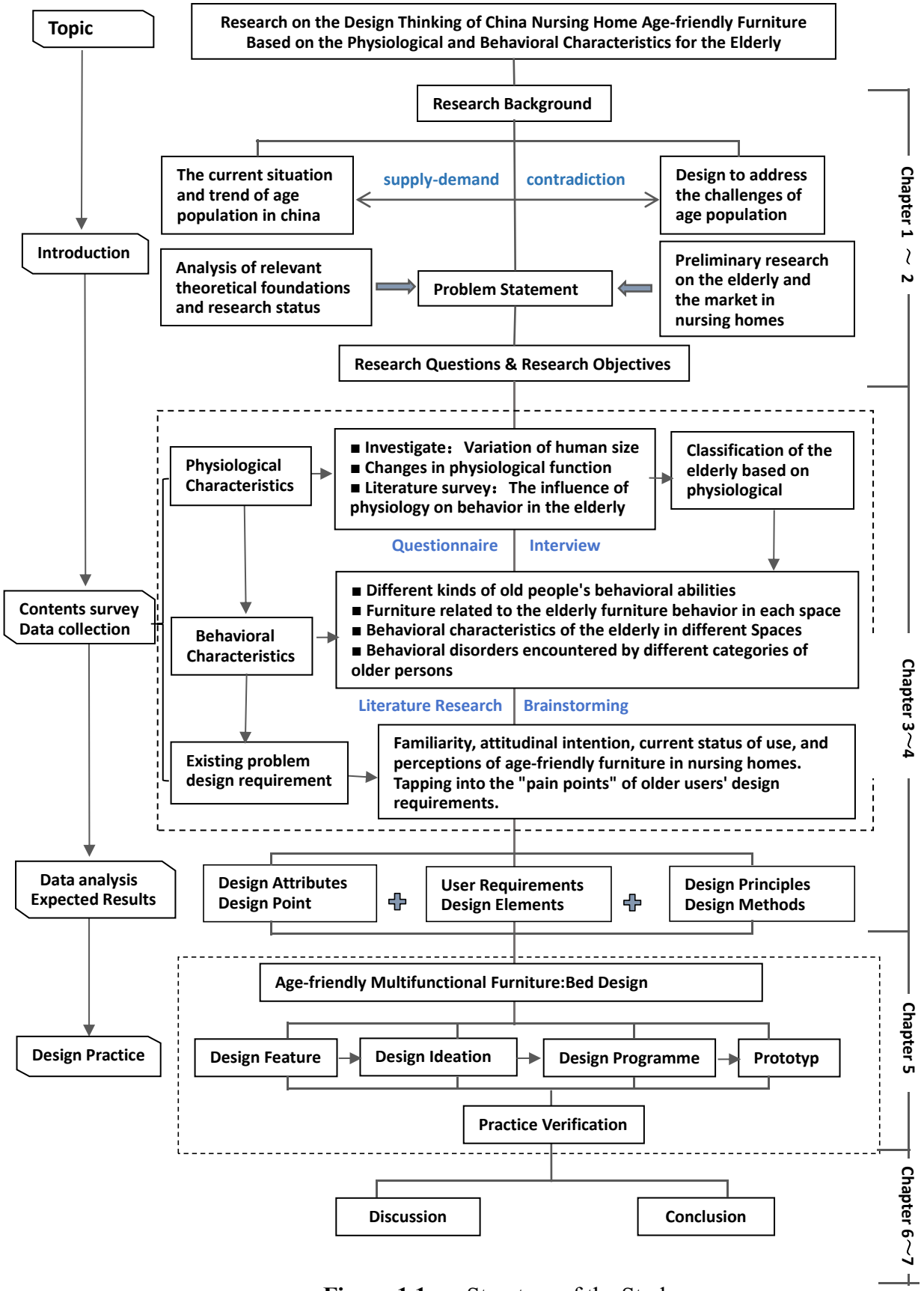


Figure 1.1: Structure of the Study

Chapter 1 provides an overview of the research background, problem statement, research significance, research questions, research objectives, research scope, research limitations, and the structure of the study.

Chapter 2 consists of a literature review. By scrutinizing the literature in pertinent fields, the current state and progress of research at both domestic and international levels are described, while the key issues and deficiencies are analysed and summarized.

Chapter 3 focuses on the research strategy, which explores the various research methods employed to collect data and information for this study. These methods are primarily derived from the research ideas and content of this study. Through field surveys, this interdisciplinary and cross-disciplinary study employs a combination of research methods including literature analysis, questionnaires, interviews, and brainstorming.

Chapter 4 concentrates on data analysis, with a primary emphasis on the analysis of literature, questionnaires, interviews, and brainstorming activities. This analysis serves to collect research data and establish a foundation for in-depth study and analysis of the design elements, principles, methods, and practices of age-friendly furniture in China nursing homes.

Chapter 5 delves into the design practice of age-friendly multifunctional furniture in nursing homes. It explores the convergence and integration between the aforementioned research findings and the design of age-friendly furniture in China nursing homes. The validation and applicability of the research problems and objectives proposed in this study are then tested and evaluated through the utilization of Mock-ups and Prototypes. The research questions and objectives proposed in this study are affirmed through product testing and evaluation of Mock-ups and Prototypes.

Chapter 6 and 7 encompass the discussion and conclusion of this study. These two chapters serve as a platform for the discussion, summary, and evaluation of the research findings. Firstly, the research findings of this study are discussed, and the main conclusions of the study are summarized. Subsequently, the innovative aspects of the design methodology and practice are recommended, while the limitations and shortcomings of this study are reflected on. Finally, the prospects for future research and the direction of future efforts are delineated.

1.11 Chapter Summary

With the rapid advancement of science, technology, and the economy, the problem of population ageing has become increasingly serious and turns to be a global concern. Similarly, the impact of ageing on China's social development is multifaceted and there is a lack systematic empirical research on furniture design suitable for nursing homes.

Currently, people concerns about the daily life of the elderly primarily focus on health conditions, medical services, living environments, economic security, social participation, cultural activities, and other related issues. Designers often focus on optimizing interior spaces, neglect the research on furniture that is closely associated with their daily life. As the area most frequently used by the elderly, many furniture designs are merely modifications of basic functions, lacking careful consideration of the physiological similarities and individual differences of the elderly in nursing homes, as well as their behavioral needs.

In view of the increasing urgency of an ageing society, this study serves as a foundational research on the current status and issues of furniture suitable for the elderly in nursing homes. By employing research methods such as questionnaires, surveys, and

interviews, the study aims to comprehend the attitudes and intentions of the elderly population in nursing homes towards age-friendly furniture, summarize the problems encountered in the use of furniture by the elderly, and collect relevant statistical data. The research focuses on the design of furniture that is suitable for ageing individuals in nursing homes.

In summary, this study takes into account the intrinsic interaction between furniture suitable for ageing individuals and the physiology and behavior of the elderly. Discuss how nursing homes in the future can better adapt to the diverse needs of the elderly, and organize and analyse the relevant elements of furniture design that cater to ageing. Furthermore, the study also emphasizes the physiological, behavioral, and demand characteristics of the elderly, aiming to comprehensively enhance the user experience in this age group from multiple perspectives. Lastly, the study proposes a series of furniture design principles and methods suitable for the elderly, and verifies the proposed research through the design practice of multi-functional beds for ageing individuals, providing theoretical exploration and practical support for the design of furniture suitable for ageing individuals in China nursing homes.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to fully understand the latest progress and applications of nursing home furniture design at home and abroad, and to precisely delineate the research questions, viewpoints, and scope of this study, the author meticulously scrutinized the literature in related disciplines. The findings reveal that preliminary research and application mainly focus on the subsequent facets.

This chapter commences by providing a comprehensive overview and summary of the current research status of new concepts in age-friendly furniture research both domestically and internationally in Section 2.2. This serves as the fundamental and prerequisite for conducting the ongoing study. Section 2.3 provides an in-depth study of the physical, physiological, and behavioral characteristics of China's elderly population. This section outlines the factors influencing the mental and physical health of elderly individuals in China and the behavioral manifestations resulting from physiological decline.

The primary focus of this chapter is to provide theoretical guidance for the interaction between the elderly and furniture in nursing homes, as well as to conduct an empirical study on the constituent elements of this relationship. In Section 2.4, the development of age-friendly design in China is examined from both theoretical and practical perspectives. This includes discussions on design perspective, application, and mainstream theory in China, as well as analysis of the current situation and root causes of the ageing society. In Section 2.5, a theoretical analysis and methodology exploration are

conducted from the perspectives of various key elements such as traditional care facilities, elderly living, and space design in the context of China.

Finally, Section 2.6 reviews and defines what ageing furniture in nursing homes is, the development and market status of ageing furniture design in nursing homes.

2.2 New Concept of Age-friendly Furniture

2.2.1 Overview Theory of Age-friendly Furniture in China

Recent years have seen numerous studies on the indoor environment and facilities for the elderly within China's ageing society (Li et al., 2020). “Furniture, commonly used by the elderly, is further categorized as elderly furniture.” The research focus of this category primarily revolves around the design methods of elderly furniture, smart furniture, barrier-free design, ergonomics, physiology, and behavior, as well as the design of elderly furniture for different elderly care modes (Zhang, 2023). These studies aim to optimize existing elderly furniture for the benefit of the elderly population, and implementing such furniture in nursing homes holds significant theoretical and practical value.

a) Design Principles and Methods

As the ageing problem worsens and the elderly population grows, developing innovative furniture that caters to elderly needs becomes increasingly important. In China, research has been conducted on design approaches for ageing furniture, focusing on specificity, emotion, accessibility, and intelligence. Initially, Wang et al. (2014) examine the design approaches for ageing products from the perspectives of emotion, inclusivity, and universality. They also provide specific design recommendations and guidance on furniture for the elderly.

On the contrary, as stated by Huang and Ouyang (2017), the survey results serve as the basis for the design process, effectively reinforcing the integration of a “user-centred” approach throughout the entire design process. This in turn enhances social identity and brand awareness in the design (Nan et al., 2020). Consequently, regarding the research scope of ageing furniture design, Liang (2018) asserts that furniture is crucial in the lives of the elderly and greatly affects their overall quality of life. By conducting on-site research on the elderly furniture market, they gain insights into the design trends of China domestic furniture for the elderly. Furthermore, Xue (2020) delves into an analysis of the current state and prevalent issues of outdated furniture, and proposes design concepts and principles for furniture in both home and elderly environments, accompanied by illustrative examples for further research and analysis.

b) Smart Furniture

In addition, Lu and He (2017) assert that the design of smart furniture for the elderly depends on the cognitive characteristics exhibited by this demographic, including conscious experience, cognitive regression, and cognitive ambiguity in information processing.

The authors explicate on the design elements of smart furniture for the elderly, emphasizing functional elements that are easy to operate, size and shape elements that are low and light that reduced multi-function or folding functions, colour matching using natural materials with low brightness and low purity, and emotional elements that cater to the social and emotional needs of the elderly.

Therefore, there is an urgent need to actively carry out functional matching research on intelligent adaptive furniture terminal modules (Cheng et al., 2022). Smart

furniture is introduced to compensate for the decline in the cognitive ability of the elderly. By utilizing sensors to gauge the needs of the elderly and employing hardware control modules to address their specialized requirements (Lu & He, 2017), smart furniture is of great significance in enhancing the happiness of the elderly (Nan et al., 2020).

c) Ergonomics and Accessibility of the Design

Meanwhile, in terms ergonomics, Shen (2019) conducts a comprehensive analysis of the arrangement of kitchen measurements, furniture, and appliances and the suitable environmental conditions for the elderly. Similarly, Gao (2019) explores the family structure of the elderly in the home care environment and the use of furniture in various areas of the home, analyses the current state and identifies existing issues. Consequently, a synthesis of furniture design requisites encompassing dimensions, functionality, and layout is derived. Henceforth, principles, methodologies, and strategies for barrier-free home design, predicated on the behavioral attributes of the elderly, have been proposed, proffering effective means to steer and enhance furniture design for the elderly (Zhong, 2016).

d) Furniture Development based on the Physiology and Behavior of the Elderly

In fact, the ultimate objective of the product is to conceptualize and construct furniture tailored for the elderly, in conjunction with the Product Service System (PSS). Fu and Wang (2016) undertake an investigation on furniture that is apt for the elderly based on their psychological and physiological attributes, with the aim of enhancing their societal and emotional well-being in their day-to-day existence, thereby fostering the advancement of furniture that suits the elderly (Dong & Yao, 2017), with the intention of better catering to the needs of the elderly (Huang et al., 2020). Zhang (2021) primarily delves into the

physiological and psychological attributes, lifestyle behaviors, and functional use of furniture of the elderly, focusing on their diverse lifestyle behavioral patterns and functional needs for furniture. Gao and Zhou (2020) dissects the design of furniture for the elderly from various perspectives such as style, materials, proportion scale, colour, and usage environment, based on the physiological and psychological characteristics of the elderly, and posits pertinent design principles for furniture geared for the elderly.

Although the elderly industry and industry of furniture designed to suit the needs of the elderly in China continue to progress and enhance with the ageing process, they are still at the basic stage in creating a more convenient living environment that is comfortable and safe for the elderly. Most elderly furniture designs are still predominantly developed based on life stages. It is determined through scientific user research that the design scale of elderly furniture used in the daily life of the elderly is not aligned with the operational behavior of the elderly (Shi & Zhang, 2023). Consequently, furniture designs targeting the China's elderly needs still cannot fully meet their actual needs. Although some researchers have recognized these issues and made effort to use qualitative and quantitative method to investigate the elderly population and furniture suitable for their needs, there remains a dearth of theoretical foundation.

2.2.2 The Development of Age-friendly Furniture Trend in Global Scenario

Since the onset of the 21st century, Europe, America, Japan, and other developed nations have transitioned into an ageing society ahead of China. Hence, these nations have achieved a more advanced level of industrial development and experienced a more protracted period of ageing, particularly in the realms of theoretical and applied research as well as social assistance.

a) European and American Countries

The European furniture industry plays a crucial role in driving sustainable growth, and makes a significant contribution to Europe's overall economic well-being, competitiveness, creativity, innovation, employment, and exports (Beer et al., 2017). One area where technology is advancing is the development of the ambient assisted living (AAL) monitoring system that can provide personalized support services and healthcare in the comfort of home (Beringer et al., 2011). The high acceptance of AAL among the elderly has led to the development of AAL technology by various alliances (Sixsmith et al., 2011). As stated by Beer et al. (2017), AAL is seen as the solution to the ageing problem faced by most European economies and is a rapidly growing industry that generates employment opportunities. Considering the specific requirements of furniture for the elderly and disabled, its functionality relies on a well-balanced combination of design, ergonomics, basic electronics, psychology, and AAL (Beer et al., 2017).

Steve Hoffacker, from the United States, authored a monograph "Common Sense Universal Design: Creating Accessible, Safe, Comfort & Desirable Homes" in 2013. This publication employs the principles of universal design in the realm of furniture design for the elderly. It combines furniture design methods that specifically address the needs of the elderly, as well as incorporating elements of enjoyment into the design process, with the overarching objective of establishing a secure, cosy, and gratifying living environment for the elderly demographic. Furthermore, American product designers have also devised a functional furniture series that caters to the physiological characteristics of the elderly. This particular design approach is based on the unique physiological changes that occur in the elderly (Jain et al., 2023). At the same time, the NEW Port furniture brand from the United States boasts a long history spanning over six decades since its establishment. Its

main product is an electric functional sofa specially designed for the elderly, draws on the principles of ergonomics and mechatronics to provide the elderly demographic with a comfortable and pleasant user experience. This amalgamation of design principles ultimately established a mature and competitive industrial chain.

b) Japan

Japanese furniture designers who specialize in creating furniture for the elderly have successfully categorized the elderly population into distinct subgroups. Their expertise lies in crafting furniture that caters to the unique physiological needs and characteristics of healthy, vulnerable, and extremely vulnerable elderly individuals. This reflects a notable advancement in the field of aged equipment design, showcasing the professionalization that has been achieved in foreign countries.

In Japan during the 1980s, scholars put forward proposals regarding the appropriate size of elderly homes and provided a summary and promotion of the concept of accessibility design for furniture intended for use by the elderly. The publication "Accessible Building Design Manual," authored by Takahashi Yiping in 2003, has played a significant role in advancing the development of accessibility design principles. This manual effectively promotes the design of living environments and furniture that meet the needs of the elderly and disabled people (Kim, 2017). Another valuable resource on this topic is the book "Design of Accessible Renovation of Residential Buildings", compiled by the Japan Institute for the elderly in 2015. The book provides a meticulous analysis of the impact of ageing-related physical changes on furniture design. It places particular emphasis on existing literature on Japanese elderly care institutions and furniture design. As a result, it offers a comprehensive and systematic introduction to the concept of "barrier-free

transformation" in the lives of the elderly, especially the concepts related to furniture design. Furthermore, Brawley et al., (2006) provides a detailed exploration of the physiological and psychological characteristics of elderly individuals. This includes a review of nursing home furniture design, with a particular focus on theories related to architecture and furniture for elderly care and living. Throughout the book, Brawley also emphasizes the importance of sustainable design and the use of environmentally friendly building materials. Starting from the physical decline experienced by the elderly, such as reduced mobility, reduced grip strength, and reduced vision, Ito Shenggui from the Japan Institute of Elderly Living and the Japan Association for Accessibility Design and Research discuss barrier-free renovation plans for various indoor spaces and this discussion highlights key considerations for furniture design (Senior citizen residence environment institute and accessibility design research association, 2015).

c) Germany

In Germany, engineers affiliated with the Munich Institute of Technology ingeniously integrated smart features into the design of seniors' wardrobes, including smart home control systems. Concealed beneath the traditional exterior of these wardrobes lies an integrated intelligent system that assists senior citizens in monitoring vital signs such as blood pressure and blood sugar levels, activating home healthcare mechanisms, forecasting weather conditions, alerting authorities in case of emergencies, and establishing communication with their offspring.

d) Russia

In Russia, based on a study conducted on the requirements of the elderly population, Virtual Reality (VR) technology is employed to develop technologically advanced

residential facilities for senior citizens with the aid of information technology and ergonomic furniture design. By taking into account the identified preferences and challenges faced by older adults, VR tables are created to facilitate their seamless adaptation, prevent the adverse consequences of detachment from reality, and enable their remote engagement in a multitude of public and private activities (Rodionova et al., 2021).

With the advent of novel technologies, the notion of AAL and the rapid transformations in social relationships, the conventional perception of furniture as an aesthetically pleasing and utilitarian stationary entity has been transcended. Consequently, the significance of smart furniture is progressively escalating as it provides remedies to enhance the living conditions of the elderly, monitor their well-being, and extend assistance throughout the entirety of the ageing process (Petrovski & Petrovska-Hristovska, 2019).

Due to the escalating mean age of the populace, the notion of environmentally assisted living is receiving growing attention. This underscores the imperative of devising intelligent furniture solutions that will facilitate the elderly in transitioning towards a wholesome and dynamic elderly existence.

Overall, developed countries such as Europe, America, and Japan have relatively mature furniture design concepts for the elderly, with a high level of research practice and intelligent technology development. They can establish rigorous and standardized design theories based on the physiological and psychological characteristics of the elderly ,and apply them to design practice.

2.3 Physiological and Behavioral Characteristics of the Elderly in China

The ageing process is a gradual one, wherein the physiological and psychological cognitive functions of the elderly gradually decline with age. The former is mainly a change in perceptual abilities (such as vision and hearing) and fine behavioral skills, while the latter primarily signifies a decline in psychological functions, such as a loss of sense of security, which will also give rise to various challenges in life (Park and Kim,2019). The definition of the elderly is not solely based on age, but also considers their physiology, psychology, and societal factors (Liu, 2015). The decline observed in elderly individuals can be mainly categorized into two distinct groups: physiological changes and behavioral changes.

2.3.1 Physiological Characteristics

On a physiological plane, individuals invariably experience a phenomenon known as the life cycle, wherein they progress from birth, development, and eventual decline. As time goes by, the physiological attributes of older individuals become predominantly evident, including weakening of a series of physiological functions such as the sensory system, nervous system, memory, cognitive capability, immune system, muscular strength, and bone integrity (Tao et al., 2018).

Relevant research has indicated that there are similarities in the physiological attributes of nursing homes geriatric care and urban home geriatric care in the context of population dynamics in China (Gao & Zhou, 2020). The author's review of the literature demonstrates a comprehensive exploration of the physiological transformations experienced by the elderly in China during the 1950s, providing a detailed overview on the deterioration of physiological functions and instances of geriatric care facilities.

According to Yang and Huang (2015), the elderly population in China experiences an elevation in lipid levels, reduced body fluid and electrolyte levels, and impaired regulatory and compensatory abilities. In various bodily organs, the central nervous system undergoes atrophy, while the functions of the heart, lungs, kidneys, digestion, and reproductive organs decline. Furthermore, there is disruption in the endocrine system, leading to abnormal proliferation, and a substantial deterioration in various sensory abilities such as hearing, vision, touch, smell, and taste. A research survey on the elderly in China shows that nearly 10% of people aged 65 and above suffer from corrected visual impairment (Kuang et al., 2007; Asante et al., 2018). Additionally, degenerative changes in bones and joints constitute distinct physiological characteristics of elderly individuals, distinguishing them from young adults. Their mobility, physical activity, and flexibility continue to decline, with grip strength rapidly declining by approximately 20%-25% after age 60, and up to 50% by age 80 and above (Yang & Huang, 2015).

During the natural ageing process of the elderly, their physiological functions and body shape will undergo a series of degenerative changes (He, 2008). As a result, their ability to adapt to the spatial environment is reduced. These changes significantly affect their behavioral activities and daily life. In China, the decline in the ability of the elderly is primarily evident in the following aspects (Xie et al., 2023): a decrease in experience ability hinders the reception of physical and social environmental information, first leading to a decline in auditory and visual impairments, and subsequent gradual degradation of other sensory systems (Wang, 2008); decline in cognitive ability, manifested by a weakened ability to adapt to new environments, difficulty in identifying the changing surroundings, and challenges in forming cognitive maps; a decline in behavioral activity capacity, characterized by reduced flexibility in daily behavioral activities among the

elderly, as well as a progressive decrease in muscle strength and control ability (Gao & Huang, 2006; Yuan, 2021); and the decline in adaptability is manifested in the elderly reduced sensitivity to temperature, humidity, and climate fluctuations, leading to weakened adaptability and increased vulnerability to health issues (Wang, 2007).

The psychological and emotional traits of the elderly are the result of both their own physiological factors and the external social environment (Zhou et al., 2011). These traits are evident in the form of a reduction in psychological well-being, diminished ability to adjust, feelings of bereavement and inadequacy, as well as sensations of loneliness and emptiness. Decreased physical function, increased vulnerability to environments, and concerns about lack of caregiver assistance in unforeseen circumstances can all impact mental health. Decreased adaptability results from fear of illness and exposure to new environments, as well as reluctance to interact with unfamiliar people, ultimately leading to detachment from society. Feelings of bereavement, inadequacy, solitude, and vacuousness arise due to a decrease in social interaction after retirement, coupled with changing social roles that also influences one's lifestyle. This phenomenon is further exacerbated by the decline of one's own physical condition and insufficient care from children (Li, 2017).

Overall, the physiological capabilities of the elderly in China will continue to decline as they age. This is primarily observed through their reduced ability to adapt to changes in their surroundings, imbalance in metabolic processes, delayed in movement, slower reaction time, and weakened resistance. The deterioration of these abilities will have an impact on the mental state and ability to engage in behavioral activities of the elderly population.

2.3.2 Behavior Characteristics

Surveying the behavior of senior citizens in China has not yet become an autonomous research field; however, it has been implemented in various disciplines such as architecture, sociology, and medicine. By reviewing literature and analysing the behavioral traits of elderly individuals (Jain et al., 2022), it can be discerned that research pertaining to the behavioral characteristics of the Chinese elderly predominantly concentrates on their behavioral tendencies, domains, and attributes.

a) Behavior Patterns of the Elderly

Scholars, including Liu (2018) and Tan et al. (2019), have expounded on the categorization of behavioral tendencies among the elderly population in China. These inclinations primarily encompass aspects of daily existence, recreational pursuits, social engagements, and healthcare interventions.

i) Living Behavior Patterns of the Elderly

The behavior of individuals in their later years is highly connected to their lifestyle. The physical capabilities of the elderly (Zhou & Salvendy, 2017) are closely related to their living habits and environment. Based on their mobility capabilities, the elderly can be categorized into two groups: those who are capable of independent exercise and those who have lost this ability (Liu, 2018). This study specifically focuses on the elderly with self-activity ability. Consequently, the activities and spaces in which these independent individuals engage in their daily lives are more varied. They have access to different areas such as living rooms, dining rooms, and more. The primary activities performed by these elderly individuals in their living spaces include meditation, reading, eating (including former meals), talking, labor (such as taking care of plants, drying clothes, air-drying

medicinal herbs, etc.), and listening to the radio, among others. On the other hand, the living activities of elderly individuals who require assistance are often repetitive and their activity spaces are rather limited (Liu, 2018).

In addition, the senior living experience is closely related to the ergonomics of the elderly population. The extent of space required for various human behavioral activities varies. The establishment of a scientific and rational living space scale is a scientific constraint the environment on human behavior. Utilizing ergonomic principles can help designers accurately assess the dimensions of human space when commencing the design and engineering process, thereby enhancing the environment's ability to effectively accommodate human behavior and satisfy the corresponding behavioral needs (Huang, 2019). In reality, the fundamental dimensions of ergonomics for the elderly can be determined by integrating the data derived from geriatric research in China with the general ergonomics principles.

ii) The Elderly Leisure and Entertainment Behavioral Pattern

Leisure behavior holds an important role in the social interaction of the older population. This article specifically centres around the daily leisure behavior of the elderly. It is a well-known fact that different groups of elderly individuals have varying interests and leisure habits. Therefore, it is observed that some elderly individuals find pleasure in drinking tea and talking, while others enjoy playing chess and card games. Furthermore, there are those who take pleasure in practicing musical instruments, singing and dancing, or simply seeking solace in quiet rest.

Interestingly, the leisure behavior patterns of the elderly are very different from those of the younger adults, showcasing notable distinctions. Young individuals have many

opportunities for leisure activities, whereas the leisure pursuits of the elderly tend to follow a more structured and fixed pattern. This includes having specific leisure companions, designated leisure locations, as well as predetermined leisure time intervals (Tan and Tang, 2019). By analyzing the psychological and behavioral aspects of the elderly's leisure behavior in China, it can be seen that their leisure activities have three distinctive characteristics: preference for outdoor endeavors, convergence of leisure content, and limited scope and short time of leisure travels (Zhang, 2016).

The physical condition of Chinese elderly individuals is affected by ageing, resulting in limitations in their mobility and a gradual weakening of their overall well-being. At the same time, their ability to adapt to their external surroundings is reduced due to a slow metabolism and weakened immune system, resulting in their perception of temperature and humidity being significantly reduced. If these problems are not seriously addressed, they may pose a threat to their physical health (Wang, 2018). Furthermore, elderly risky outings may cause concern to their children because the risk of physical harm. These aforementioned factors play a significant role in determining the short duration and close proximity of leisure activities for the elderly (Tan and Tang, 2019). Currently, most elderly people participate in group activities organized by their respective units. They derive enjoyment from the tranquillity and freedom these activities bring and freely choose the companions of those with whom they have a tendency to socialize, thereby freely choosing the nature and manner of their leisurely pursuits.

iii) Social Interaction

No one can live alone, and so the interaction with others will become a vital means for retired individuals to acquire information, express their emotions, and enhance their life

in later years. It is generally accepted that the initial unit of socialization is the family; then, the second unit consists of relatives, friends, classmates, and colleagues. Furthermore, individuals who meet by chance constitute the so-called third social circle (Wu, 2006). After retirement, the frequency of interaction within the first social circle of the elderly population will gradually increase, while in the second social circle, more people will play the roles of neighbours and friends. As the body's ageing process reduces physical activity levels and responsiveness, their range of social connections also gradually shrinks. The habitual places of activity and fixed spatial areas of the elderly demographic are called regional characteristics of behavioral activities. They tend to associate with people who share common interests because it gives them a sense of security (Zhang, 2016).

iv) The Behavior Mode of the Elderly

Medical treatment is a very important behavior in the daily life of the elderly (Huang et al., 2020). The subjective elements that affect the medical behavior of older individuals comprise their own physical and psychological demeanour, while the objective factors that impact their medical behavior include the accessibility of medical institutions, medical expenses, medical insurance, spouses, and family-related aspects and others (Han, 2016).

The medical-seeking behavior of the elderly in China exhibits three distinct attributes, namely strong initiative, high frequency, and preference for seeking medical treatment nearby. The medical treatment behavior of the elderly is contingent upon various factors such as their age, gender, economic capabilities, and educational attainment. These factors in turn influence the behavioral patterns of the elderly, including aspects such as the extent of their medical travel, the manner in which they travel, and the frequency of their

medical treatment. Furthermore, the elderly with different educational backgrounds demonstrate different levels of understanding and awareness when it comes to diseases and their importance, as well as their comprehension of medical mechanisms (He et al., 2011). Specifically, those with higher levels of education tend to prioritize hospitals that adhere to rigorous medical standards. It is worth noting that the medical treatment behavior of the elderly is not only influenced by but also constrained by the existing medical system and the spatial distribution of medical services (Tang et al., 2004).

b) The Formation of Behavioral Activities Among Elderly in Nursing Homes

Different from the conventional conceptual framework within the realm of environmental psychology, this scholarly article elaborates the distinguishing characteristics of daily life behaviors and the various categorizations of the elderly population. The aim is to classify the behavioral domains of elderly individuals living in nursing homes into discrete individualistic behavioral domains (encapsulating their personal behavior and privacy), and integrated behavioral domains (encapsulating interactions and engagement amongst elderly individuals). The primary focus of this behavioral categorization is to investigate and comprehend the interactive relationship between the physical environment of elderly care facilities and the conduct exhibited by the elderly residents (Hongyi et al., 2016).

The behavioral domain configuration of the elderly in nursing homes is affected by various factors such as the surrounding environment. By considering the activity characteristics and behavioral necessities of the elderly, the behavioral realm can be categorized into two distinct groups: the individual behavioral realm and the collective behavioral realm (Wang, 2018). The individual behavioral realm offers private spaces for

the elderly to shield themselves from external influences, while also serving a defensive purpose. Conversely, the collective behavioral realm provides a space for the elderly to fulfill their requirements for group communication behaviors.

The classification of attributes within the behavioral domain. In ecological psychology, the concept of "domain" refers to the behavioral territory in which individuals or groups possess or occupy a specific place or area to fulfill particular needs, and personalize it accordingly (Huo, 2003 & Wan, 2018). Based on the inherent needs of the elderly, the general behavioral domain can be divided into two types: the individual behavioral domain of the elderly and the cluster behavioral domain of the elderly (Huang, 2019).

c) External Behavioral Characteristics of the Elderly

Chinese scholars initiated their research on the subject of environmental behavior using relevant theories at a relatively delayed stage. It was during the 1980s that these pertinent theories were first introduced to China and subsequently applied to architectural research (Zhang et al., 2020). Since the commencement of the 11th Five Year Plan, there has been an increasing focus among scholars on the development of elderly care facilities and the exploration of this topic from various perspectives. In essence, research based on the relevant theories of environmental behavior can be classified into two categories: one is the examination of behavioral patterns exhibited by the elderly, while the other is the examination of the intrinsic relationship between behavior and spatial environment (Gao, 2021).

The temporal occurrence, range of action, frequency, and extent of mobility of elderly individuals residing in nursing homes are distributed across different spatial levels

and domains (Ma, 2013). The behavioral activities of the elderly have distinctive features. These include the periodic nature of their activity timing, as evidenced by differences in daily routines between the elderly and younger individuals, characterized by reduced sleep duration and increased leisure time (He, 2020). Moreover, their activities display certain regularities and periodic patterns, with a significant emphasis on entertainment and physical fitness. Domain characteristics are apparent in the constraints imposed by various factors on the activity domains of the elderly. These factors encompass their social background, physiological and psychological attributes, behavioral habits, ethical beliefs, as well as the influence of their surroundings and location of activity (He, 2008). The elderly require a domain space that ensures safety and possesses a certain level of privacy, security, and distinctiveness. Social characteristics are characterized by a relatively stable target audience and a well-defined selection of communication methods (Jia, 2009). The main target audience comprises family members, relatives, neighbours, colleagues, and classmates, and the means of communication may involve conversations, physical exercises, and so on (Gotou et al., 2008). Notably, due to the physiological attributes of the elderly, observing and being observed represent the most prevalent activities among them (Zhang et al., 2009). The behavioral activities of the elderly individuals within institutionalized elderly care buildings exhibit distinct behavioral characteristics and living conditions, influenced by the nature of their surroundings.

In summary, the impact of age on the elderly is of considerable significance, and as they gradually transition into their advanced years, they devote greater attention to the ramifications of ageing. In actuality, some individuals are disinclined to confront the reality of their elderly status. They may refuse to acknowledge their advanced age and experience feelings of disorientation and despondency. The process of ageing is a gradual

one that manifests in various dimensions, encompassing psychology, physiology, and behavior. With the accumulation of age and life experience, the social role of Chinese elderly has changed and they have gradually withdrawn from the primary social group. At the same time, they have concerns about becoming a burden to society and their families, particularly for those whose health has seriously deteriorated or even suffered physical and cognitive impairments, and they may experience disillusionment and depression due to their circumstances. Their psychological sense of bereavement becomes even more pronounced, engendering a sensation of being overlooked by society and their families. Consequently, elderly individuals necessitate the companionship, attention, and support of their families, friends, colleagues, neighbors, and all sectors of society in order to maintain frequent and close interactions, thereby ensuring their psychological, physiological, and behavioral well-being during the process of ageing as well as a contented retirement.

2.4 Age-friendly Design in China

2.4.1 Current Research Status of Product Design for the Elderly

In recent times, there has been a substantial surge in research focused on the elderly population in China, particularly in recent times. The act of designing products and services tailored specifically for the elderly is currently a prevailing trend and area of interest. Numerous studies in product development and design are centred around this subject matter, delving into the realm of age-friendly design through theoretical, methodological, and practical exploration (Tian, 2017). This development is inherently linked to the escalating issue of population ageing and the heightened attention it has garnered from academia, government, and society at large.

Ageing friendly design emerged from the realm of architectural design, wherein interactive systems are incorporated based on accessible design to address the daily life and travel requirements of the elderly (Cui & Chung, 2023). In relation to physical well-being, it serves to aid the elderly in adapting to the impacts of physical ageing and ailments, while also combating detrimental emotions in terms of mental well-being for the elderly (Wang, 2017). Subsequently, the notion of ageing friendly design was further assimilated into the realm of product design for the elderly, consequently leading to the advancement of ageing friendly products.

a) Physiological and Psychological Characteristics

China has extensive research findings concerning the design of ageing, with the Healthy China 2030 Plan serving as the basis for the introduction of numerous novel concepts and measures. A considerable portion of scholars focus their research on the methods and strategies for designing products tailored to the elderly, drawing insights from an analysis of their lifestyle, physiological attributes, and cognitive psychological characteristics (Yin, 2007; Liu, 2012; Gong, 2014). Furthermore, He (2014) takes into account various factors such as the living environment, personal circumstances, psychological and behavioral traits, and functional requirements of the elderly population. By adhering to a people-centric design approach, He (2014) strives to create a living environment that is both aesthetically pleasing and comfortable for this specific demographic (Shi & Zhang, 2023). Fu and Zhang (2019) adopt an emotional design perspective, integrating the physiological and psychological characteristics of the elderly population. As a result, they propose the functional expression of emotions and design principles that cater to the needs of elderly homes.

b) Home Design Suitable for the Elderly

In reality, the integration of age-friendly design into the home environment is an approach rooted in behavioral science, as evidenced by current research, (Miao & Yang, 2020) put forth a conceptual design for home products that takes into account the behavioral patterns of the elderly during periods of assistance and care. Similarly, Zhou et al. (2020) proposes a design methodology for elderly furniture that caters specifically to the self-care needs of the elderly, drawing from the hierarchy of needs theory (Jain et al., 2022). They furthermore expounded upon the aspects that elderly individuals prioritize throughout the process of designing their homes for old age (Zhou et al., 2020). Within this process, the design of appropriate furniture for the elderly is deemed particularly crucial for the establishment of suitable elder-friendly residences (Wang & Fu, 2020). Simultaneously, Feng et al. (2020) draws insights from Japan's ageing furniture products in order to assess the inadequacies of China's current ageing furniture. By combining the strengths of Japanese ageing furniture with the characteristics of traditional Chinese furniture, they drew conclusions about the influence of Japanese ageing furniture on the field of ageing furniture in China. This analysis can serve as a valuable point of reference for the design and development trends within the realm of ageing furniture in China. In contrast, Zhang et al. (2021) delve into the application of age-friendly design in the realm of smart health and elderly care products, aiming to enhance the level of age-friendliness through auxiliary design (Dou & Tan, 2021). Notably, they explore intelligent wearable devices (Lu, 2016), intelligent mobility assistance products (Zhang, 2007), and electronic newspaper readers for the elderly (Huang, 2013). In a similar vein, Tang (2020) drawing upon the ERG demand theory model, outlines the physiological needs of the elderly as well as their medical safety needs in daily life.

Additionally, they identify auxiliary needs such as emotional social relationships and personal value expression and propose corresponding design strategies for home-based elderly care products to better accommodate the ageing process. Conversely, scholars have approached this study from various angles and methodologies, such as materials and technology, thus offering a wider array of research methods and entry points. For instance, Fu (2015) and Guo (2016) conduct a detailed study on the design of elderly products and rehabilitation medical products guided by industrial design theory and summarize the principles and methods of rehabilitation medical products through the lens of industrial design theory, ultimately summarizing the principles and methods of rehabilitation product design based on elderly care.

Overall, based on the above literature review, it can be seen that research on elderly home design has been conducted from different fields, practical applications, and design methods. Based on the literature review presented above, it is evident that investigations into the design of homes for the elderly have been conducted across various disciplines, practical contexts, and design approaches. The findings of Chinese scholars regarding the design of homes for the elderly offer significant insights and serve as a crucial foundation for the development and exploration of products catering to the needs of elderly individuals within nursing home settings (Qian et al., 2022).

c) Research on Internet Products for the Elderly

Currently, there is a limited amount of relevant literature available concerning internet products for the elderly. However, there is an increasing focus on various issues including intelligent design for the elderly, technological advancements in internet products, design research and development, and production practices (Yang, 2021).

According to the studies conducted by Sar et al. (2012) and Song et al. (2019), it indicate that the utilization of the internet can alleviate the feeling of loneliness among elderly individuals. In fact, as the elderly population in China continues to grow, they become more susceptible to experiencing psychological states of loneliness and lack of confidence. Consequently, their behavior becomes influenced by their psychological environment. However, Jia et al. (2019) and Wei (2019) argue that the current products available fail to adequately address the spiritual needs of the elderly. Instead, they simply simplify existing products and superficially meet their needs without fully considering the behavioral characteristics and cognitive abilities of the elderly (Cui & Chung, 2023). Therefore, for the design of elderly internet products, it is necessary to fulfill the needs of the elderly (Dong & Yao, 2017), accommodate their usage habits, and provide them with a positive user experience (Kalimullah & Sushmitha, 2017; ALsswey et al., 2018; Dong et al., 2020). Additionally, apart from meeting the functional requirements of the elderly, these products should also address their physiological, psychological, aesthetic, and consumer needs (Huang, 2015). Furthermore, in terms of the role of internet products utilized by the elderly, Wu et al. (2020) posits that exposure to high-tech products can enhance their cognitive abilities and help prevent dementia.

In reality, the theoretical exploration of product design suitable for ageing in China is also progressing, albeit differing from the systematic and integrated research framework and standard specifications that have already been established within the domain of architecture. Consequently, with regards to product design, research on ageing friendly design is primarily on the physiological and psychological attributes of elderly users, ageing friendly home design, elderly internet products, and human-machine ageing friendly products.

d) Cultural and Contextual Factors on Age-Friendly Furniture Design in China

In age-friendly furniture design, cultural and contextual factors largely influence the needs and preferences of older users, especially in countries with unique cultural backgrounds, such as China. China's cultural background and unique social environment have a significant impact on age-friendly furniture design. Research has shown that designing age-friendly furniture requires not only attention to ergonomics and functionality, but also consideration of multiple cultural, social, and psychological factors. These factors influence the living habits, aesthetic needs and usage preferences of older people. Therefore, the design of age-friendly furniture must take these contextual factors into account in order to better meet the actual needs of older persons.

Chinese traditional culture is profound, which has a far-reaching influence on furniture design. These ideas have been inherited and innovated in the design of modern furniture for the elderly, which not only enhances the cultural connotation of furniture, but also meets the emotional pursuit of traditional culture of the elderly. At the same time, symbols, patterns, colours and other elements of traditional culture are cleverly applied to the design of age-friendly furniture to make it more personalized and artistic, which not only beautifies the appearance of the furniture, but also carries a good meaning. In addition, the design of furniture for the elderly not only focuses on the inheritance of form, but also emphasises the conveyance of cultural spirit. Through the design, the elderly can feel the charm and power of traditional culture in the process of using furniture, so as to enhance cultural confidence and sense of belonging. This combination can improve the quality of life of older people while maintaining their sense of identity with traditional culture.

The rapid development of urbanisation in China has led to significant changes in the living environment of the elderly. Older people are moving from rural to urban areas, or transitioning from independent living to community retirement, and this change poses new challenges for furniture design (Gao & Feng, 2021). As China's population ages, the market demand for age-friendly furniture continues to grow. This background factor has prompted designers to pay more attention to the actual needs and experiences of the elderly, thus promoting the continuous innovation and improvement of elderly furniture design. The Chinese government has implemented a series of policies in recent years to support an ageing society, such as the "Healthy China 2030" strategy and the ageing in place policy. These policies have influenced trends in the design of age-friendly furniture, particularly in the design of public elderly care facilities and home care equipment.

The design of suitable furniture for the elderly should not only meet the physiological needs of the elderly, but also pay attention to their cultural identity and psychological needs. Research has shown that older people's need for cultural identity makes them favour furniture designs with traditional cultural elements, such as wooden materials and carving techniques. In addition, older people tend to pay more attention to the emotional value of furniture, such as the connection between furniture and family memories, which requires special attention in design.

In summary, China has presented a certain theoretical basis and practical achievements in the design of ageing products, especially home products. However, the vast majority of design research lacks a comprehensive grasp and systematic research on the design of ageing products (Qian et al., 2022). At the level of product (or system) design alone, the most studied approach is to propose a series of design principles for one or more

products, with a small portion involving the emotional aspect of the user experience, but without comprehensively considering user perception factors such as usefulness, security, ease of use, and pleasure. Furthermore, some studies have made design improvements and practices on the details of a certain ageing product design, but there is a lack of a comprehensive and logical thinking process from theoretical model construction, analysis of design methods and summary principles, to practice and verification. Analysing various aspects such as cultural identity, psychological needs, and policy background helps us to better understand the unique needs of Chinese elderly people in furniture design.

2.4.2 Application and Mainstream Theory of Ageing Product Design

Through extensive research and analysis of literature and related designs, it has been discovered that in response to the increasing elderly population, scholars have systematically conducted theoretical research on design to accommodate the needs of the ageing society. This research uses several theories, including “Universal Designer” “Inclusive Design” “Environmental Behavior” “Design for Accessibility” “Usability Design” and “Adaptability Theory” among other relevant design theories. Notably, both the general design, which originated from the United States, and the inclusive design, which originated from the UK, have emerged as prevailing theories in the field of ageing design (Zhao, 2012).

a) Universal Design

The notion of universal design originated from American architects in the 1980s. These architects held the belief that the design of buildings should be inclusive of all potential users, including the elderly and those with disabilities. Since its introduction, the

concept of universal design has spread around the world, and has influenced and integrated with related concepts such as AAL design, life design, and inclusive design.

Architect Ronald Lawrence Mace is credited with being the first to define the concept of universal design. Mace proposed that products and environments should be designed to be accessible to the greatest degree possible without the need for adaptation or special design (Beer et al., 2017). Today, universal design has become a philosophy and strategy embraced by democracies and increasingly permeates our daily lives.

This design approach can be applied to both public spaces and industrial facilities. It is important to note that universal design is not a rigid set of rules and standards, but rather a concept that aims to maximize usability and flexibility of outcomes. In other words, the objective of universal design principles is to achieve better solutions that cater to user needs and ensure their availability, regardless of physical health, abilities, or knowledge (Beer et al., 2017). Therefore, universal design extends beyond merely adapting public spaces to accommodate individuals with disabilities. It is the practical implementation of human rights, aiming to prevent discrimination, marginalization, and stigmatization of people with limited functionality. Additionally, the concept of universal design can also be applied to AAL design, and the design of AAL furniture can draw upon existing research and experience (Beer et al., 2017).

b) Inclusive Design Concept

Inclusive design posits that when the user's capacity requirements for the product surpass the user's actual capacity, the user will be excluded from utilizing the product (Dong & Dong, 2020). Moreover, inclusive design attributes the incongruity between user capacity and product and environmental needs to external factors, contending that the

external environment presents obstacles to user utilization. Consequently, the primary approach of inclusive design is to mitigate the capacity requirements of products and the environment for users.

The measurement of the physiological capacity of the elderly and the identification of the deterioration of their capacity in the ageing process have emerged as significant focal points for research. To advance the implementation of inclusive design, Cambridge University has introduced a method for estimating design rejection. This method consists seven specific capacities: Vision, Hearing, Thinking, Communication, Locomotion, Reach & Stretch, and Hand Flexibility. However, these seven capacities exclusively pertain to physical and cognitive biological capabilities, placing the elderly in a disadvantaged position and disregarding the user's inherent potential to problem-solve.

c) Environmental Behavior Theory

The behavioral psychology and behavioral patterns of individuals are derived from their own actions, and their clothing, food, housing, and transportation are intricately linked to the surrounding environment. The environment plays a crucial role in providing the necessary living conditions for individuals. Therefore, during the initial stages of environmental development, it is imperative to comprehensively comprehend the needs and current circumstances of individuals within the environment.

By adopting behavior theory as a framework for research, taking into account human habits as needs, and utilizing behavioral psychology and behavior patterns as starting points, investigation and research serve as the means to gather authentic data and ensure the quality of the human environment. According to Xu (2003) in her book Human Behavior and Social Environment, human behavior can be defined as an activity that

occurs as a result of environmental influence, aimed at adapting to meet one's own needs. Human behavior is a manifestation of environmental perception formed under the constraints of objective elements. Through the analysis of human behavior, a deeper understanding of the relationship between individuals and the environment can be attained, enabling better alignment of the environment with human behavior and needs. Furthermore, from a geographical perspective, the behavior patterns of the elderly can be analyzed by examining the spatial dimension. By scrutinizing the factors that influence their behavior patterns and studying their daily behaviors such as medical treatment, shopping, leisure, and daily living, indicators can be established to enhance the quality of life for the elderly. (Kong, 2021).

Indeed, some scholars have proposed that the study of the living environment for the elderly should be approached from a multidisciplinary integration of architecture and sociology. The behavior patterns of the elderly have a comprehensive impact on their living environment, while the environment in turn exerts a certain influencing effect on the behavior patterns of the elderly (Wang, 2017 & Lu et al., 2018). In order to construct a living environment that is suitable for the elderly, it is imperative to begin with an understanding of the behavior modes of the elderly, ensuring that the physical and social environments complement and regulate one another to better serve the elderly population (Zhang, 2016).

d) Accessibility Theory

The concept of accessibility design was initially introduced by the United Nations in 1974, with a primary focus on individuals with physical disabilities (Li, 2016). However,

due to the emergence of an ageing society, the scope of accessible design has expanded, making it a crucial aspect of design for the elderly.

In terms of accessibility design, the field of building accessibility has the longest history of development, and there are already well-established international standards and requirements in place. Developed countries such as Europe, America, and Japan have been pioneers in the area of accessible buildings, particularly in the realm of architecture and urban construction, where they have achieved a high level of maturity. These countries have also enacted numerous laws, regulations, and research initiatives. For instance, Sweden and Denmark have established dedicated facilities for disabled individuals and have even begun providing specialized apartments for the elderly (Yang, 2006). These apartments have been designed with a "accessibility" approach. In the late 1950s, the United States was the first to propose the construction of accessibility facilities and introduced the world's inaugural "Accessibility Standards" in 1961 (ONTARIO, 2004).

Simultaneously, Japan, located in Asia, entered an ageing society as early as the 1970 (He, 2015). The welfare and medical needs of the elderly have become increasingly prominent in Japanese society (Gao, 2003). Consequently, the Japanese government has extensively studied Western countries and developed a set of practices suitable for its own national circumstances. In 1972, Japanese real estate companies began implementing a priority housing system for the elderly and disabled individuals, providing them with suitable housing options (Cheng, 2005). Additionally, barrier-free design has been incorporated into the unified urban planning and building regulations established by the state. Notable examples include the Love Building Law and the Welfare Town Construction Planning Regulations.

At the same time, China's research endeavors focus on the domain of barrier-free buildings and housing for the elderly. Corresponding studies have also been conducted on the physiological and psychological characteristics of the elderly, as highlighted by Shi and Zhang (2023). Li (2008) have expounded upon the design of functional space within houses, drawing from contemporary ergonomics and taking into account the shape, size, and performance characteristics of the latest family comfort facilities. Furthermore, an analysis of common behaviors, such as walking, has been conducted in order to establish a construction and housing system that can effectively meet the needs of an ageing society. Additionally, Wang et al. (2020) have explored the connection between the behavior of the elderly and the design of barrier-free products, opening up a new avenue of ideas for the design of such products for the elderly.

e) Ease of Use Theory

The concept of ease of use pertains to the consideration of specific issues related to the physical functioning of the elderly, based on the theory of barrier-free design. This is done in order to cater to their requirements for simple operation, user-friendly experience, and ease of learning when it comes to using furniture and facilities. The aim is to avoid complex operations and alleviate the memory burden of the elderly (Zhou & Salvendy, 2017). In the case of intelligent facilities, apart from the aforementioned aspects, it is also essential to simplify the design of the interactive interface, incorporate intelligent sensing devices, and other similar features. This helps in reducing the complicated steps involved in operating such facilities for the elderly, allowing them to have more freedom in limb movements while addressing their physiological, psychological, and behavioral characteristics. Ultimately, these considerations aim to enhance the daily lives of the elderly (Chen, 2019). Jiang (2012) focusing on the ease-of-use aspect, combined with an

analysis of the physiological, psychological, and behavioral characteristics of the elderly, the genuine needs of the elderly for products are examined. Based on this analysis, the products are developed in a manner that combines the relevant knowledge of this field, thereby ensuring a user-friendly experience (Jiang, 2012).

f) Adaptability Theory

The term “adaptability” refers to the ability of a space to change in response to variations in the four seasons, climate, environment, as well as time, location, and purpose. This flexibility allows for the consideration of both dynamic and static aspects of functional space. In nursing homes, the elderly employ adaptive strategies to accommodate changes in their physiological and psychological needs, resulting in a more flexible and variable environment (Qiu & Wei, 2017).

Through the use of intelligent technology, adaptability enables elderly individuals in institutions to have control over various aspects of the space, such as the form of objects, information exchange, lighting, colour transformation, spatial layout, indoor temperature, and humidity. This intervention facilitates the creation of living spaces that are suitable for the relatively static lifestyle of the elderly, while also providing multiple areas for living, entertainment, communication, and interaction. The aim is to achieve sustainable nursing homes that can adapt to the complex needs and spatio-temporal changes that arise in such environments (Wei, 2017). Intelligent facilities for elderly care institutions are designed with a thorough understanding of the characteristics of the elderly, undergoing necessary transformations and optimizations to enrich their emotional experiences and enhance their awareness. This enables them to adapt to changes in the spatial environment, while also fulfilling their material safety and emotional needs (Li et al., 2018).

g) Human Factors and Ergonomics

Human factors theory examines how products and environments can be designed based on human capabilities and limitations. It was explored how human factors principles can be applied to age-friendly furniture design to enhance the experience and safety of older people (Nielsen & Pedersen, 2020). Ergonomic theory focuses on comfort and functionality in furniture design. Human factors and ergonomics are central to designing furniture that enhances the physical comfort, safety, and usability for older adults. In the design of elderly furniture, the study of human factors helps to understand the use habits, preferences and limitations of the elderly, so as to design furniture that better meets their needs. Through user research and testing, it is possible to understand older people's preferences for furniture color, material, and ease of operation, and then optimize product design.

Ergonomic research is crucial to understanding how furniture can better support ageing bodies, which often face challenges like reduced mobility, muscle weakness, and joint stiffness. However, research in this area still lacks a comprehensive, user-centreed approach that addresses these challenges effectively.

In general, these concepts are rooted in humanistic care and emphasize the varying abilities of different groups. The aim is to design spaces that are as adaptable as possible to cater to the widest range of user needs. Developed countries like Europe, America, and Japan have been pioneers in the field of accessible buildings, particularly in architecture and urban construction, where there exist numerous laws, regulations, and research practices. In China, sociology has been the earliest discipline to study adaptive ageing theory, conducting theoretical research in urban planning, demography, and other related

fields. Given the increasing ageing population in society, it is crucial to study product design for the elderly. Therefore, exploring the theoretical framework of product design for the elderly holds significant importance (Zheng et al., 2016; Lu & He, 2017).

2.4.3 Conceptual Frameworks and Models for Age-Friendly Furniture Design

In age-friendly furniture design, the development of conceptual frameworks and models helps to systematise the design process and guide design decisions. The following is a literature review of relevant conceptual frameworks and models, including their theoretical foundations, application examples and development trends.

a) User-Centred Design Model

User-centred design model is often used to design furniture that needs to be personalised to suit the specific physical and psychological needs of older people, ensuring that the design is comfortable, functional and safe. It's emphasizes the importance of empathy and understanding the user's context, leading to more inclusive and accessible designs (Norman, 2013). User-centred design model for age-friendly furniture emphasises that the furniture should be based on the actual needs of elderly users and covering the whole process from needs analysis to product testing (Zhang & Liu, 2020).

b) Integrated Demand-Oriented Framework

Integrated demand-oriented framework is centred on the comprehensive needs of the elderly, including physiological needs (e.g. changes in body functions), psychological needs (e.g. sense of security, sense of belonging), social needs (e.g. social interaction) and environmental needs (e.g. barrier-free environment) (Wang et al., 2019). Through in-depth analysis of these needs, designers can develop a comprehensive and systematic design plan for age-friendly furniture. For example, furniture heights, armrests and non-slip designs

can meet the physical needs of older people, and warm colours and comfortable materials can meet the psychological needs of the elderly.

c) Functional and adaptive design frameworks

The functional and adaptive design framework focuses on how products can meet user needs and also adapt to changing usage environments and user preferences. The framework can be adapted to the physiological, psychological and cultural needs of elderly users during the design process, and is particularly suitable for the application of age-friendly furniture design, which can significantly improve the quality of life and experience of the elderly (Wang & Li, 2021). Through functional assessment and adaptive adjustmen, designs furniture products, such as adjustable beds and chairs, that can be adjusted in response to changes in user needs, to provide greater convenience and comfort for older users. Moreover, it focuses on how to take into account the physiological and cognitive changes of older people when designing age-friendly furniture (Yu & Zhang, 2022). The framework integrates ergonomics, psychology and design principles that are dynamically adapted to meet the needs of different older users. It includes functional analyses, adaptive adjustments and user feedback with the aim of improving the suitability and comfort of furniture for older users.

d) Smart Age-Friendly Furniture Conceptual Model

With the development of intelligent technology, the integration of intelligence and personalisation has become an important trend in the design of age-friendly furniture. The framework emphasises the combination of intelligent technology and personalisation to provide a more convenient, safe and comfortable living environment for the elderly. The conceptual model of smart age-friendly furniture combines traditional design principles

with emerging technologies such as sensors, the Internet of Things (IoT), and Artificial Intelligence (AI). The Smart Age-Friendly Furniture Conceptual Model explores how the Internet of Things (IoT) and smart technology can be used to support for the elderly (Liu & Chen, 2022). This model emphasizes the integration of technology to improve the safety, comfort, and independence of the elderly. For example, Smart bed design that can monitor the vital signs of the elderly.

e) Multi-dimensional User Experience Models

Multi-dimensional user experience model is a methodology that comprehensively considers the various feelings and needs of older users in the process of using a product or service, emphasising user participation and feedback to guide the design process (Brown & Wilson, 2021). This model not only focuses on the functional needs of older users, but also explores in depth the emotional, cognitive, social and physical aspects of their experience. Multidimensional user experience model that focuses on optimising design by integrating user comfort, safety and ease of use (Smith & Johnson, 2022). Their study demonstrates how the design of furniture for older people can be improved through the multiple dimensions of user experience.

The holistic needs-based framework, user-centreed design model, and smart age-friendly furniture conceptual model are just a few examples of the innovative approaches being explored in this area. As the field continues to evolve, it is essential to stay abreast of emerging trends and best practices to create designs that enhance the quality of life for older adults.

By integrating these models and frameworks,the researcher designed the conceptual framework for the design of age-friendly furniture, as shown in Figure 2.1. Developing

conceptual frameworks and models for age-friendly furniture design requires an understanding of the physical, psychological, social, and cultural aspects of ageing. This conceptual framework provides a comprehensive approach to designing age-friendly furniture that caters to the diverse and complex needs of elderly individuals, improving their quality of life.

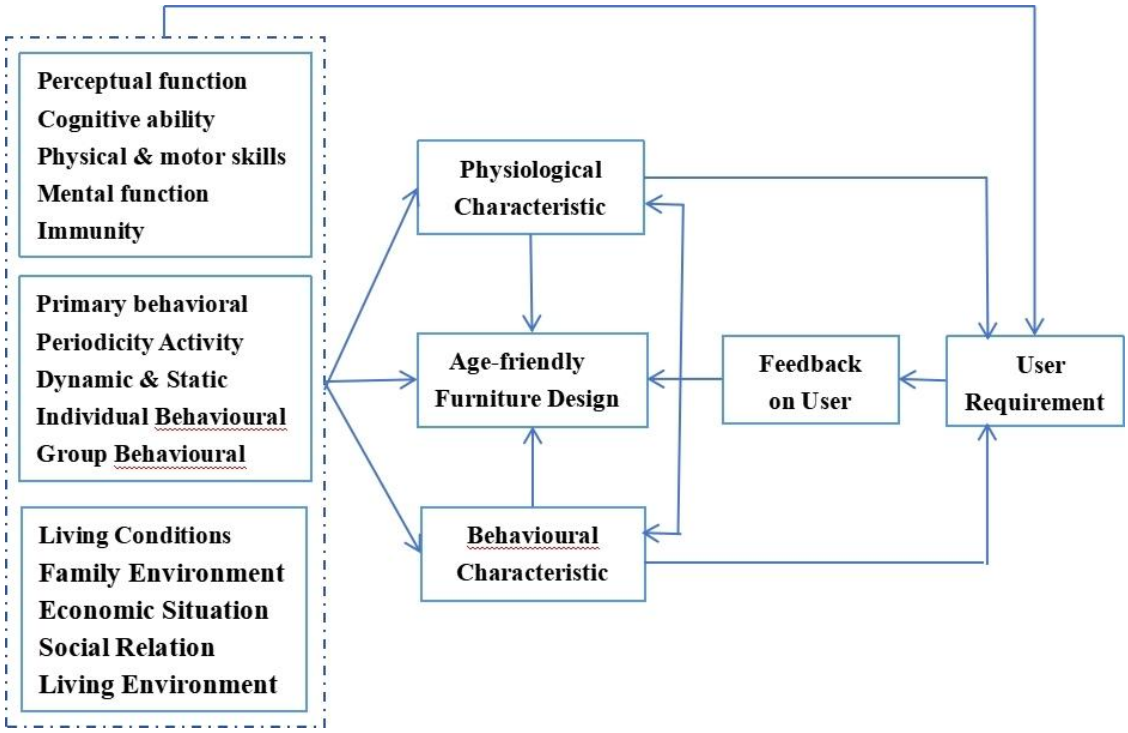


Figure 2.1: Conceptual Framework of Age-friendly Furniture

2.4.4 Nursing Home Elderly Care Facilities Design

In recent years, due to the remarkable surge in the ageing phenomenon in China, the populace's requirement for elderly care establishments has correspondingly escalated, to the extent that even securing a bed has become arduous. With the objective of augmenting the quantity of elderly care institutions to adequately address the demand for elderly care services, a variety of elderly care facilities, encompassing nursing homes, care homes, and welfare establishments, have emerged. In a majority of instances,

comprehensive care service facilities are lacking, and there is a dearth of facilities catering to the needs of the elderly and ensuring accessibility. The level of this insufficiency is rather low, and the expected norms and standards are not harmonized.

Regarding the design of living space facilities in nursing homes, it is crucial to summarize the principles derived from domestic and international cases, thoroughly analyze the functional space configuration of elderly facilities, explore the architectural components within indoor space (Liu et al., 2022), evaluate the spatial scale and functional configuration, assess the common furniture facilities and overall environment within the elderly space, and propose interior design principles (Cui & Chung, 2023). Additionally, research on the design of indoor public activity space facilities in nursing homes should encompass a comprehensive summary of the design aspects related to space function form, furniture and facility configuration, elements, and the resulting environmental ambiance. In 2018, the book “Housing for the Elderly” by Zhou et al. systematically summarized the design methodologies for ageing facilities in terms of functional spaces such as bedrooms, living rooms, kitchens, and bathrooms, taking into account the physiological characteristics of the elderly. The book also provides a comprehensive overview of the layout characteristics and interior space design of elderly care facilities.

By synthesizing significant literature and monographs from different time periods, the primary findings of the analysis concentrate on the, corresponding examination and summation of conventional elderly care facilities and their design for the ageing population. This consists the functional spatial arrangement of living rooms, bathrooms, dining areas, and main entrances in such facilities. The study primarily centres on the ageing design in relation to the psychological, physiological, and behavioral attributes of the elderly through

the integration of ageing product facilities (Shang, 2020), expounds and scrutinizes the independence, comfort, safety, and privacy experienced by the elderly within institutional settings. Additionally, it involves an analysis of the layout of ageing equipment and facilities, as well as ageing furniture products. Throughout this process, this study obtains crucial theoretical support, particularly in the context of the ageing design of residential and public spaces within institutions, thereby offering a certain degree of inspiration and reference value.

2.4.5 China's Intelligent Ageing Facilities

From an examination of the current research status and a review of the literature on the retrieval of intelligent elderly care facilities in China, it is evident that the development of intelligent elderly care facilities commenced in 2013 and experienced rapid growth between 2016 and 2017. This growth is projected to continue steadily until 2020. Intelligent ageing facilities primarily centre around the concept of smart elderly care, encompassing Internet plus smart home, Internet of Things modalities, and the utilization of modern technologies such as smart sensor technology, artificial intelligence, and intelligent systems.

Simultaneously, digital information and traditional integration system such as safety monitoring systems, disaster prevention systems, intelligent electrical systems, intelligent products, integrated operations, and intelligent monitoring management have been established. Noteworthy literature, such as Yan Xueling's "Application and R&D Conception of Sensors in Intelligent Elderly Clothing Design" in 2010, Wu Jianxin's "Research on the Application of Intelligent Systems in Elderly Housing Interior Design" in 2016, and Ke Wensi's "Design and Implementation of Bluetooth Based Indoor Positioning

System for Elderly Homes" in 2019, discusses the main topics in this field. Furthermore, in addition to the systematic design proposed in the literature, research also includes the examination of individual intelligent facilities, such as smart beds, smart toilets, smart bathrooms, smart daily necessities, smart wheelchairs, smart wearables (cardiovascular monitoring, daily care), smart mobile aids, smart tables and chairs, smart medical products, smart walkers, and smart healthcare. The proposed studies explore the functionality, ease of use, safety, and emotional effects of these facilities. Shi Liumei (2020) and Li Yue (2021) put forward a comparative analysis of the intelligent implementation equipment's color, shape, material, human-machine interaction interface, intelligent voice etc., in the research on the adaptability design of elderly care institutions' health care spaces, based on the integrated perspective of medical care and health care, which includes rehabilitation therapy spaces, elderly care spaces, and rehabilitation entertainment spaces under the concept of health care integration.

Overall, Based on an extensive review of the literature, this study presents a concise overview of the research conducted on traditional elderly care facilities and their intelligent design for ageing in both domestic and international contexts. The primary accomplishments entail an examination and synthesis of the functional layout, spatial configuration, furniture and equipment components, as well as the integration of smart technologies within elderly care homes. Nonetheless, Chinese elderly individuals may encounter various challenges, such as inconveniences, inefficiencies, and limited adaptability when utilizing the furniture and facilities found in traditional care settings. Furthermore, the current investigations on intelligent elderly care facilities in China primarily focus on individual products that are designed for home use, thereby hindering their seamless integration within the spatial environment of nursing homes. Simultaneously,

the design field's doctoral theses lack any pertinent research that combines the spatial design of elderly care homes with the design of furniture catering to ageing individuals, particularly when considering the behavioral and psychological needs of the elderly. To address this gap, the present study employs research methodologies rooted in environmental behavior and the Analytic Hierarchy Process. In summary, the key to determining the suitability of designs for the elderly, whether they pertain to traditional care facilities or direct and indirect smart solutions, lies in their multidimensional adaptability to the elderly population. Nevertheless, a thorough analysis of existing theories and designs can broaden the research perspective for this study and furnish a more robust academic foundation.

2.5 Overview of Nursing Home Age-friendly Furniture

2.5.1 Definition of Nursing Home Furniture

a) Definition of the Elderly

Elderly individuals allude to a condition wherein an individual is incapable of upholding equilibrium under physiological stress conditions (Saputri et al., 2021). This deficiency is connected with diminished survival capability and heightened individual susceptibility (Hawari, 2001). Gerontology has emerged in relation to advanced age. Gerontology is derived from the Latin term Geros and logos, signifying old age, while logos pertains to the discipline that investigates the process of ageing and the predicaments faced by the elderly. Gerontology is a scientific discipline that examines the process of ageing and the predicaments faced by the elderly (Kim, 2017). Ageing is the gradual disappearance of the network's capacity to self-repair, replace, and uphold its normal functionality, rendering it incapable of enduring and restoring the damage sustained

subsequent to infection. Individuals of varying ages will undergo distinct stages of ageing. Each elderly individual have distinct habits, thus no solitary factor has been discovered to impede the process of ageing. These theories can be categorized into two groups, specifically biological theory and social psychology theory (Saputri et al., 2021).

b) Age-friendly Design

The subject of age-friendly design has garnered significant attention within the academic community due to the emergence of an ageing society. Specifically tailored for the elderly population, age-friendly furniture takes into consideration a multitude of factors including body size, living environment, behavioral characteristics, psychological characteristics, and functional requirements. The objective is to establish a living environment that is both comfortable and accommodating for the elderly population (Shi & Zhang, 2023).

c) The Meaning of Ageing-appropriate Design in Nursing Homes

The design of nursing homes for the ageing looks into various aspects such as living space, activity space, rest space, and other living areas within the facility. Additionally, this involves the refurbishment or enhancement of furniture and amenities within the nursing home. The aim is to ensure the safety, convenience, and comfort of the elderly individuals residing in the nursing home, while also catering to their physiological and psychological traits (Wang, 2018). By adhering to the principle of “elderly-oriented” design, the goal is to meet the daily living requirements of the elderly while also ensuring the accessibility of space and furniture facilities.

d) Definition of Furniture

Furniture, which includes household equipment such as chairs, tables, and cabinets, holds its etymological roots in the term “mebel” derived from the word “moveable”. In ancient times, tables, chairs, and cabinets were relatively easy to detach from large stones, walls, and roofs. The word “furniture” itself derives from French, signifying household furniture (Saputri et al., 2021). The etymology of “furniture” lies in the term “fournir”, it referring to furniture or furnishings within the home or room. While “mebel” and “furniture” have distinct meanings, they both pertain to tables, chairs, cabinets, and similar items. In essence, tables, chairs, and furniture serve as objects within a residence, providing seating, reclining, or storage for small items.

e) Definition of Age-friendly Furniture in Nursing Homes

The term “age-friendly furniture in nursing homes” refers to a specific category of furniture that is specially designed for the collective use of elderly individuals residing in centralized elderly care institutions (Wei & Li, 2021). By conducting an analysis of the existing scenarios in these care institutions and considering the needs of the users, it is possible to identify the design requirements for such furniture. Notably, due to the growing market demand, the initial enterprises that ventured into designing furniture suitable for the elderly, such as Tiantan Furniture and Mereson Furniture, have progressed from producing household furniture to introducing institutional furniture series. Through an examination of various types of centralized elderly care facilities, we have compiled a summary of the issues encountered in the development of elderly products in China. This comprehensive overview allows us to gain a thorough understanding of the current situation and the existing challenges in the design field.

The provision of comfortable and safe furniture for elderly individuals can significantly enhance their quality of life. In July 2020, the Ministry of Civil Affairs, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Housing and Urban Rural Development, the National Health Commission, the China Banking and Insurance Regulatory Commission, and the National Office for Ageing jointly released the "Guiding Opinions on Accelerating the Implementation of the Elderly Home-based Ageing Renovation Project" (Liu & Sun, 2022). This document emphasizes the importance of addressing fundamental needs to guide efforts to improve living conditions and care received by elderly people. It specifically aims to ensure the safety, comfort, and convenience of living spaces, as well as enhance the quality of home care services. This national-level initiative highlights the significance placed on renovating the living environment for the elderly, with furniture facilities within institutions serving as essential auxiliary resources for their daily lives and as a crucial foundation for enhancing their overall quality of life (Dong & Yao, 2017). Consequently, this represents a noteworthy market opportunity that deserves our attention.

2.5.2 Research and Application of Ageing Furniture Design in Nursing Homes

Currently, there is a lack of cohesive research on the development of furniture suitable for elderly residents in nursing homes, both within national boundaries and on an international scale. Within the realm of designing furniture for the ageing population in nursing homes, the emphasis still lies on the exploration of design theories. By conducting a thorough examination of relevant literature and designs, it was determined that the primary areas of focus in Chinese nursing homes for the design of furniture catering to the elderly population revolve around medical furniture, furniture for medical care, furniture for promoting health, and furniture tailored to specific groups of individuals.

a) Design of Age-friendly Furniture for China Nursing Homes

Medical Furniture. Currently, based on the existing circumstances pertaining to medical furniture within China, there exists a multitude of medical spaces, while the research on furniture design within sanatorium spaces remains scarce. The primary focus of medical furniture design lies in products that have explicit medical functionalities, such as nursing beds, wheelchairs, toilets, and crutches. In the realm of medical furniture design and research, scholars such as Li et al. (2020) have comprehensively analysed the current state of medical furniture and have identified that contemporary medical furniture still exhibits functional limitations. It is crucial to acknowledge that medical furniture represents an enhanced iteration of civilian furniture, yet it fails to significantly enhance the operational efficiency of medical personnel. Furthermore, it has been stressed that innovative designs in modern medical furniture should harmonize with the architectural environment and spatial ambience of hospitals. Moreover, Wang (2007) has summarized four fundamental design principles that medical furniture must embody, namely functional space, furniture colour, special design and detail design principles, as well as the "people-oriented" design principle. Additionally, he has also delineated four essential elements that medical furniture design ought to incorporate, encompassing environmental sustainability, safety, comfort, and support. Meanwhile, certain scholars have postulated that furniture design within the medical domain is restricted to a confined range of functional applications. Researchers such as Chen et al. (2021) utilized examples and comparative methodologies to deduce that the progress of hospital bed products is leaning towards humanization, integration, and intelligence. Simultaneously, it also highlighted that China medical furniture is currently dominated by mid to low-end products, and manual control still the primary method for regulating hospital beds.

Medical Care Furniture. The notion of medical care furniture embodies the integration of medical and recuperative elements within furniture design. Diverging from conventional medical furniture, medical care furniture primarily finds its utility within healthcare institutions and nursing homes, offering a user-centric and lifestyle-oriented approach. Primarily manufactured by office furniture makers, medical and nursing furniture is deemed to lag behind office furniture in terms of spatial planning, research and development, design, and product quality, consequently failing to adequately address the needs of medical personnel and patients. This shortcoming presents an immense opportunity for enhancement. Moreover, only a handful of Chinese enterprises adhere to the "health-centred" principle, incorporating the innovative 3H (Hospital, Home, Hotel) concept, which seamlessly amalgamates elements of "hospital care, home warmth, and hotel comfort." Furthermore, forward-thinking industrial designers have devised a range of contemporary medical furniture products that expertly integrate aesthetics, intelligence, and medical care, aligning with the daily requirements of medical staff and patients. Consequently, our proposal offers an all-encompassing design scheme for medical and nursing spaces within elderly healthcare institutions, nursing homes, and welfare homes. Notably, the market and users have highly acclaimed smart seats equipped with health tracking functionalities and intelligent lift tables featuring prolonged sitting reminders. Medical care furniture represents an innovative stride within the realm of traditional medical furniture, emerging as a tangible manifestation of the national call for improved medical and elderly care services. It simultaneously constitutes a design exploration aimed at enhancing the quality of life for the elderly during their later years (Meng et al., 2020). However, existing medical furniture predominantly caters to hospitals and elderly care establishments, leaving a noticeable design void within the domain of home care furniture.

Health Care Furniture. Healthcare furniture is a byproduct of the advancement of the healthcare industry (Dong & Yao, 2017) , which can be construed as an augmentation of medical care furniture. The development trajectory of the healthcare furniture sector exhibits certain distinctive features, as indicated by scholars like Zhou et al. (2020) integration with medical care, judicious employment of wood pharmacology, and employment of wood as the primary material for furniture; segmentation of healthcare furniture categories and customization based on specific requirements can effectively facilitate the advancement of healthcare furniture; the integration of new intelligent technology has opened up new avenues for healthcare furniture, such as “Internet plus” “Intelligent+” and “Health Care+” (Zhou et al., 2020). In reality, numerous researchers have developed healthcare furniture products tailored specifically for the elderly residing in nursing homes.

Healthcare furniture places greater emphasis on elevating the health status of users, endeavouring to employ furniture design in conjunction with internet technology and intelligent technology to rectify or enhance users’ usage habits, thus constituting a pioneering exploration of furniture design. Given that relevant research is still in its nascent stage of development and exploration, a coherent theoretical framework has yet to be established.

Auxiliary Furniture for Specific Groups of People. There is a dearth of research pertaining to the design of furniture for specific disabled groups residing in China nursing homes. This research primarily focuses on the design of mechanical medical care beds and first aid tools, neglecting aesthetic considerations and exhibiting a relatively limited range of functions. The reason behind this is that emerging industries such as healthcare and

medical care (Xie et al., 2023) are still in their nascent stages, with the target demographic primarily consisting of elderly individuals residing in nursing homes. Consequently, the main utilization scenario revolves around elderly care spaces, with the needs of paralyzed individuals remaining inadequately investigated. The practicality of design theory has not been comprehensively validated, and its relevance to paralysed individuals is minimal, rendering it unsuitable as a comprehensive guide for furniture design catering to this demographic. As a result, there remain substantial gaps in design that warrant further exploration.

Presently, elderly care facilities in China prioritize homogeneity in terms of decor, furniture, and style. However, the effective integration of specific furniture configurations and types with diverse users has not been sufficiently explored. Merely a preliminary examination has been conducted on the visual comfort in the design of these elderly care facilities (Mei, 2006 & Wang et al., 2022). Unfortunately, there is currently no established definitive standard applicable to the indoor furniture arrangement within nursing homes (Wang et al., 2022). As individuals age, their physical, psychological, and behavioral habits undergo transformations, thereby imposing greater challenges in their daily lives. Consequently, China's elderly care system necessitates improvement (Wang, 2007), and the general population’s awareness and understanding of nursing homes remain alarmingly low (Shi & Zhang, 2023).

b) Current Status of Ageing Furniture Design in Nursing Homes in other Countries

The The phenomenon of global population ageing is currently occurring at an accelerated rate, particularly in developed nations. This demographic shift has led to an increased demand for nursing homes as a means of providing care and support to older

individuals who struggle to maintain their independence. Nursing homes serve as residential social service establishments that aim to meet the social and psychological needs of individuals aged 65 and above in a tranquil environment (Sanford et al., 2015).

In the past, Western countries primarily focused their research efforts on elderly homes and their standards. However, in the 21st century, there has been a shift towards studying the care facilities within nursing homes, leading to a newfound understanding and development of standards. A notable publication, “Design Guidelines for Elderly Apartments and Elderly Homes,” authored by the American Institute of Architects in 2004, offers a comprehensive compilation of case studies on elderly care homes and facilities (Zhang, 2015).

Japan has emerged as a leading force in the field of ageing furniture design for nursing homes in recent years. The country has dedicated significant resources to researching accessibility design, as well as the fundamental dimensions of furniture. Moreover, Japan places great emphasis on studying the daily behaviors, physiological changes, living habits, and indoor environmental transformations experienced by the elderly population. Additionally, the ageing design industry within Japanese nursing homes demonstrates a meticulous, diverse, and rigorous division of labor. Brawley’s book, “Design Innovations for Ageing and Alzheimer’s: Creating Caring Environments,” delves into a detailed exploration of the physiological and psychological characteristics of elderly individuals. The book particularly focuses on the architectural and furniture theories pertaining to elder-care and living, with a strong emphasis on sustainable design and environmentally-friendly building materials (Brawley, 2006). Consequently, the design of elderly care furniture for institutional use differs significantly from that of universal elderly

furniture and elderly care homes in Japan. The former prioritizes the perspective of the elderly, aiming to cater to a broader range of individuals and accommodate the selection and utilization of various types of elderly care institutions. Furthermore, Japan's ageing society has witnessed numerous advancements and applications of intelligent technology, such as intelligent alarms, health monitoring systems, and smart health chairs, which have become ubiquitous. Simultaneously, Japanese elder-care institutions are integrating on-line and off-line medical resources to construct intelligent elder-care systems, incorporating internet technology into the overall design practices of elder-care homes.

The attention given to the design perspective of perceived meaning in the physical environment is more pronounced in the furniture of Swedish nursing homes, as stated by Jonsson et al. (2014). The discussion regarding the relationship between individuals and furniture in nursing homes is based on industrial design. The study was carried out in three nursing homes in Stockholm. The focus lies on the role of furniture in nursing homes and their indispensability in providing continuity, socialization, and safety. Consequently, it is advised to incorporate the elderly's experience in the design process and make informed decisions regarding furniture investments for nursing homes.

c) Recent Advancements and Innovative Approaches on a global scale

With the advancement of technology, smart furniture specially designed for the elderly has also developed rapidly. These not only improve the quality of life of the elderly, but also reflect society's deep concern for the elderly. Recent advances in age-friendly furniture design are manifested in multiple ways, often employing sensors, actuators and other smart technologies to monitor an individual's health and well-being, as well as to adjust the furniture's settings to optimize comfort and safety. For example, smart beds are

designed to automatically adjust their firmness and position according to the sleep patterns of individual older persons, and smart chairs can provide support and assistance to older persons while sitting and standing.

Smart furniture is an innovative approach to combining modern technology with traditional furniture design. It includes health monitoring, self-adjusting features, and other innovations that significantly enhance the functionality of furniture and the quality of life of older adults (Jones & Kumar, 2022). In addition, multi-functional furniture can meet the diversified needs of the elderly. The application of multifunctional furniture in nursing homes, including folding beds, adjustable chairs and so on, which are designed to not only improve the utilization of space, but also enhance the comfort and convenience of the elderly. Moreover, user participation in design is an effective research methodology to ensure that the design meets the actual needs of the target users. The design of age-friendly furniture can be improved through feedback from elderly users (Miller & Lee, 2023), emphasising the importance of considering user needs in the design process. Then, some scholars mainly conduct research on the design methods and practices of elderly friendly furniture from the aspects of environmental adaptive design, sustainable design, biophilic and sustainable design, etc (Huang et al., 2023).

Existing research on age-friendly furniture design has achieved certain results in terms of basic principles, successful cases and specific strategies, but there are still problems such as limitations in research methods, one-sidedness of research content and applicability of research conclusions. Future research should focus on areas that lack sufficient research, address the contradictions and shortcomings of existing research, and combine interdisciplinary knowledge and methods to conduct in-depth studies. At the same

time, communication and exchanges with the elderly should be strengthened to understand their real needs and preferences, so as to provide more scientific, comprehensive and personalized guidance for the design of age-friendly furniture.

d) Case Studies of Successful Implementations in Nursing Homes

As an important means of improving the quality of life of the elderly, the design of age-friendly furniture has become a hot spot of concern in the academic and industrial design communities. Researchers like Chen et al. (2021) have designed an easily accessible wardrobe that optimizes functional zoning and size design. Drawing upon the physiological characteristics of self-sufficient elderly individuals, they have ingeniously incorporated functional zoning and concealed benches into the wardrobe.

The furniture and accessory design process for Melania Nursing Home in Jakarta aims to cater to the specific requirements of elderly residents or nursing homes, as it pertains to the physiological and psychological needs of the elderly. A noteworthy endeavour to meet these needs involves expanding the entertainment spaces with ergonomic and aesthetically pleasing designs. Hence, the colour scheme of these rooms is aligned with the principles of colour psychology for the elderly, with the belief that it can induce a sense of calm and comfort among them (Saputri et al., 2021).

Japan, with its rapidly ageing population, has been at the forefront of designing age-friendly furniture. Japanese elderly apartments meticulously account for every detail, encompassing indoor furniture, auxiliary systems, and accessible exits. Japanese companies such as Panasonic have developed furniture that integrates robotics and automation, helping older adults with mobility and daily tasks (Matsumoto, 2018). The cloud-based food delivery service system devised by Fujitsu and Nissin Health Food

Company in Japan directly caters to the nutritional needs of healthcare, elderly care, and other care facilities.

In the United States, ELDERLUXE company shares a similar commitment to serving the unique requirements of the elderly population by creating a positive and vibrant living environment for them. In addition to meeting the functional accessibility needs of the elderly. Their range of products, which encompasses residential and transportation items, household products, health monitoring devices, and gifts, all strive for an impeccable design and a strong emphasis on the elderly's sense of care. In addition, German company Tekvorcare has made significant advancements in the field of ergonomics and has applied its expertise to the design and production of care products. The bed products offered by Tekvorcare have garnered extensive acclaim in both Europe and America, primarily due to their superior comfort, enhanced safety features, and distinctive design elements.

2.5.3 Market Situation of Nursing Home Age-friendly Furniture Products in China

In recent years, a new economic term “silver economy” has emerged, meaning that the deepening of population ageing has promoted the generation of new consumer markets (Liu et al., 2011). Elderly consumers will begin to play an increasingly important role in the market.

a) The Current Market Situation of Nursing Home Furniture Products

After the enactment of the Law on the Protection of the Rights and Interests of the Elderly in China on July 1, 2013, the notion of “frequently returning home” was integrated into the legislation (Liu, 2017), and the mention of “appropriate furniture for the elderly” commenced. Based on a survey, it is observed that 70% of parents still opt to reside in their

own homes for the purpose of elderly care (Quan & He, 2021). The primary rationale behind this choice is twofold: firstly, the current business model for elderly care in China remains immature, with incongruent pricing and service provisions. Secondly, the existing age-friendly furniture in nursing home fails to cater to the long-term living requirements of the elderly, who perceive the level of comfort in institutions to be inferior to that of their own homes. A decade ago, there was scarce demand for elderly furniture in China.

In light of the conspicuous ageing of our nation, numerous furniture enterprises have recognized the potential of engineering projects. Moreover, large furniture companies have commenced a shift from manufacturing household furniture series to the research and development of furniture specifically designed for nursing home. In response to the emerging elderly care model, the country has formulated a fresh direction for elderly care products and facilities, with a central emphasis on fortifying the utilization of health services and rehabilitation nursing services from diverse perspectives (Quan & He, 2021). However, the incongruity between the actual functions and utilization requirements of furniture in elderly care institutions can largely be attributed to the deployment of the original guidelines for home-aged furniture in the design of institutional furniture(Li et al., 2022).

Product homogenization is a rarity within the Chinese furniture market, as furniture products specifically tailored for the elderly are lacking in-depth research (Huang et al., 2020). This deficiency is evident in the unprofessional design and limited range of styles and functions offered by the furniture. Consequently, the unique requirements and genuine needs of elderly individuals in relation to furniture have not been adequately considered (Ma, 2016 & Huang et al., 2020).

Recent observations at the Shanghai International Furniture Exhibition indicate that among the numerous participating furniture companies, there are few dedicated furniture design companies and manufacturers specifically catering to the elderly. Most furniture companies have not undertaken research or product development related to the behavioral habits and physiological characteristics of the elderly, thereby neglecting the special needs of this demographic when it comes to furniture (Cui, 2021). Although some furniture product brands do target the elderly, their designs lack age-ability. Their design process often remains superficial, focusing solely on conceptualization rather than genuinely considering and experiencing design from the perspective of the elderly. This failure to meet the actual needs of the elderly in terms of furniture products, combined with imprecise market positioning, further exacerbates the issue (Dong and Yao, 2017).

However, despite China being labeled as a “super ageing country”, the elderly care institutions and supportive furniture industry are still inadequate in comparison to developed Western nations. Additionally, the living conditions of the elderly in China sub-par due to various constraints, resulting in differing consumption patterns among this demographic. Enterprises involved in this sector often overlook the daily needs of the elderly (Cui & Chung, 2023), and there are still significant shortcomings in terms of product development and research.

b) Analysis of China's Age-friendly Furniture Brands and Current Situation

The abstract is a summary of the entire study. It should briefly outline the research according to the 2022 survey on the top ten brands of furniture for the elderly in China, it is evident that the current state of development for such furniture in the country can be summarized. Among the top ten brands, a total of eight companies were originally known

for their office furniture, including Tiantan, Melson, Weisen, Jianwei, and Yongheng. These brands primarily focus on engineering projects that cater to the furniture needs of elderly care homes. This indicates that domestic office furniture brands have long recognized the potential of the elderly furniture market and are eager to capitalize on it. Qumun Furniture Co., Ltd. was established in Shanghai in 1997. Their sales approach aims to provide comprehensive solutions for elderly living spaces. In 2017, they officially launched their Shilao furniture brand, Melson, which specifically targets the health and leisure needs of the elderly. This sub-brand has since become one of the leading brands in the Chinese elderly furniture industry (Zhou & Salvendy, 2017). The official website of the company categorizes elderly furniture as a series of medical care furniture, highlighting the continued reliance of elderly furniture on medical aspects. Tiantan Co., Ltd. is the first brand in China to have a well-established series of furniture suitable for ageing individuals in the market. Their furniture is designed to offer comfortable usage scenarios for the middle and upper-class elderly in China.

From the standpoint of designers, certain designers frequently lack a fundamental comprehension of ageing furniture and often conflate it with the concept of antiquated or outdated furniture. The design and research efforts dedicated to elderly furniture products remain insufficiently thorough and professional, with a notable prevalence of plagiarism. Consequently, the resulting ageing furniture fails to effectively address the physiological and behavioral characteristics of the elderly (Cui & Chung, 2023).

In summary, with the steady development of the Chinese economy, the living standards of the elderly are also constantly improving, and the demand for material and spiritual aspects is increasing. The quality of furniture is closely related to the comfort of

daily life. Therefore, furniture design for the elderly population is increasingly valued by the Chinese furniture market. Considering the examination of the present market circumstances, China nursing home age-friendly furniture confronts the subsequent categories of characteristic predicaments.

i. The quantity of institutional aged furniture commodities is limited, and the quality is inconsistent. They predominantly remain health products, and the range of products is inadequate, thereby rendering it arduous to attain effective expansion in market coverage.
ii. There exists a disparity between the supply and demand of products, and there are not numerous household brands that target elderly consumers.
iii. The configuration of shape and function is comparatively antiquated, and there exists a substantial disparity with the ongoing design pursuit.
iv. The furniture market lacks sufficient segmentation, immature product research and development, and unstable product types.
v. The amalgamation of humane consideration into design is not particularly substantial, and it proves challenging to transition the design from manifest ageing to implicit ageing.

2.6 Chapter Summary

This chapter primarily conducts pertinent research on the current state of domestic and international materials, literature, and market pertaining to elderly care furniture in nursing homes. Simultaneously, a detailed analysis is conducted on the relevant definitions, design theories, and market status of elderly care design. Research is conducted to acquire the practice and developmental context of elderly care furniture in nursing homes based on diverse classification requirements. Furthermore, a thorough examination and analysis of

the theory and methods concerning the comprehensive assessment of space risk and furniture in nursing homes is undertaken, accompanied by a comprehensive summary of the concept, significance, technology, and fundamental principles that must be adhered to for the intelligent design of elderly care furniture. Elaboration is provided on the changes and characteristics of the psychological, physiological, and behavioral aspects of the elderly population in China, and a targeted evaluation and analysis system is developed to enhance theoretical and methodological research for the establishment of a model system and practical framework for elderly furniture in nursing homes in the future.

Judging from the current research status at home and abroad, the study on ageing design in nursing homes abroad is considerably profound and comprehensive. Through the analysis of foreign elderly furniture, it is deduced that developed nations have gradually established relatively systematic and comprehensive theoretical research on ageing design, which can satisfactorily address the reasonable needs of diverse elderly individuals in varied elderly care modes and living conditions from multiple perspectives. Correspondingly, the elderly furniture market is also improving day by day, and the design system of elderly furniture in nursing homes has also made certain progress. In comparison to China, there exists a dearth of research on the design of elderly home furniture within the country. Despite the rapid ageing process in Chinese society, the development of the elderly home furniture industry is still in its nascent stage, and the theory and practice are not adequately specific. Moreover, the majority of proposals merely present concepts without systematically classifying or refining their applications in various functional spaces of elderly homes.

At the present time, numerous corporations and educational institutions are presently incapable of providing adequate research funding and research and development technology to invest in the design, research, and production practice of suitable antique furniture. Therefore, some domestic research on the design of elderly furniture lacks systematic classification or detailed research and practice on the functional spaces of elderly furniture in nursing homes. Their focus is predominantly on economic advantages while disregarding humanistic care, causing the furniture, facilities, products, and service systems in their nursing homes to be unable to effectively fulfil the diverse needs of the elderly (Dong & Wei,2023). As a result, based on a comprehensive review of existing literature, the author has identified the entry point for the design of furniture for the elderly in nursing homes, based on the physiological and behavioral characteristics of the elderly in China.

Deficiencies and contradictions in existing research. While the above studies demonstrate progress in age-friendly furniture design, several gaps remain. Existing studies often focus on the immediate benefits of age-friendly furniture, such as improved comfort and safety. However, there is a lack of research investigating the long-term effects of these designs on older adults' health outcomes, quality of life, and caregiving costs. This gap and called for longitudinal studies to assess the sustainability and cost-effectiveness of age-friendly furniture interventions. Firstly, there are still some areas that lack sufficient attention in the current research on the design of furniture for the elderly. For example, there is less research on the specific differences in the needs of older people of different ages and health conditions, and there is insufficient research on the differentiated design of age-friendly furniture for home care and institutional care. Research in these areas would help to provide more accurate and personalised design solutions. Secondly, contradictions

and shortcomings of existing research. Contradictory conclusions or shortcomings sometimes appear between different research. For example, on the application of intelligent technology, some research concluded that intelligent technology can significantly improve the quality of life of the elderly, while others pointed out that over-reliance on intelligent technology may lead to loneliness and dependency among the elderly. These contradictions and shortcomings suggest the need for further in-depth research and exploration of best practices in designing age-friendly furniture. Finally, there is a need for more interdisciplinary research that integrates insights from gerontology, healthcare, design, and economics. This would help address complex challenges, such as balancing safety with autonomy and individualizing designs to meet the diverse needs of older people.

Previous studies on age-friendly furniture design have employed various methodologies, ranging from qualitative user-centred approaches to quantitative ergonomic assessments. These approaches provide different perspectives for understanding the design needs of age-friendly furniture, and each approach also has unique strengths and limitations. For example, user-centred design and participatory design methods are widely used in age-friendly furniture research. These approaches focus on involving older adults directly in the design process to ensure that products meet their unique needs. Another common approach to age-friendly furniture research involves ergonomic studies and human factors engineering, where quantitative data is used to assess how furniture affects the comfort, mobility, and safety of older people. However, the approach focuses primarily on physical needs and neglects psychological and emotional needs. In addition, differences in mobility and cognitive abilities between different groups of older persons are often not adequately taken into account. They are used to compare different furniture designs in

controlled settings. However, experimental studies may not reflect the complexity of real-world environments, and results obtained in controlled environments may not be generalisable to everyday use and are difficult to generalise to other environments. From the review of methodologies used in age-friendly furniture research, it is clear that each approach has unique strengths and limitations. To enhance the robustness of future research, it is important to adopt a mixed-methods approach, combining the strengths of qualitative and quantitative methodologies.

In summary, the aforementioned research findings provide a wealth of reference content and have significant reference value for this study. However, there are still the following deficiencies in the research. First, from a research perspective, existing domestic and international research on individual furniture products for the elderly is relatively extensive, but there is still a lack of comprehensive comparative research on the design of furniture for the elderly in China nursing homes within the research scope of China, which urgently needs to be supplemented. Second, from a research theory standpoint, existing accomplishments primarily focus on the exploration of design for ageing furniture. Throughout this process, experts and scholars have also proposed various design concepts, such as accessible design, humanized design, and universal design, and have endeavored to apply these theories to various design practices. However, there is still a dearth of research findings that integrate research methods such as field investigations, interviews, and case studies. Additionally, through theoretical research, the design of medical furniture, such as modern health care space furniture and traditional health care furniture, still primarily relies on various auxiliary functional forms in design practice. However, there are very few practical design plans for furniture in elderly homes that cater to the physiological and behavioral characteristics of Chinese elderly individuals, and the design is relatively

monotonous. This aspect also represents the crux and challenge of this study. Third, in terms of research content, it has been observed through literature that there is a relative dearth of existing research results on the comprehensive system of design for ageing adaptation, specifically addressing the psychological, physiological, and behavioral characteristics of elderly individuals in institutional nursing homes in China, and these areas still require supplementation and enhancement. This represents the research space of this paper.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter delineates the research methodology applied in this investigation.In general, it involves a mixed method to identify, collect and analyse the research data. By employing a blend of qualitative and quantitative methods, more accurate data systems can be generated and scrutinized (Creswell, 2009). This mixed method includes qualitative and quantitative to achieve the Research Objective (RO) and to answer the Research Questions (RQ) as described in the first Chapter. This study is characterized as an exploratory inquiry, encompassing both design and practice, aiming to facilitate a practical exploration of the design process for age-friendly furniture in China, rooted in academic development. In order to fulfil the objectives of this research and address the research questions, a combination of qualitative and quantitative research methods was utilized to summarise, gather, and analyse the research data, as well as to identify the principal issues and solutions of the research program.

The qualitative method includes literature review, open-ended interview, brainstorming, and design practice. The qualitative method is applied to identify the difficulties and challenges faced by elderly individuals in nursing homes while using furniture, as well as to gather their suggestions for improving the design of age-friendly furniture. This study analyses the physiological and behavioral attributes of the elderly population in China nursing homes, with the purpose of establishing a theoretical foundation for the design of age-friendly furniture in such establishments and identifying

the determinants of age-friendly furniture design in nursing homes.The data obtained are analyzed before being included in this thesis.

The questionnaire was distributed to selected elderly people in Chinese nursing homes, and completes the quantitative method. The quantitative method is used to collect a substantial amount of information and data about the living conditions, physiological and behavioral characteristics of the elderly in nursing homes, and assessing their satisfaction with and design needs for existing furniture in nursing homes.

Subsequently, based on the aforementioned research, this study takes into account the unique characteristics of China's national context and evaluates the development of age-friendly furniture design as well as the current research landscape through the collection and organization of relevant literature. This study integrates interviews, observations, and literature review to investigate the significant factors that influence the design process of age-friendly furniture, and additionally, conducts brainstorming workshops to stimulate innovative thinking and propose creative design ideas to foster inventive solutions.

3.2 Research Framework

The main objective of this study is to develop a new type of multi-functional furniture design that caters to the physiological and behavioral characteristics of the elderly population in China nursing homes. Consequently, this study selects age-friendly furniture in nursing homes as the research subject, which is divided into four main phases of implementation. As depicted in figure 3.1, the research framework is comprised of four phases, each incorporating a distinct research methodology and objectives with topic-specific tasks, all aimed at accomplishing the research goals.

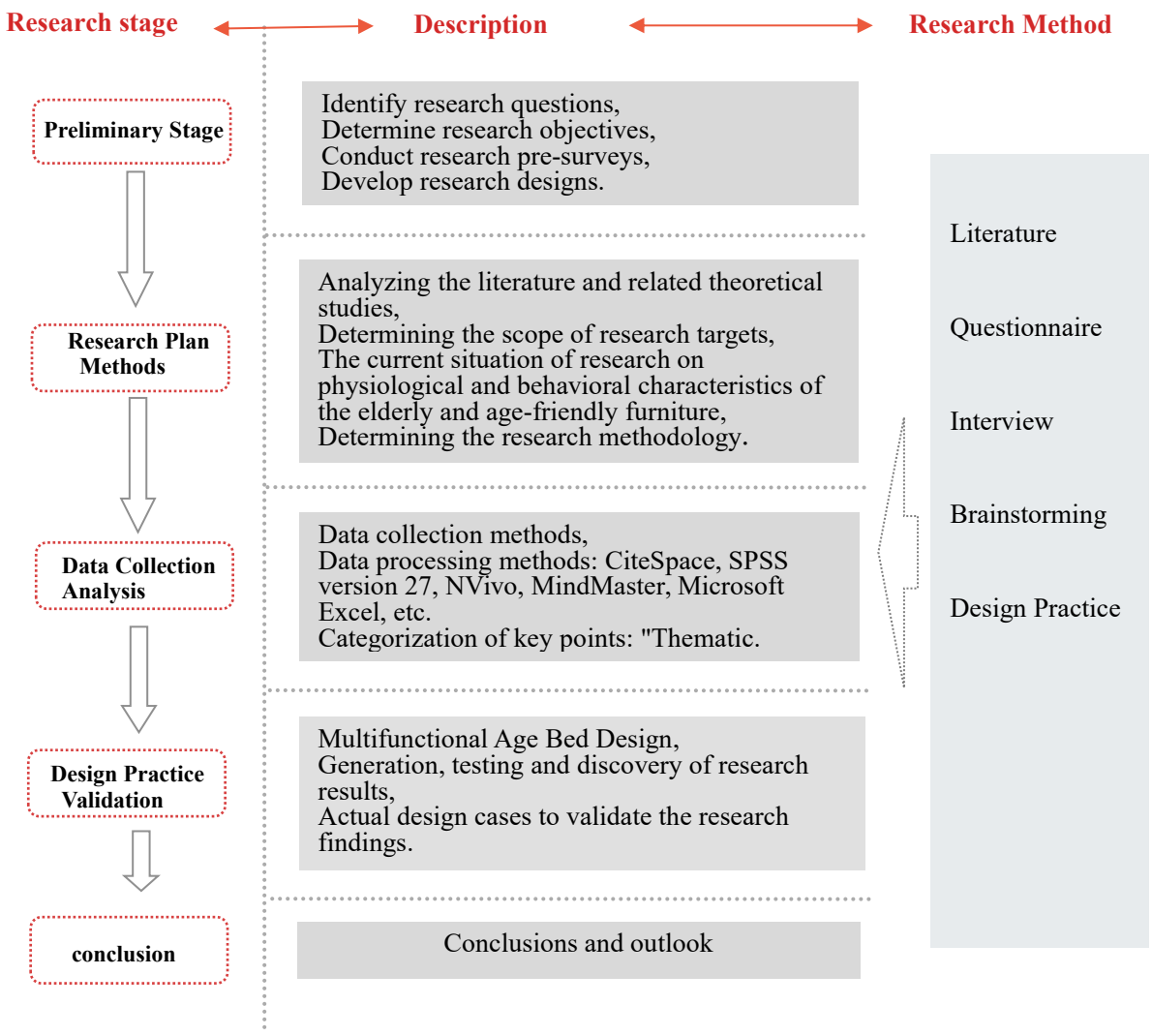


Figure 3.1: Research Framework

3.2.1 Phase One: Preliminary Study

The first stage of the research entails defining the research objectives by identifying the research problem. This phase concentrates on the pre-study preparation, encompassing the collection and examination of various types of literature, identification of the research population and research scenarios, design of questionnaires and interviews, execution of preliminary research surveys, and development of the research design prior to formalizing the study.

This stage introduces the background and significance of this study. Then utilize the Cite Space software for the visual representation and analysis of the quantity of articles, research institutions, research highlights, and developmental pathways in the realm of furniture design for the elderly, both domestically and internationally, over the past decade. By examining the development of furniture design that accommodates the needs of ageing individuals, conducting a current situation analysis, and identifying emerging trends. These literatures cover a variety of types related to the development of ageing, covering multiple fields such as ergonomics, medicine, economics, gerontology, and psychology. Then the researcher summarizes the characteristics and trends of current research, identifies the key objectives and problems of the research, and formulates the research design.

3.2.2 Phase Two: Research Plan and Methods

The second stage involves an exploratory study, which mainly based on investigation. According to the objectives of this study, based on the previous researches in Phase Two focus on how literature analysis and related theories contribute to planning the research methodology.According to the objectives of this study, based on the previous researches in mainstream theory of ageing product design(Beer et al., 2017; Lu et al., 2018; Wang et al.,2020), The research incorporates theoretical knowledge from environmental behaviour, ergonomics, sociology, and barrier-free design, a mixed-method strategy is adopted to obtain data collections and analysis. This study involves surveys such as questionnaires, interviews, and observations of elderly individuals in nursing homes and relevant professionals in different Chinese cities.

The research methodology includes four phases based on the four research objectives to design ageing- friendly furniture. The first step is analyzing the literature and

related theoretical studies, determining the scope of research targets. The researcher reviewed current research status, application and mainstream theory of ageing product design. and choose few mainstream theories, environmental behavior theory, accessibility theory & ease of use theory. The second step focus on the current situation of research on physiological and behavioral characteristics of the elderly and age-friendly furniture and then the mixed method is used that includes qualitative and quantitative methods. As part of the qualitative method, observation, open-ended interview, brainstorming, and protocol study are conducted, and final step is design practice of age-friendly multifunctional furniture in nursing homes.

3.2.3 Phase Three: Data Collection and Analysis

The third stage focuses on manipulation of the collected survey data and documentation, as well as the theoretical analysis and development on the data collection and analysis of data.

a) Data Collection

This study applies with a qualitative research method based on multi-channel data, including questionnaires, participatory observation, interviews, literature research, and other data collection methods. The study focuses on various stakeholders such as elderly individuals, elderly care institutions, designers, experts, and scholars. The aim is to gather targeted descriptions of existing problems related to age-friendly furniture in nursing homes, as well as suggestions for improvement. The collected data, such as survey reports, meeting minutes, academic literature, norms and standards, interview records, documents, and research reports, are consolidated into a database. It consists of three main parts.

Part I: Based on literature and theoretical research and analysis, the living situation of China's contemporary elderly population is investigated and analyzed. The physiological and behavioral characteristics of the elderly are classified and refined. Questionnaires, interviews, and observations are used to study and address the first research question, which involves generalizing the physiological and behavioral characteristics of the elderly, as well as studying and summarizing their feedback on existing furniture use and design requirements.

Part II: Based on the above, a survey is conducted on the current practice of age-friendly furniture in nursing homes. Through questionnaires and field research, the phenomenon description, causes, and improvement suggestions regarding the current use of age-friendly furniture in nursing homes are sorted out. The living space, behavioural patterns, and furniture use of the elderly in different nursing home living scenarios are analysed, and their usage demands are derived. Furthermore, the direction of age-friendly furniture design in nursing homes is explored, and improvement entry points and overall goals are proposed. This part addresses the second research question, which involves assessing the design demands of the elderly and analysing the evaluation, principles, and methods of age-friendly design.

Part III: This part is primarily based on questionnaire and interview surveys, with focusing on the requirement of elderly users in nursing homes. Building on preliminary data collection and organization, as well as field research, the questionnaires and interviews are designed to gather information on the current life situation of the elderly group in the nursing home, their living behaviour, and the design requirements for age-friendly furniture. When conducting the interviews, the interviews aim to gather an

objective assessment of the existing furniture in nursing homes from the perspective of the interviewees, as well as a subjective evaluation of their satisfaction with the furniture. This includes obtaining design suggestions for furniture that caters to the requirements of the elderly. The main objective is to collect real data on the current state of age-friendly furniture in nursing homes, which will help answer the third research question. This question focuses on proposing a design strategy for age-friendly furniture in nursing homes, taking into consideration the physiological and behavioural characteristics of the elderly.

b) Methods of Processing Data Information

The information gathered for this study consists of text-based sources, specifically questionnaire data statistics, interview transcripts, academic literature, research summaries, and survey notes. To systematically summarize and organize the data, various proprietary analytical software such as CiteSpace, SPSS version 27, NVivo12, and Microsoft Excel are employed for data processing and analysis. To ensure the accuracy and reliability of the data, the researcher use the double entry method. In-depth interview data and information are mainly reviewed and organized manually through multiple examinations of audio files and field notes. The researcher verifies the specific points discussed by interviewees through repeated analysis of audio recordings and transcripts, studying both the audio files and transcripts, and employing NVivo12 for Verbal Protocol Analysis (VPA).

In this stage, the main data and applications included in the questionnaire were used to realize the quantitative approach of this study. Furthermore, the qualitative methodology utilized in this study encompassed conducting on-site visits to various elderly care facilities, engaging in discussions and dialogues with elderly individuals of varying functional capacities, observing their daily routines, and carrying out interviews with experts, scholars,

designers, and others. These activities facilitated the compilation of data on the physiological and behavioral characteristics of the elderly population as well as their shared concerns, thereby enabling the implementation of the qualitative approach in this study. The detailed findings of this data analysis will be elaborated upon in Chapter 4.

3.2.4 Phase Four: Design Practice and Validation

The fourth stage is design practice and validation research. In order to answer research question 4 and achieve research objective, the researcher chose the most commonly used sanatorium bed as the object of design practice, and to provide basic samples for the extension of the design of age-friendly furniture for nursing homes in the future through the complete design thinking and process.

This stage entails the generation, testing, and discovery of research outcomes and is divided into two parts. The first part is based on the findings of preliminary data investigation and analysis. Through an examination of relevant literature, it identifies the disciplines associated with age-friendly furniture in nursing homes. Additionally, it explores the fundamental theories and practical cases that can serve as references. The aim is to delve into the convergence and integration between existing theoretical research results and age-friendly furniture. Finally, the multifunctional elderly bed design is utilized as a case study for design practice.

The second part of the research focuses on the examination of practical investigation, design methods, and prototype design and production at each stage. Detailed discussions are conducted to generate research results that address the fourth research question and establish a practical plan for furniture design suitable for the elderly in nursing homes. Furthermore, the research results are applied to a practical case involving

the design of multi-functional age-friendly beds in nursing homes. The produced furniture model of the multi-functional bed is then utilized to comprehensively evaluate the design scheme of age-friendly furniture in nursing homes, preliminarily verify its applicability, collect product practice feedback, and evaluate and compare the research results through design practice to ascertain their rationality and provide reference for subsequent optimization. Chapter 5 delves into the detailed information concerning the design practice of age-friendly furniture solutions.

3.3 Research Thinking

This study established a theoretical framework for the design of age-friendly furniture in nursing homes through methods such as literature research, questionnaires, interviews, and brainstorming. The framework is tailored to the physiological and behavioural characteristics of Chinese elderly individuals. It primarily consists of three core elements: the physiological and behavioural characteristics of the elderly, the design strategy for age-friendly furniture, and the design practice of age-friendly furniture. These elements will be analysed in the fourth, fifth, and sixth chapters respectively. In the context of solving the issue of elderly-centred design practices and specific design processes of age-friendly furniture for nursing homes in China, design thinking stands as the most suitable choice for thinking outside the box. Details about the design thinking process will be presented in Chapter 5 within the practical activities of designing age-friendly furniture.

Existing design thinking research offers a complete flow of design activities. One of the most influential models in this regard is the design thinking model developed by the Stanford University School of Design (D.School, 2004). This model is widely adopted in practical projects and design education within the industry and holds a high level of

acceptance.It comprises five stages: Empathize, Define, Ideate, Prototype, and Test (D.School, 2004; Kouprie & Sleeswijk Visser, 2009; Avelino, et al., 2020). Based on the design thinking process proposed by the Stanford University Graduate School of Design, this study developed a six-stage process termed “design for active ageing”. This process includes active empathy, problem definition, design conceptualization, design development, design prototyping, and evaluation and optimization. Therefore, in the design process, this study is based on the design thinking process as depicted in Figure 3.2.

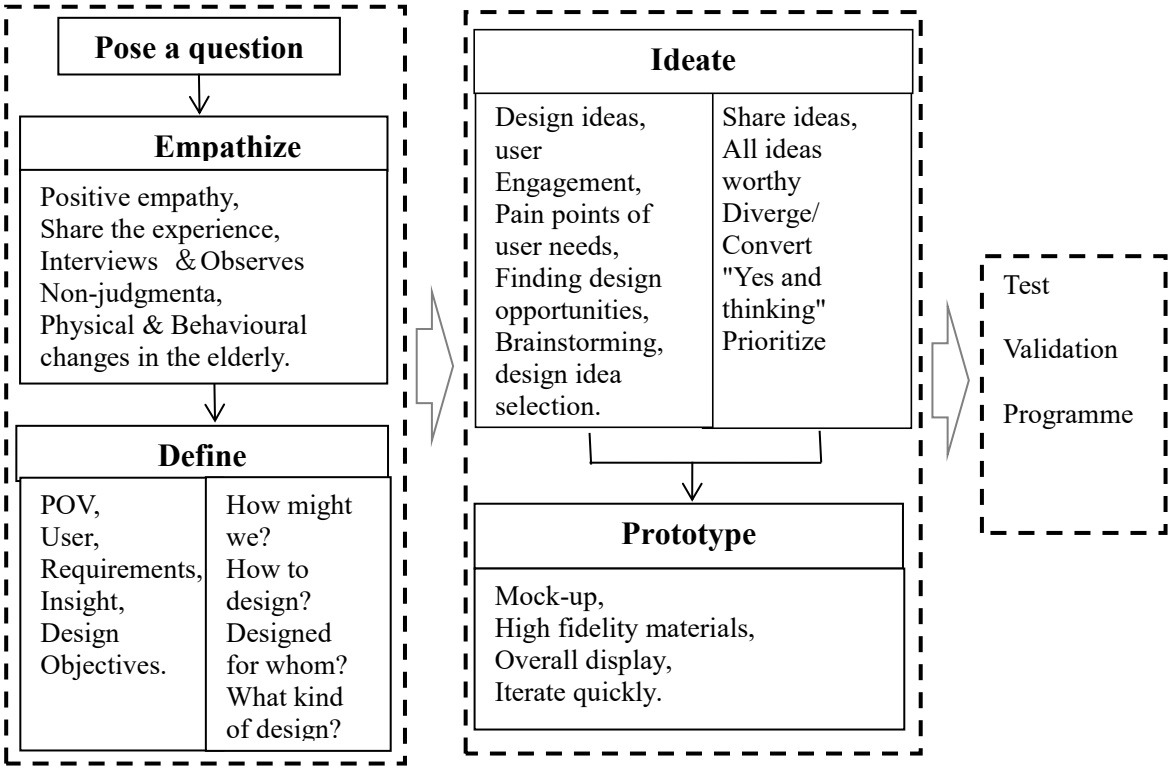


Figure 3.2: Design Thinking Framework

a) Phase One: Empathize

Empathy is the psychological process by which individuals perceive and visualize the emotions of others and share in experiencing the feelings of others (Li, 2020). Early researchers drew empathy into design, arguing for a focus on context and personal

experience in user research, rather than just objective and rational data (Koskinen, et al., 2011). Similarly, this study focuses on understanding the situated experiences of the elderly rather than relying solely on objective data. Therefore, the design of the process is based on the design thinking process in this study.

To enhance the comprehension of older individuals by designers, the author examines empathy as the initial stage of the design thinking process, emphasizing its human-centred nature. In psychology, positive empathy refers to an individual's understanding and indirect sharing of another's positive emotional state (Yue & Huang, 2016), which is relative to negative empathy. Research has demonstrated that positive empathy towards older individuals can alter prevailing stereotypes. Thus, during the empathy phase, design activities are focused on fostering positive empathy and deepening understanding of older individuals through interviews and observations. The main aim is to draw attention to the physical and mental changes that occur during the ageing process, such as physiological and behavioural characteristics and the evolving state of older individuals. Moreover, the aim is to challenge designers' cognitive biases and problematization tendencies. In this study, face-to-face communication and physical activities are employed as empathy methods.

b) Phase Two: Define

A problem definition is a convergence of what problem the design should solve based on user understanding, with the goal of creating a meaningful and actionable problem statement (D School,2004). A problem definition entails summarizing the design's purpose based on an understanding of the users, with the aim of formulating a meaningful and actionable problem statement. To define the problem, designers must

acquire a deeper understanding of the daily needs of elderly users in nursing homes and position the design accordingly based on research outcomes concerning the needs of this population.

Stanford's design thinking process offers methods for addressing general problems, such as Point of View (POV). The POV approach consists three key elements: users, requirements, and insights. This study centres on the following questions through the lens of these elements: What is the furniture requirements of elderly individuals in nursing homes? What insights can be derived? Design Thinking also introduces the "How Might We..." approach to facilitate a clearer understanding and description of the problem. This description provides guidance on designing age-friendly furniture for nursing homes. The problem definition phase proposed in this study draws from the POV and "How might we" methodology, requiring a clear problem statement in the design practice phase that addresses how to design, who to design for, what to design, and the design goals to be achieved (D School,2004). This is crucial in defining the problem and directing the design of suitable furniture for the elderly in nursing homes.

c) Phase Three: Ideate

This phase is primarily designed to inspire user-empowerment thinking, generate as many concepts as possible that can motivate active user participation, and develop a systematic design solution to address the approach (Dong et al., 2021).This phase is divided into two parts: "design conceptualization" and "design deepening." The design conceptualization phase involves analysing the requirements and pain points of elderly users in order to identify design opportunities. This process primarily aims to stimulate the thinking of older users, encourage their active participation in the design concept, and

serve as a foundation for the development of systematic design solutions that address the furniture requirements of older individuals. During the design conceptualization process, a brainstorming session was organized, where participating designers were tasked with generating concepts and ideas that leverage the resources of older people and eliminate potential barriers in the design process. At the conclusion of the brainstorming session, the design ideas were subjected to a selection process.

Following the development of a systematic design concept, the design solution is further refined. And here involve with a problem statement, how to delve into the specific details of conceptualization and program design? This stage, known as design deepening, involves delving into the specific details of conceptualization and program design. The design deepening phase requires careful consideration of the objective barriers that older adults in nursing homes may encounter when engaging with various aspects of daily life. The previous two phases, which focused on empathy and design orientation for older people, provide the basis for the design deepening process. At this stage, the researcher has undertaken a comprehensive and systematic reflection and expression of the design solution for age-friendly furniture in nursing homes, thus marking the completion of the initial phase of designing age-friendly furniture for nursing homes.

d) Phase Four: Prototype

The fourth stage involves prototyping the design in preparation for subsequent evaluation and optimization processes. Design prototyping is a hands-on session that provides more explicit content. Depending on the fidelity, the prototype can be a low-fidelity prototype or a high-fidelity functional prototype. In this study, the realization of the prototype design for age-friendly furniture is divided into two major parts: an overall

consideration of the furniture architecture, including functional modules, modeling, and spatial structure, and a local consideration of the interaction design, encompassing aspects such as button clicking, behavioral aids, intelligent switching, and the overall display of local functional modules. From the perspective of design implementation, the process of transitioning from a holistic approach to a more localized and gradually refined approach is better suited for the production of prototypes. This approach aims to effectively showcase the original design intent and fulfil the later design requirements and assessment tests by utilizing authentic high-fidelity materials that are proportionate to the actual product.

e) Phase Five: Test

The final stage is to evaluate and optimize the design solution. The testing stage serves as an evaluative and optimization process for the design solution, gathering feedback from real or target users (D School,2004). It aims to determine whether the design practice aligns with the physiological and behavioural characteristics of the elderly residing in nursing homes. During the assessment optimization stage, the elderly are invited to experience the design prototype of the program, while experts and relevant professionals are consulted through research and interviews to obtain authentic insights. By incorporating feedback from the elderly, experts, designers, manufacturers, and related professionals, the research team can further refine the design scheme and effectively communicate the optimized solution.

3.4 Research Approach

Aligned with the research concept and content of this study, five research methods, mainly using a mixed approach of qualitative and quantitative methods, were chosen to ensure the comprehensiveness and cohesion of the investigation, analysis, and research

work. This study involves surveys such as questionnaires, interviews, and observations of elderly individuals in nursing homes and relevant professionals in different Chinese cities. The research also incorporates theoretical knowledge from environmental behaviour, ergonomics, sociology, and barrier-free design. As a result, the samples, sizes, and objectives of each phase in this study vary, making the mixed research method suitable for this research.

Literature research is primarily employed to categorize the fundamental theories and existing research outcomes of design that is conducive to ageing and its associated disciplines. Questionnaires are an integral part of the quantitative methodologies and are used to investigate the physiology, behaviour, and interactions related to furniture among research subjects. They are primarily utilized to analyse the focal aspects of furniture design for the elderly in China nursing homes and to identify the entry points for determining the factors that influence such design. Interviews are mainly conducted to obtain first-hand information on the design practice of furniture that is suitable for the ageing population. They also serve to collect information regarding the elderly individuals' perception of furniture in elderly institutions, their willingness to make demands, and their design aspirations. The process of brainstorming is primarily employed to generate innovative ideas and cultivate problem-solving skills that are creative in nature. Design practice serves as a preliminary validation of the previously researched content, proposed design principles, methods, and strategies, as well as their application to the design case of multifunctional ageing beds in nursing homes.

3.4.1 Literature Review

Literature reviews occupy a significant role in academia since scientific research is fundamentally a cumulative endeavour (vom Brocke et al., 2009). This section synthesizes existing literature to identify the gaps in knowledge that empirical research addresses (Sylvester & Johnstone, 2013). The literature research method is one of the primary methods employed in this study. Its purpose is to comprehensively organize and analyze the established research findings in the relevant subject areas at home and abroad. This study mainly applies Cite Space, a scientific knowledge mapping visualization software, to sort out the relevant literature on age-friendly furniture and age-friendly research from domestic and international sources. It conducts metrological visualization analysis in terms of keywords, research hotspots, research fields, and the number of published articles. The objective is to systematically summarize and conclude research fields, current state, developmental trends, and future predictions regarding the design of age-friendly furniture over the past decade.

a) Overview of the Literature Review Process and Steps

As explained in Templier and Paré (2015), there are six generic steps involved in conducting a review article:

i. Developing a research question and objectives (Cooper & Hedges, 2009; Webster & Watson, 2002; Jesson, Matheson, and Lacey (2011).

ii. searching the extant literature (Cooper, 1988; Paré et al., 2015).

iii. screening for inclusion (Levy & Ellis, 2006; vom Brocke et al., 2009; Liberati et al., 2009; Shea et al., 2009).

iv. Assessing the quality of primary studies (Petticrew & Roberts, 2006; Shea et al., 2009).

v. Extracting data and analyzing (Cooper & Hedges, 2009; Okoli & Schabram, 2010).

vi. Synthesize data and discuss. (Dixon-Woods et al., 2005; Thomas & Harden, 2008; Jesson et al., 2011). Formulating the research question(s) and objective(s), searching the extant literature, screening for inclusion, assessing the quality of primary studies, extracting data, and analyzing data.Although these steps are here are presented sequentially, it is important to remember that the review process can be iterative and many activities can be initiated in the planning phase and then refined in subsequent phases (Finfgeld-Connett & Johnson, 2013; Kitchenham & Charters, 2007).

To effectively address the challenges encountered in the utilization and design process of age-friendly furniture in nursing homes and cater to the diverse requirements of users, the author adopts a research approach that involves problem identification, analysis, and solution generation. This study aims to explore and visualize the current status, development, and dynamics of research in the field of age-friendly furniture design at both domestic and international levels (Figure 3.3).

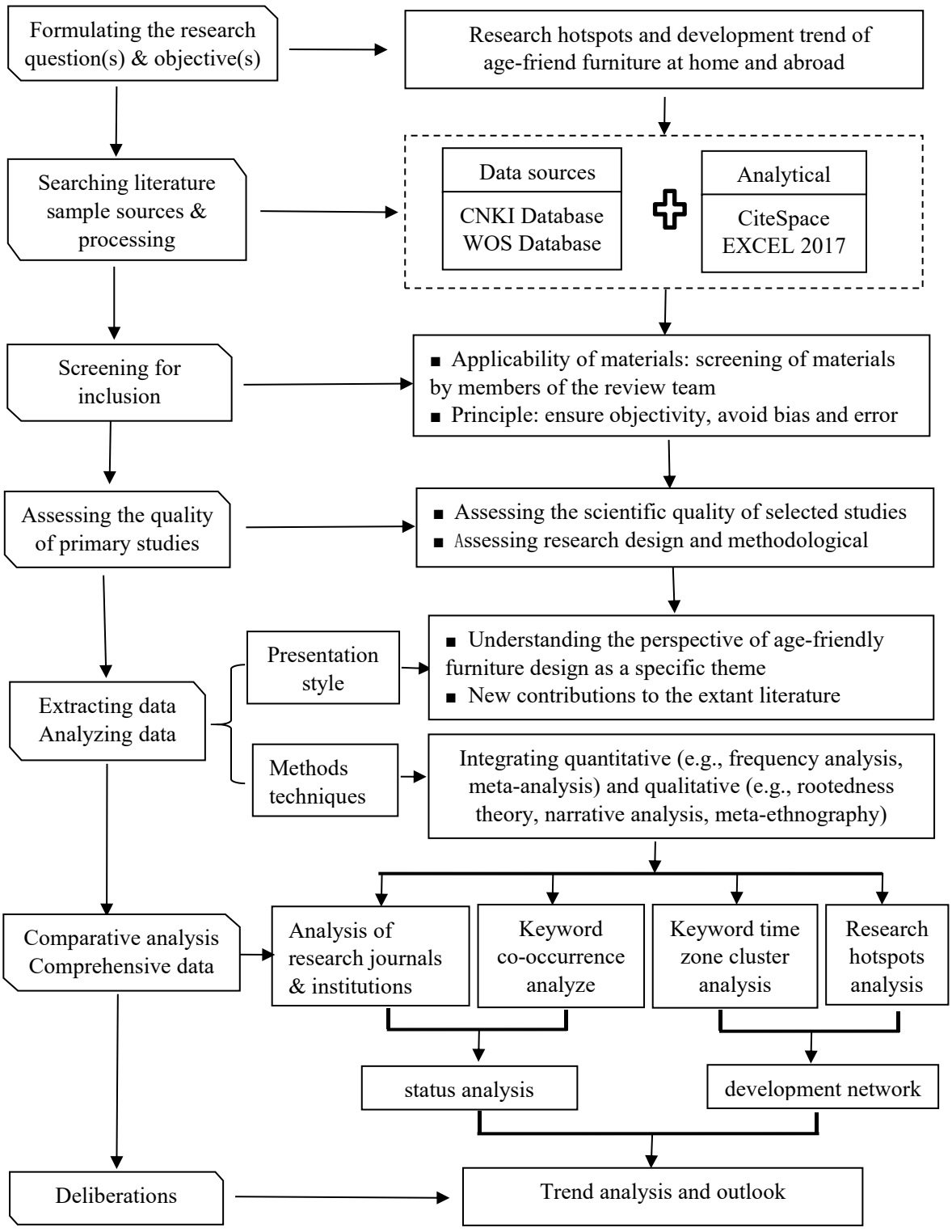


Figure 3.3: Overview of the Literature Review Process and Steps

b) Using Citespace archive RO and answer RQ

Using CiteSpace for a literature review on age-friendly furniture design is an effective way to achieve the research objective and answer the research question. By leveraging CiteSpace's analytical capabilities, it can systematically explore the existing literature, visualize key trends, identify influential works, and highlight emerging areas.

Defining research objectives and issues. First, the research objectives clearly point to the key aspects of age-friendly furniture design. For example, analysing the current state of research on age-friendly furniture design, identifying key trends, identifying the core design elements, and gaps in the literature to guide future work. Then, explore research questions in age-appropriate furniture design. For example, how has age-friendly furniture design evolved over time, and what are the key trends and challenges identified in the literature? How do they address physical, Behavioral, and emotional needs?

Steps to Archive the Research Objective and Answer the Research Question. First, Research Objective is to understand the overall structure and evolution of age-friendly furniture design research. CiteSpace generates co-citation maps and keyword clusters, which allow you to visualize how research in age-friendly furniture has evolved over time. For instance, we can chosen keywords were "age-friendly furniture," "elderly care facilities," and "nursing home furniture design,"as key topics within this field.The software divides the literature into clusters based on citation patterns. Each cluster represents a distinct sub-field or topic. For example:One cluster might focus on ergonomic design, another on smart furniture for the elderly, and another on inclusive design principles.

Then,identifying key authors, institutions, and works; analysing the evolution of research themes; identifying gaps in the literature and answering the research question. In order to highlight influential studies, key authors and institutions that have made a significant contribution to the field, CiteSpace allows to perform author and citation analysis to discover the central nodes, i.e. the most cited authors, papers or institutions. The researcher can also identify the most cited papers, such as important studies on height-adjustable furniture, which have influenced future research directions. Subsequently, emerging trends, innovations and future research areas are identified.CiteSpace's Citation Surge Detection feature identifies papers or keywords with sudden spikes in citations, thus pointing out new trends in the literature.

Finally， answering the research question 1 , the co-citation and keyword analysis provide a clear chronological view of how age-friendly furniture design has evolved, helping to identify important milestones. CiteSpace helps you identify research gaps, answering: What areas in age-friendly furniture design have not been sufficiently addressed? By identifying these emerging trends, you can answer questions, such as: What new innovations are shaping the future of age-friendly furniture design? And helps you identify research gaps, answering: What areas in age-friendly furniture design have not been sufficiently addressed? These studies can provide evidence-based support for research objectives, utilizing data-driven insights to validate or refine research objectives.

By visualizing how topics like ergonomics, assistive technology, and sustainability have shaped age-friendly furniture design, you can answer questions about what trends have emerged, who are the key influencers, and what challenges remain unaddressed, thereby ensuring your research contributes valuable new knowledge to the field.

c) Sample Acquisition and Data Analysis

This investigation utilizes the CNKI database and WOS as data sources, selecting relevant literature on age-friendly research and age-friendly furniture from both domestic and international sources between 2013 and 2023 for indexing and organization. Visual mapping techniques are used to analyze the number of articles, research fields, diverse approaches, and emerging trends to identify commonalities and differences, with the aim of exploring the development and research trends of furniture design for the elderly both domestically and internationally from 2013 to 2023. Finally, with the assistance of Cite Space software and EXCEL2017, an extensive range of literature, project texts, and other materials were analysed through data and visual mapping comparisons.

Data Collection. Start by collecting relevant literature from academic databases like Web of Science. Literature data related to age-friendly furniture design was retrieved from authoritative databases (e.g., Web of Science, CNKI, etc.) (Figure3.4). The search terms may include: “age-friendly furniture design” “Furniture for elderly” “Ergonomic furniture for seniors” “Assistive furniture design” ,etc. Limit the search to relevant fields such as Design, Ergonomics, Gerontology, and Architecture. Specify a time range, 2014–2024, to include recent research and historical developments. Export the results as a .txt or .csv file containing metadata like title, authors, keywords, abstract, citations, and references. This data will be imported into CiteSpace for further analysis.

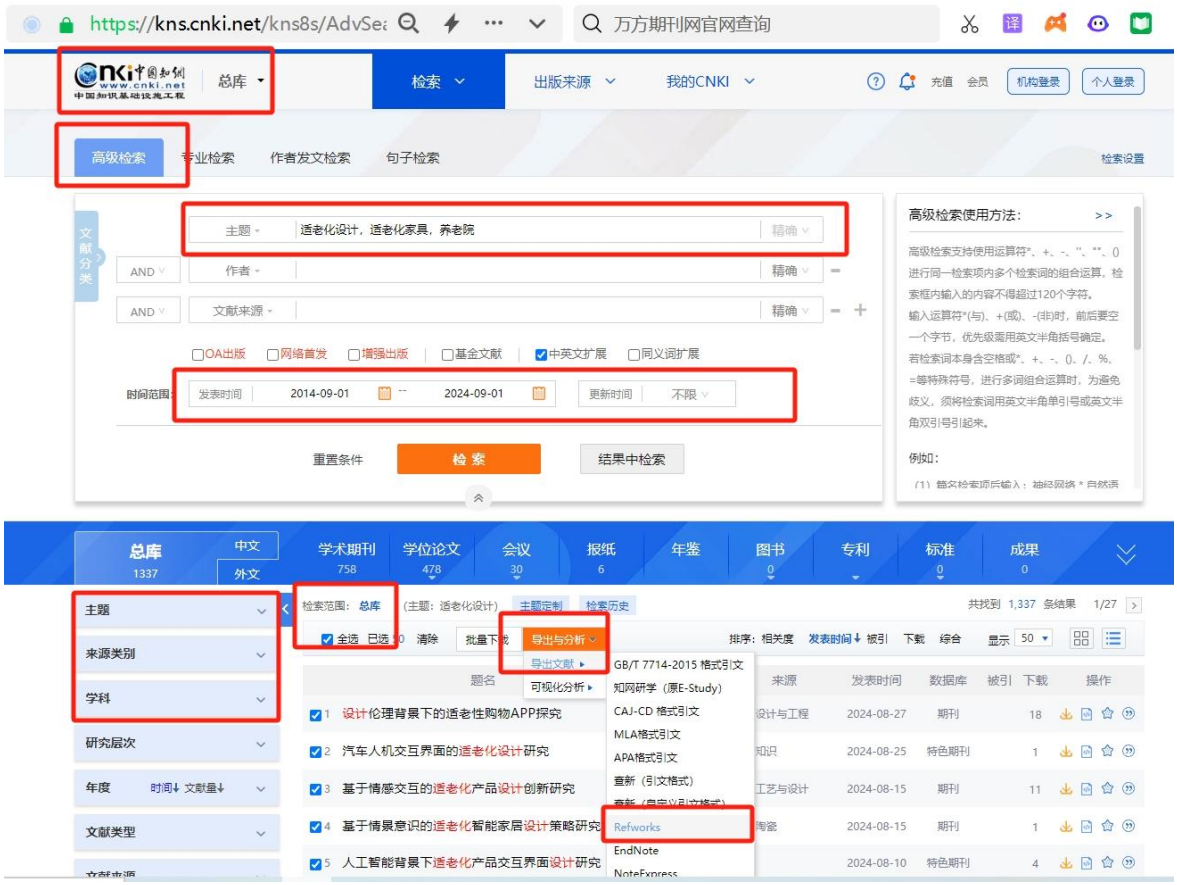


Figure 3.4: Step-by-step diagram for data collection

Setting up CiteSpace. Open CiteSpace and import the collected data from Web of Science (Figure3.5). The time span of the analysis (2014-2024) was chosen and the length of the slices was set to 1 year in order to track the evolution of the research trend from year to year, which helps to observe the development trends in the field of age-friendly furniture design. un CiteSpace analysis and generate maps. Run CiteSpace and the software will analyze and process the literature data according to the set parameters (Figure 3.6). After the analysis is completed, visualization maps are generated, including keyword co-occurrence maps, author co-occurrence maps, institution co-occurrence maps, and literature co-citation maps. These maps will visualize research hotspots, trends, core

authors and institutions, and knowledge evolution paths in the field of age-friendly furniture design.

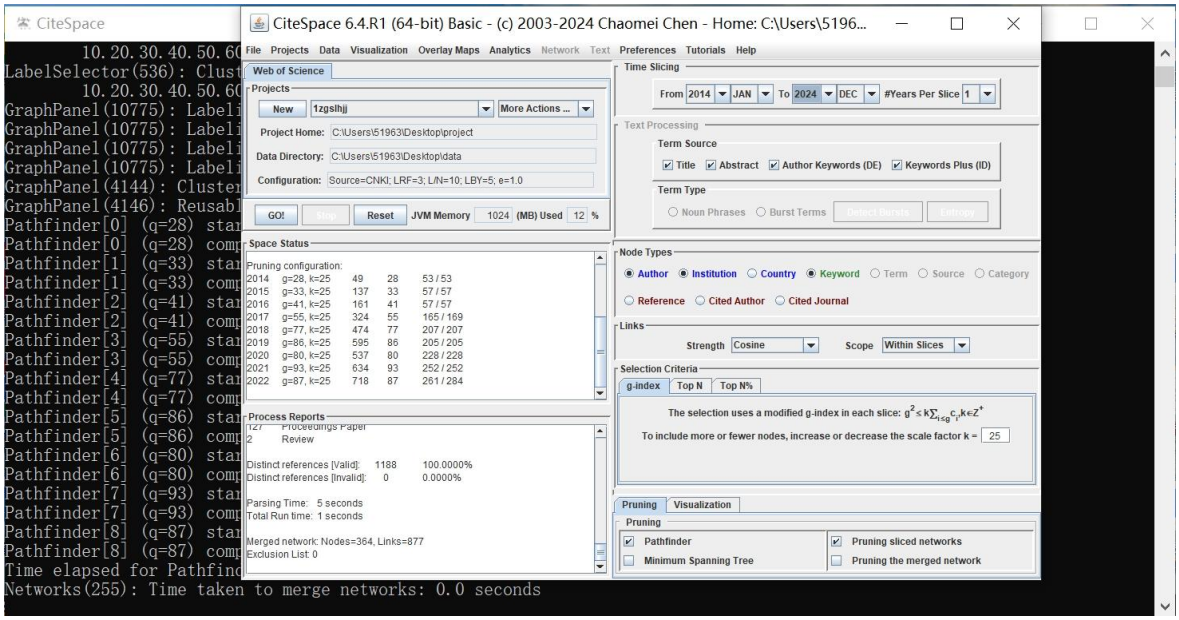


Figure 3.5: Setting up CiteSpace Software Screenshot

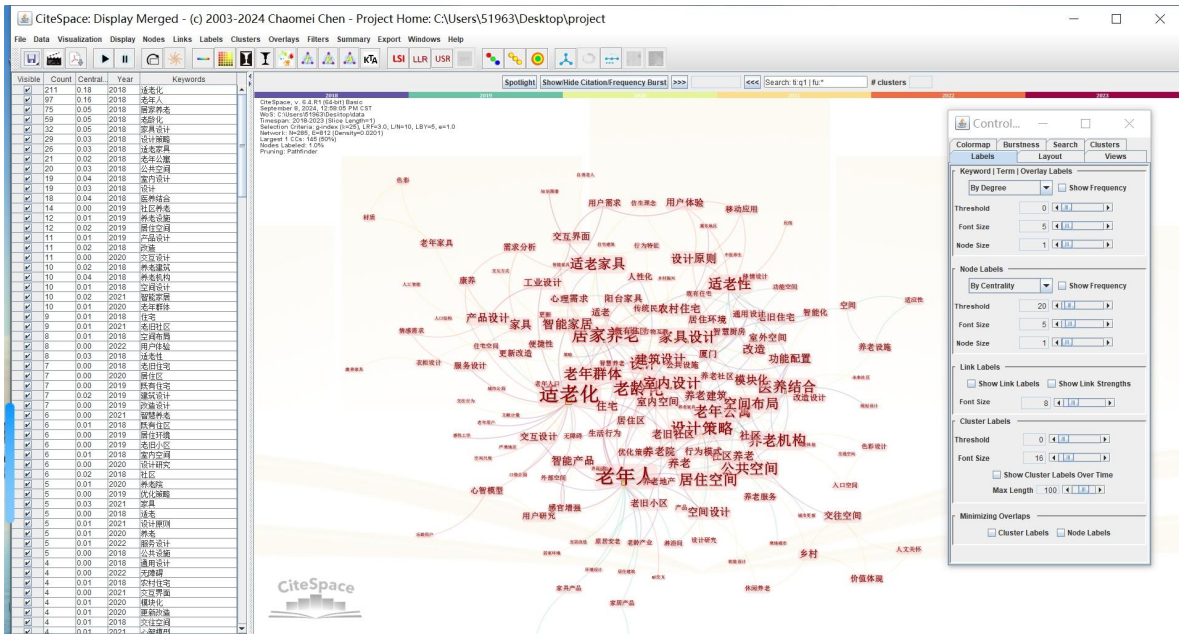


Figure 3.6: Literature Review CiteSpace Analysis Software Screenshot

Through the above steps, using CiteSpace can effectively answer the research objectives of age-friendly furniture design, can effectively analyze and answer the research

questions of age-friendly furniture design, and can provide valuable references and insights for researchers in related fields.

3.4.2 Questionnaire

Questionnaires represent a fundamental and crucial quantitative method for surveying the lifestyle of a specific population. They are also considered one of the primary instruments used to collect information during surveys (Martin & Haninton, 2012). Questionnaires, as a structured method of data collection, enable the systematic collection of opinions and feedback from a large number of target groups. In designing the questionnaire survey for age-friendly furniture, the researcher drew on previous studies to frame the questionnaire and select the questions. For elderly users, the evaluation of furniture design must take into account not only physical attributes but also cognitive and emotional needs, which are best understood through direct feedback. This direct communication through questionnaires allows researchers to tailor furniture design.

Questionnaires are essential for gathering qualitative and quantitative data in the design of age-friendly furniture. Designing effective questionnaires for age-Friendly furniture research. In developing questionnaires for this type of research, several factors must be considered to ensure they capture relevant information. Below are key aspects to consider: dimensions, height, depth, armrest positioning, material, shape, colour, etc. In addition, accommodating physical and cognitive needs. This is because elderly respondents might face challenges like limited vision, mobility issues, or cognitive impairments. Moreover, ergonomics and user satisfaction. In a study by Wu et al. (2021), questionnaires were used to evaluate user satisfaction with ergonomically designed chairs for elderly users. Also, safety features. Such as anti-slip materials or support for mobility aids. Using a

combination of closed-ended and open-ended questions, the researchers collected data on how elderly individuals perceived safety features, such as anti-slip flooring materials, grab handles, and rounded edges. Then, emotional and psychological well-being. Park & Kim (2019) explored the emotional impact of furniture design on elderly users. Their questionnaire focused on the emotional well-being associated with furniture use, particularly how it contributes to a sense of independence and dignity.

Questionnaires help to standardize and streamline the data collection process, providing standardized phrasing of questions and a consistent procedure for their delivery. In accordance with the needs of this study, the questionnaire was designed in line with sociological research methodologies. Specifically, it was tailored to complement the qualitative research and address the research questions and objectives outlined in chapter one.

a) Description of the Questionnaire

In the present study, a questionnaire survey is employed to examine the daily activities of the elderly population residing in certain China nursing homes. Through this survey method, information pertaining to the specific demands of the elderly user groups for age-friendly furniture in nursing homes is acquired during the initial stages of the study.

The design of the questionnaire revolves around the research inquiries and objectives of the study. The structure of the questionnaire is based on the preliminary data collection, sorting, and field research. Furthermore, it takes into account the current situation of the elderly residing in nursing homes, their physiological and behavioural characteristics, and the necessary information for furniture design. The questionnaire topics are categorized into five major aspects: basic information of the elderly living in nursing

homes, survey on physiological and behavioural characteristics, design requirements for age-friendly furniture in nursing homes, existing issues, and evaluation and improvement of the content.

b) Questionnaire Design

This survey is categorized into three main sections and comprises(include) five distinct surveys. Questionnaire 1 was used to analyse the basic living conditions of the senior population. Questionnaire 2 was to analyse the physiological, psychological, and behavioral characteristic of elderly individuals residing in nursing homes. Additionally, Questionnaire 3 was a questionnaire formulated to address matters pertaining to age-friendly furniture in nursing homes. Furthermore, Questionnaire 3 can be further divided into three separate questionnaires: a survey that targeting the elderly to evaluate their contentment with the age-friendly furniture in nursing homes (Questionnaire 3-1), an examination of the level of familiarity with age-friendly furniture and requests for its design (Questionnaire 3-2), and lastly, an investigation into the elderly population's utilization and feedback on the existing furniture in nursing homes (Questionnaire 3-3). The detailed data analysis of this questionnaire will be discussed in Chapter 4, and the complete questionnaire set can be found in Appendix 1.

The question set of this questionnaire is split into two primary parts. The first part serves demographic purposes, with respondents sharing their basic personal information such as gender, age, height, and occupation. Respondents are required to select the appropriate choices from the provided options. In the second part, two main patterns are observed: firstly, questions are organized in accordance with the Likert scale, where respondents indicate their level of satisfaction using the options as (1)“very satisfied”

(2)“satisfied” (3)“mostly satisfied” (4)“dissatisfied” and (5)“very dissatisfied”. Secondly, respondents are presented with pre-designed questions and are asked to make single or multiple choices from the given options. All collected data are then summarized and organized using computer software. The three questionnaires are subsequently analysed and summarized using the software package for social sciences (SPSS) version 23 and Microsoft Excel.

c) Questionnaire Distribution and Data Collection

In the study of designing age-friendly furniture, the questionnaire method was used through a systematic process of data collection and analysis. The use of questionnaires is a powerful tool to achieve research objectives and answer research questions. Questionnaires can efficiently gather information on user needs, preferences, and experiences. This method helps achieve research objectives and answer research questions by providing statistically significant data that can guide design improvements. The research objectives of age-friendly furniture design usually include physiological and behavioral characteristics of older people, existing problems, and user needs. Furthermore, questionnaires allow researchers to collect quantitative data on user needs and preferences through structured questions. This data can be analysed to identify common trends and patterns among a large sample of elderly users. The combination of quantitative and qualitative data from questionnaires allows researchers to create a user-centred approach to design, ensuring that the needs of elderly individuals are met effectively and comprehensively.

First of all, it is necessary to clearly define the objective of the research, which is to design age-friendly furniture that meets the physiological and behavioral characteristics of

the elderly in order to enhance their quality of life and living comfort. At the same time, it is also necessary to clearly define the research questions, such as what are the specific needs of the elderly in the use of furniture? What are the current problems with age-friendly furniture? How satisfied are they with their existing furniture? The researcher assessed satisfaction with the existing nursing home furniture through Questionnaire 3-2. For example, respondents were asked about their satisfaction with existing furniture in terms of comfort, safety, size, colour, functionality and ease of use (Figure 3.7). By analysing the responses, common problems and possible shortcomings of the existing furniture can be identified to guide improvements.

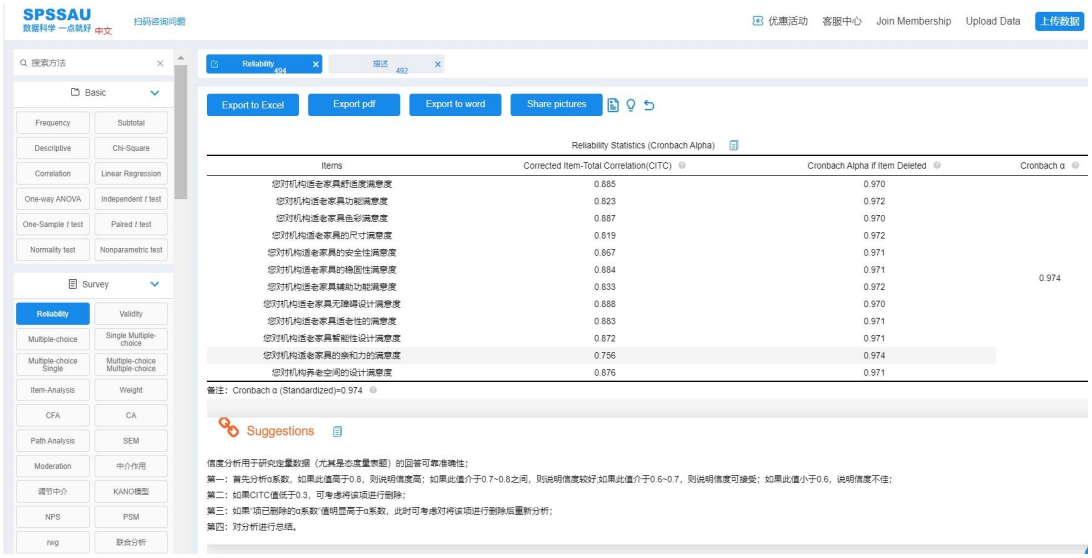


Figure 3.7: Screenshot of Furniture for the Elderly Satisfaction Analysis Software

d) Questionnaire Distribution and Data Collection

This survey was conducted in December 2022 via the administration of questionnaires in the form of questionnaires employing the utilization of Question star, web links, and on-site paper questionnaires for the self-completion of the survey in all provinces and cities across China, for the purpose of distributing the questionnaires and

collecting data. Recovered questionnaires that met the necessary qualifications were treated as factual statistics. The target population for this questionnaire survey included elderly individuals staying in elder care facilities in the provinces of Jiangsu, Zhejiang, Hunan, Guangxi, and Guangzhou. A total of 1,200 questionnaires were distributed using both online and on-site methods, and the elderly who received the questionnaires completed them diligently and actively. This approach resulted in the acquisition of a substantial amount of valuable first-hand information, ultimately leading to the attainment of the anticipated outcomes and fulfilling the research requirements.

Throughout the course of this survey, the distribution of questionnaires was facilitated via the utilization of the questionnaire link (https://www.wjx.cn/vm/eUAtvsL.aspx#), the online interview link (https://www.wjx.cn/vm/eUAtvsL.aspx?interview=1), and the WeChat QR code. A total of 1,200 questionnaires were distributed, and 1,080 questionnaires were successfully retrieved. Among these, 1,029 questionnaires were deemed valid, with 518 of them being completed by male respondents, accounting for 50.34%, and 511 completed by female respondents, accounting for 49.66%. The author undertook field research at various elderly care organizations between October 2021 and December 2022 in the provinces of Zhejiang, Jiangsu, Hunan, Guangxi, and other provinces in the eastern and central-western regions of China. During this period, the questionnaires were completed to the best of the respondents' abilities, with the inclusion of auxiliary questions and answers (including inquiries directed at caregivers) or by taking into consideration observed real-life situations. The overall validity rate of the questionnaires was determined to be 95.28%.

e) Data Analysis

The data that was collected went through systematic, statistical, and analytical testing with the assistance of the Statistical Package for Social Sciences (SPSS27) and EXCEL software. In order to analyse the results of the questionnaire, it is necessary to first test the reliability and validity of the section that pertains to the design of the questionnaire and involves measurements using multiple items. Currently, Cronbach's alpha coefficient is commonly employed in social science research for analysis. Generally, a reliability coefficient above 0.9 indicates excellent reliability, while a coefficient between 0.8 and 0.9 indicates very good reliability. If the coefficient falls between 0.7 and 0.8, it suggests good reliability, and if it ranges from 0.6 to 0.7, it is deemed acceptable. A coefficient below 0.6 indicates the need for revision.

When considering attitude scale questions, a judgment matrix is constructed and the mean of each analyzed item is calculated to obtain the judgment matrix using mean size division. AHP hierarchical analysis is then employed to calculate the weights when determining the importance of the indicators. Additionally, it is necessary to conduct a validity test analysis, which examines the consistency of the evaluation weight calculation results(Figure 3.8).

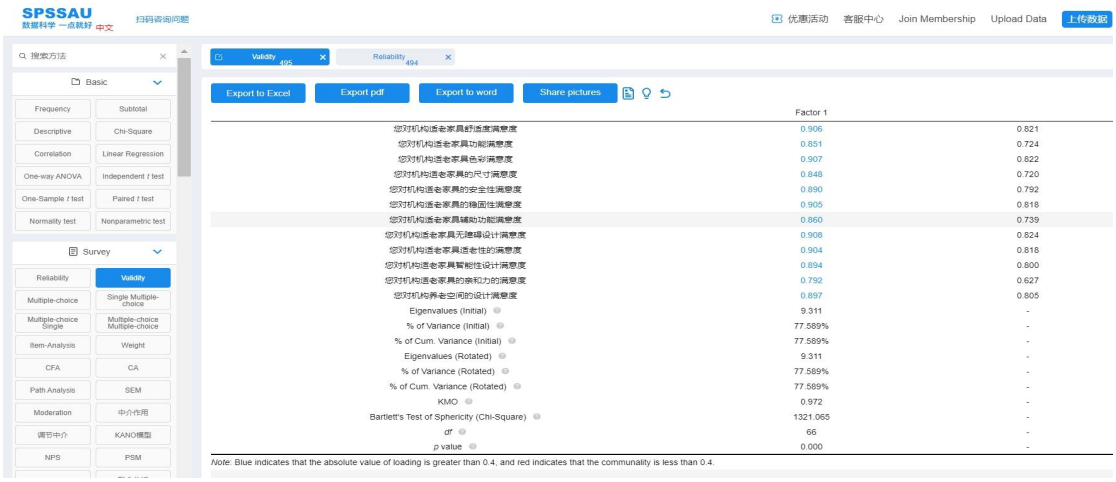


Figure 3.8: Validity test analysis software screenshot

When conducting multiple choice analysis, response rate and prevalence analysis are utilized. Multiple response is employed to analyse the proportion of choices for each multiple-choice item. Response rate is used to compare the relative proportion of choices for each option, while prevalence rate is used to analyse the popularity of a specific choice. The difference between the two lies in the number of divisors. Furthermore, frequency and descriptive analyses are employed in the statistical analysis of specific data. Frequency analysis is conducted to examine the distribution of data within fixed categories, while descriptive analysis is used to study the overall quantitative data and determine the overall average score. The specific data analysis obtained from these tests will be discussed in detail in Chapter 4.

The questionnaire survey method can effectively achieve the research objectives and answer the research questions through a systematic process of data collection, analysis and organization. In this study, the research questions are aligned with the objectives and can be answered through the data collected. These data are essential for evaluating existing designs, guiding design improvements, and ensuring that new furniture solutions meet the specific needs of older users. The questionnaire method plays an important role in the study of elderly-friendly furniture design in nursing homes, providing strong support for designing elderly-friendly furniture that better meets the needs of the elderly in nursing homes.

3.4.3 Interview

The study relied heavily on interviews as the primary source of evidence, as determined through a literature search and the administration of questionnaires. Interviews serve as a fundamental research method that allows direct interaction between the

researcher and the participants (Marzuki, 2011; Martin & Hanington, 2012). Moreover, they are widely regarded as the most popular methodological tool in qualitative research (Denzin & Lincon, 1994). It is well established that interviews are indispensable for obtaining primary data. Interviews, as a qualitative research methodology for in-depth exploration of issues in a specific field, are of significant importance to research on age-friendly furniture design. Interview methodology plays a vital role in the study of designing age-friendly furniture, which not only helps to achieve the research objectives but also answers the research questions effectively. As the physical conditions, living habits and aesthetic preferences of the elderly are different, their needs for age-friendly furniture are also characterized by individualization. The data collected through the expert interview method is not only reliable and in-depth, but also provides personalized and targeted guidance for design. The interviews were able to personalize the questions and discussions to each respondent's unique situation, resulting in more refined information about needs. This personalized understanding helped the researcher to design furniture products that better meet the individual needs of older adults.

In the context of designing age-friendly furniture, interviews are invaluable for understanding the specific requirements of elderly users and gathering detailed feedback on design concepts. This discussion examines the credibility of interviews as a research method, focusing on academic practices, and applies it to the design of age-friendly furniture, backed by references and previous studies. Interviews are particularly effective in age-friendly furniture design research because they provide the opportunity for in-depth exploration of subjective experiences.

In conclusion, the interview method has unique advantages and high credibility in the study of designing age-friendly furniture. Through in-depth interviews with the elderly, we can obtain information about their living habits, physiological conditions, behavioral characteristics, experience in using furniture, and specific needs, which can provide valuable references for designers. The data collected through the expert interview method is not only reliable and in-depth, but can also provide personalized and targeted guidance for design. Therefore, the interview method is an important method to be promoted and applied in areas such as designing age-friendly furniture.

In line with the objectives outlined in Chapter 1, this study deliberately selected the elderly living in nursing homes and individuals involved in the design of age-friendly furniture as interview subjects. The interviewees mainly included the elderly in China nursing homes, designers, experts, scholars involved in the research and implementation of age-friendly furniture design, and staff members from organizations engaged in elderly care services. The interviews were designed to understand their design needs and opinions based on specific actual scenarios.

a) Using Interview Approach Archive RO2-3 and Answer RQ2-3

The interview approach is particularly well-suited to achieving research objectives and answering research questions in studies focusing on age-friendly furniture design. This method allows for the collection of rich, qualitative data, enabling researchers to explore the nuanced needs and preferences of elderly individuals. In the case of age-friendly furniture design, interviews allow researchers to understand not only the physical and behavioral needs of elderly users but also their ergonomic, emotional, cognitive, and social needs. Achieving RO3 and answering RQ3 through expert interviews.

In order to realize the purpose of this study and to answer the research questions, in-depth interviews were conducted with experts in different roles and older people in this process, mainly focusing on the key factors, problems of the traditional head age-appropriate furniture design method.

The interview approach is a powerful qualitative research method, allowing for in-depth exploration of participants' needs, preferences, and experiences. In the context of designing age-friendly furniture, interviews provide essential data from elderly users, ensuring that the furniture design aligns with their functional and emotional requirements.

Achieving the research objective through interviews. The research objective in the context of designing age-friendly furniture typically involves understanding the specific needs, limitations, and preferences of elderly individuals and translating these insights into practical, user-centred designs. For example, during the interviews, older participants would express the difficulties they faced when interacting with furniture, such as difficulty getting out of bed, discomfort due to incorrect ergonomics, or lack of assistive design. In addition, safety is a major issue for the ageing population, especially in the design of age-appropriate furniture. Interviews allowed older users to describe their fears and experiences with furniture-related insecurities. For example, they have fallen out of low chairs or found it difficult to use recliners.

Answering the research question through interviews. The research questions in age-friendly furniture design often aim to explore the usability, safety, and emotional impact of furniture on elderly users. Interviews help answer these questions by providing qualitative insights directly from the users themselves. By interviewing elderly participants, the research captures their firsthand experiences and challenges. For example, an elderly user

might explain that a chair without armrests makes it difficult to rise to a standing position, or that a soft cushion exacerbates back pain. Such insights allow researchers to design features like adjustable armrests, firmer cushions, or higher seat heights to improve usability.

The interview approach is a highly effective method for achieving research objectives and answering research questions related to age-friendly furniture design, and uncover unforeseen issues, validate design hypotheses, and help identify key themes, all of which are crucial for creating furniture that truly meets the needs of ageing populations.

b) In-depth Interview for Nursing Home Elderly Population

This study focuses on the design study of furniture suitable for the elderly, and the interviews were conducted to directly understand the needs of the elderly group from their subjective perspective. The primary objective of the interviews was to gain insights into the daily habits, physiological functions, and behavioral traits of this elderly population residing in nursing homes. Additionally, the interviews aimed to identify the challenges faced by elderly individuals in nursing homes when using furniture, the problems they encounter, and their suggestions for age-friendly furniture design.

The key to conducting in-depth interviews with elderly individuals in nursing homes is to overcome the psychological barriers between the interviewer and the interviewees, establish effective communication, and encourage the interviewees to express their genuine thoughts and emotions. By establishing close rapport with the elderly, we can gain insights into their physiological and behavioral characteristics, as well as their requirements for furniture design in nursing homes.

Interview Format. This section employed various forms of interviews, including informal interviews, in-depth interviews, and structured questionnaires, to comprehend the daily behaviors of the elderly and their specific needs regarding age-friendly furniture. During the in-depth interviews, the focus was on elderly individuals residing in nursing homes, allowing them to use their own language and vocabulary to articulate their thoughts and requirements for daily furniture, rather than merely responding to the researcher's questions.

Subsequent to initiating the interviews, the researcher informed the key personnel in each service organization about the purpose and content of the interviews through an informed consent form. With the assistance of these key personnel, 3-5 interviewees were identified for each organization. Interviews were conducted with the consent of the elderly individuals in the nursing homes and took place in either one-to-one or one-to-two settings, either face-to-face or through online meetings, with each session lasting approximately 60 minutes. The interviews were conducted in the form of conversations with the elderly in order to establish a closer connection with them, comprehend the obstacles and challenges they faced when using furniture, and solicit their valuable opinions on furniture design.

Scope and specificity of the question. Table 3.1 outlines the topic scope and specific content covered in the interviews. The purpose is to guide the interviewees to reflect on their own experience of using nursing home furniture, elucidating the existing problems they observed, and offering analyses, interpretations, and suggestions regarding these issues. The author will make appropriate adjustments to the interview expressions for specific interviewees, in order to align with their perceptions and sentiments.

Table 3.1: Range of Topics and Specific Content of Interviews with Elderly in Nursing Homes

No.	Scope of Question	Sample Question for Open-Ended interview
1	Understanding the realities of life and the physical and mental states of the elderly (physiological and behavioural states)	How do you feel about your physical condition? What are the biggest obstacles encountered in physical functioning or behavioural states? How were they overcome? Do you need external assistance?
2	Evaluate the use and effectiveness of existing nursing home furniture	Review what barriers and problems were encountered in the use of the existing furniture? Were these problems eventually resolved? What parts of the furniture currently in use are positive? How effective is it? Which parts are still problematic? What are the causes of these problems? This can be illustrated with specific cases.
3	Describe the functional needs of older people for furniture	What do you think are the basic needs of age-friendly furniture applications? What are the individual needs and expectations you would like to see in furniture for the elderly? What are the main reasons? You can illustrate with specific cases.
4	To present views on the design of age-friendly furniture and suggestions for improvement.	What do you think are the main problems that occur in the use of furniture today? If they can be solved, how exactly? What changes would you like to see in the design of age-friendly furniture compared to existing furniture?

The interviews were conducted with the informed consent of the interviewees. The author recorded the entire interview process, transcribed and organized the recordings

afterwards to create a transcript of the interviews. This transcript served as the primary source of data analysis for Chapter 4 of the study.

c) In-depth Interview for Experts, Designers and Furniture Makers

In line with the study's objectives, the researcher deliberately selected relevant practitioners involved in the design of age-friendly furniture in nursing homes as interview subjects. The interviewees primarily consisted of personnel from elderly service organizations engaged in the design industry of age-friendly furniture, manufacturers, experts, scholars, and designers involved in the research and implementation of age-friendly furniture.

Interview Format. This section consists of a range of interview types, including informal, formal, and in-depth interviews. Its main objective is to guide the interviewees in describing the existing problems they have observed, as well as their analyses, interpretations, and suggestions for resolving these issues.

After the interview began, the researcher apprised each respondent of the purpose and content of the interview in the form of an informed consent form. The interviews were conducted with the consent of the interviewees and were carried out in either a one-on-one or multi-person group format, utilizing face-to-face communication. Additionally, the duration of each interview was carefully controlled, ranging from approximately 30 to 60 minutes. The author is responsible for conducting interview research with more than 40 interview subjects. During the implementation of the interviews, the author, when appropriate, adapts their expressions to align more closely with the cognitive and expressive habits of the specific interviewees. This allows the interviewees to utilize their own language and vocabulary to describe their design concepts, strategies, and methods.

The interviews were conducted with the informed consent of the interviewees. The author recorded the entire interview process and transcribed and organized the recordings to create a transcript of the interviews, then carry out a language protocol analysis (VPA)(Figure 3.9). This transcript served as a valuable source of data analysis for Chapter 4 of the study.

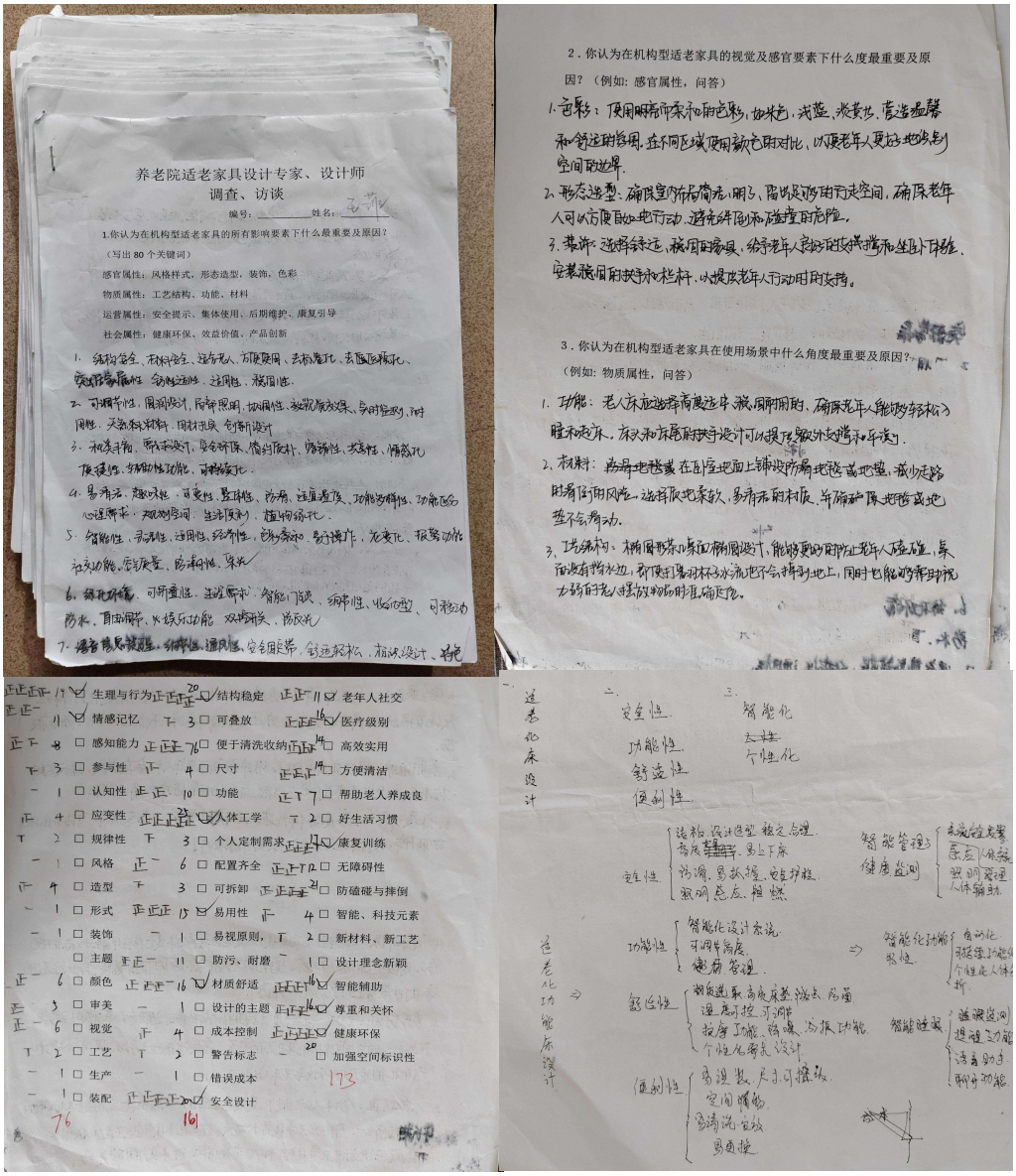


Figure 3.9: Language Protocol Analysis of the Interview

Scope and Specificity of the Question. The expert interviews served as evidence for this study on the thought processes and ideas involved in the practice of designing age-

friendly furniture for nursing homes. The interviewees were asked to discuss professional topics related to the design of age-friendly furniture, particularly within the context of their own practical design cases and research. The interviews aimed to assess the current status of product design and user feedback regarding age-friendly furniture in nursing homes. Furthermore, the interviews explored the most significant design perspectives, influencing factors, and rationales behind age-friendly furniture in nursing homes. Principles, methods, and strategies for designing age-friendly furniture in nursing homes were also proposed. Table 3.2 provides an overview of the topics and specific contents covered in the interviews.

Table 3.2: Topics and Specific Content of Expert Interviews

No.	Scope of Question	Sample Question for Open-Ended interview
1	Sensory Properties	Style, Form, Decoration, Colour, etc.
2	Physical Properties	Process, structure, function, materials, etc.
3	Operational Properties	Safety tips, group use, post-maintenance, rehabilitation guidance, etc.
4	Social Properties	Health and environmental protection, benefit value, product innovation, etc.
5	Emotional Properties	Nostalgia, humanization, accessibility, communication, etc.
6	Intelligent Properties	Voice assistance, intelligent recognition, data collection, health monitoring, etc.

d) Data collection and transcription

Data Collection. To ensure the precision of the recorded information and prevent data loss, the author obtained consent from the interviewees to audio-record the entire

interview process. In addition to the audio recordings, written notes were taken during the interviews.

This methodology is highly suitable for conducting interviews with older adults and expert panels, as well as facilitating discussions. This approach allows interviewees to be more receptive to the researcher's questions by considering the diverse perspectives associated with furniture that promotes age-friendly environments in nursing homes. The interviews were carried out by the researcher using open-ended questions and responses from survey questionnaires or user interviews. The data was obtained through audio recordings, photographs, and transcripts of the interviews.

Data Transcription. Upon completion of the interviews, the audio recordings were transcribed to create a transcript. Any unclear or inconsistent information from the interviews was clarified with the interviewees to ensure the final transcript accurately represents the interviews. Firstly, all interview transcripts were meticulously organized. The original transcripts were stored as digital files to facilitate easy saving, locating, encoding, and sharing of the audio files. A file naming convention was employed, incorporating the interview date, source, and topic of discussion, to promote efficient identification of common themes. Next, transcribe the interview transcripts. Although there are now many tools available online to automate this process, due to the qualitative research needs of this program, accurate transcription is required, therefore, the author chose is to use a 100% human-generated transcription service, create a Microsoft Excel spreadsheet with a word document to compile the data, and map all the data collected into an e-text to make the interview data more accurate.

e) Data analysis

In this study, NVivo12 was used for the analysis of the interview data. NVivo12 facilitated the researcher in collecting, organizing, analyzing, presenting, and evaluating the reliability and validity of the qualitative study's data. During the core phase of data analysis, NVivo12 provided various functional and convenient methods of "coding" and allowed for text keyword searches using the "query" feature(Figure 3.10).



Figure 3.10: Interview Transcript NVivo Software Analytics Screenshot

The initial step is to import the interview materials, including the transcribed text from the interview recordings, into the NVivo12. For this program, the import process involved dividing the nursing home elderly interview records and expert interview records into separate files, which were further divided into multiple sub-files for import. Nodes were then created using the "Create Node" function, and the data were associated with the nodes through a coding process, assigning multiple codes to each interview. The next step

involved creating themes, which involved analysing and organizing the coding further. Themes were developed based on common characteristics of the nodes, and related codes were grouped together to identify and analyse patterns and relationships in the data. Finally, cross-analysis was conducted to examine cross-comparisons between nodes, themes, and other items. By comparing nodes, themes, and coding across different datasets, new associations and meaningful insights were discovered, leading to a comprehensive data analysis and the formulation of results.

Once the analysis of the interviews was completed, the key findings and insights from the interviews were documented. These insights were then utilized to construct and validate the findings, answer key questions related to the design of furniture that is suitable for ageing individuals in nursing homes, and support the research questionnaire and objectives in Chapter 1, which played a crucial role in developing the post-design practice plan.

3.4.4 Brainstorming

The primary objective of the brainstorming session in this study was to generate and record ideas pertaining to the design of furniture that is suitable for ageing individuals in nursing homes. Additionally, the session aimed to identify design keywords, foster the generation of creative ideas about age-friendly furniture design through lateral thinking, and identify key elements of the problem to stimulate creative solutions based on the ideas shared by participants.

In the field of age-friendly furniture design, brainstorming is particularly helpful in generating innovative design ideas. In the context of designing age-friendly furniture, brainstorming is an effective method for ideating solutions that accommodate the needs of

elderly users. This discussion explores the credibility of brainstorming in academic settings, supported by citations from published research, while focusing on its application in age-friendly furniture design.

a) Theoretical Foundation and Credibility of Brainstorming

Alex F. Osborn introduced the concept of brainstorming in 1953 in his book Applied Imagination (Osborn, 1953). This model became foundational in academic research, particularly in design-related fields where creative ideation is necessary. For instance, in age-friendly furniture design, a brainstorming session might aim to generate multiple ideas for addressing the mobility challenges faced by elderly users.

Brainstorming encourages divergent thinking, the ability to explore many possible solutions to a given problem. This concept is crucial in academia, where complex problems often require multifaceted approaches (Guilford, 1967). When designing age-friendly furniture, divergent design thinking can generate a range of ideas to improve product functionality. For example, from simple seat armrests to more complex innovations, armrest force sensors can be added.

The credibility of brainstorming as a research method in academic and design practices is supported by a wealth of literature. Some key aspects that contribute to its validity include. Structured Brainstorming Enhances Credibility. This method could be especially effective in brainstorming for age-friendly furniture design, ensuring that every participant's voice is heard, including elderly users and caregivers. Numerous studies have confirmed the effectiveness of brainstorming in fostering creativity, and that brainstorming produces more creative and varied ideas in a team environment than individual work (Paulus & Yang, 2000). In age-friendly furniture design, this creativity is essential for

addressing the diverse needs of elderly users, such as improving ergonomics, safety, and accessibility.

Brainstorming promotes interdisciplinary collaboration, which is crucial for solving complex problems in areas such as design. The collaborative nature of brainstorming makes it a valuable tool for addressing multifaceted design challenges like creating ergonomic furniture for the elderly. In the case of age-friendly bed design, involving healthcare professionals, gerontologists, and product designers in brainstorming leads to more comprehensive, user-centred solutions. Brainstorming accelerates the problem-solving process by encouraging the simultaneous exploration of multiple ideas. In the case of age-friendly furniture design, brainstorming helps identify creative features that might emerge from a more linear, individual approach. Brainstorming yields a higher number of creative ideas compared to other methods. This is particularly applicable in academic design research, where complex challenges, such as designing age-friendly furniture, require innovative approaches.

b) Using brainstorming approach archive RO3-4 and answer RQ3-4

The brainstorming approach is a powerful tool for achieving research objectives, particularly in design-related fields where innovation is key. The third research objective of this study is to propose the attributes, elements, principles and methods of designing age-friendly furniture from the perspective of the physiological and behavioural characteristics of the elderly in China nursing homes. In the context of designing age-friendly furniture, brainstorming facilitates the generation of diverse and creative solutions that address the needs of elderly users.

In research on age-friendly furniture design, goals may include improving the safety, accessibility, comfort, and meeting the specific needs of older adults so that subsequent research efforts can be centred on these goals. Answer the research questions by analysing the ideas and solutions generated from the brainstorming discussions. For example, to address the question of how to improve the design of existing furniture, specific improvement solutions can be proposed in terms of comfort, safety, ease of use. To address the question of the application of new materials or technologies in age-appropriate furniture, it is possible to explore which materials or technologies have the potential and make corresponding application suggestions. Therefore, the brainstorming approach is a creative, collaborative method designed to generate a wide range of ideas and potential solutions to a given problem. This method aligns with the research objective by fostering collaborative ideation and ensuring a broad range of possible solutions.

The brainstorming approach is highly effective for achieving research objectives and answering research questions, particularly in design-related fields such as age-friendly furniture. By encouraging divergent thinking, promoting collaboration, and facilitating the generation of creative and feasible solutions, brainstorming ensures that research objectives-such as improving the usability and comfort of furniture for elderly users-are met. Moreover, by involving elderly users and caregivers in the process, brainstorming ensures that the research question is answered in a way that addresses the specific needs and challenges of the target population.

c) Brainstorming Session

A total of two rounds of brainstorming were conducted in this project, each corresponding to a specific theme. Each phase had a distinct meeting theme that aligned

with a particular thematic task in order to achieve the research objectives. The implementation of the brainstorming sessions consisted two phases.

Phase 1: Identifying important keywords for the design of furniture that is suitable for ageing individuals in nursing homes.

Phase 2: Identifying design keywords and functional hierarchy models for age-friendly multifunctional beds.

d) Conference Organization and Implementation

Participants and Research Parameter. The theme for the brainstorming session was determined and formulated based on the pre-existing documentation, interviews, and questionnaire surveys and analyses conducted in this study. The theme was further refined to ensure its suitability for the practical application of age-friendly furniture design in nursing homes. In light of the characteristics pertaining to the topic of discussion, the specific members, role design, and behavioral activities can be found in table 3.3.

Table 3.3: Behavioural Analysis Table for Brainstorming Methods

Participant	Number of participant	Research parameter
Research	1	Interpretation of the theme, decomposition of the objectives of the meeting, regulating the atmosphere of the meeting, controlling the pace of the meeting, regulating the discipline of the meeting, encouraging the members of the meeting.
Participants	10	Come up with ideas
Research secretariat	1	Organize and summarize meeting ideas

Meeting Program Process and Framework. From February, 2023 to March 5, 2023, a total of two rounds of experimentation were conducted (Figure 3.11). It was deemed inappropriate to have the same group of experimental participants engage in repeated experiments within a short period of time, as this may lead to creative stagnation and resistance. Consequently, the researcher scheduled the specific timing for each experiment, ensuring that the same group of experimenters would not partake in the experiment more than once within a two-day period.



Figure 3.11: Brainstorming Session Implementation

The entire meeting was divided into three primary phases (Figure 3.12). The initial phase involved preparation, whereby the organizer was responsible for coordinating conference attendees and gathering all necessary materials for the conference activities. For participants who were unfamiliar with the methodology, an introduction to the meeting method was provided, along with an opportunity for participants to acquaint themselves with the meeting's topic and materials. This process typically lasted around 15 minutes. Subsequently, the action phase commenced. During this phase, the researcher presented pre-prepared warm-up topics and distributed materials relevant to the meeting. This phase lasted approximately 40 minutes. Once it was established that participants had familiarized themselves with the relevant rules, role intelligence, and topic materials, the researcher officially commenced the meeting. At the same time, the organizer documented the meeting process through photography and audio recording. Lastly, there was a post-conference stage during which participants could review ideas, engage in free discussion, and appropriately record the outcomes. Furthermore, 3-5 expert members were invited to organize and evaluate the results of the creative stimulation, while the organizer provided a suitable summary of the meeting.

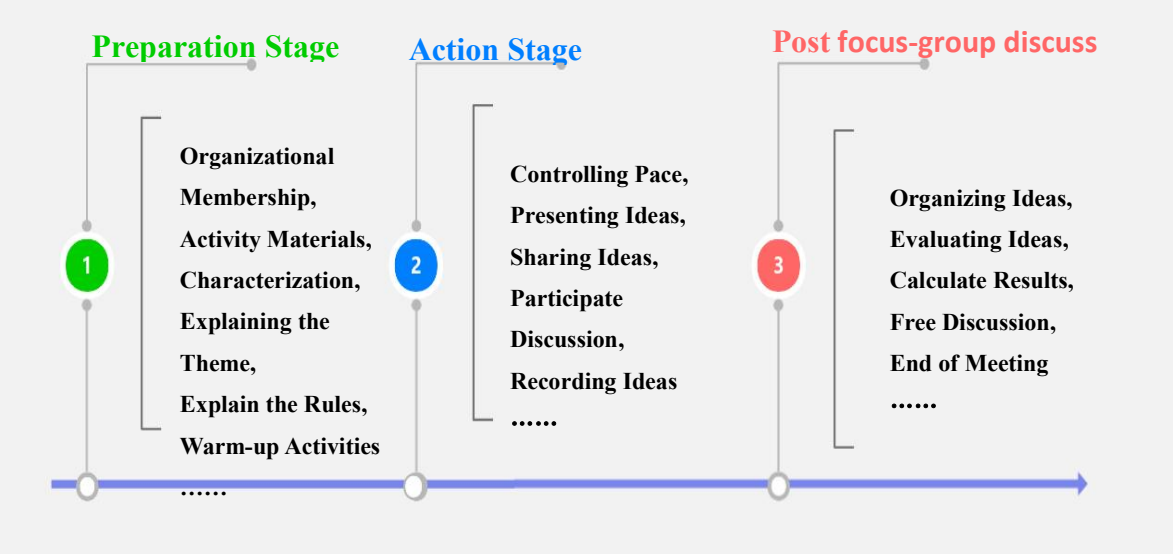


Figure 3.12: Brainstorming Session Implementation and Process Framework

e) Methodology for Analysing the Results of the Meeting

The results of the brainstorming session were analysed using two approaches: session outcome data and participant experience feedback. The effectiveness of this practical implementation was assessed on two levels: design keywords, creative ideas, and quality. Specifically, the quantity of creative ideas was quantified as the number of effective ideas generated by each group throughout the entire process, while the quality of creative ideas was measured by the attainment of a final consensus solution or opinion.

The data was systematically organized by categorizing participants' experiences and feedback. The first step involved identifying the challenges associated with designing furniture suitable for nursing homes to accommodate ageing individuals. Subsequently, potential solutions were then explored in small groups, with an open-minded approach that embraced all ideas. During this phase, we conducted a statistical analysis to separate the generation of ideas from the subsequent discussions. In the third stage of the organizational meeting, we proceeded to define the design strategy and practice by employing mind mapping as a technical tool. Each team member was encouraged to individually jot down their design ideas for age-friendly furniture in nursing homes. Mind mapping was employed to commence with the theme of age-friendly furniture design, considering the physiological and behavioral characteristics of the elderly. Lines were drawn from the centre, with headings representing categories and important facts, and further breakdowns were made to develop each detail.

3.4.5 Design Practice

Design practice is a significant form of scientific inquiry. It is founded upon existing scientific theories and the practical requirements of the field. Based on the user

data obtained from preliminary research, the user group is selected as the primary focus of the design practice, and a design program is proposed. This section aims to develop a specific design practice for the design of age-friendly furniture for nursing homes based on the physiological and behavioral characteristics of the elderly, in order to address the research question “Research on the Design Thinking of China Nursing Home age-friendly Furniture.” The study begins by outlining the overall stages of the practical framework, followed by a detailed examination of the contents and key aspects of each stage. Ultimately, the design thinking and findings are validated through a case study involving the design of a multifunctional bed for the elderly in a nursing home.

a) Design Practice as an Academic Approach

Design practice serves as a bridge connecting theory and practice, emphasizing the verification of design concepts through actual operation and experiments. In the design of age-friendly furniture, design practice is particularly important because the physiological and psychological needs, as well as the daily habits of the elderly, are unique. It is essential to continually optimize and improve design solutions through practical design practice to meet the actual needs of the elderly. Design practice generates new knowledge through the artefacts created. In the case of an age-friendly multifunctional bed, elderly users’ needs are central to defining the design parameters. This study used design practice to create prototypes, test them with elderly participants, and refine the designs based on user feedback.

Prototyping and creating tangible outputs allows for the generation of “design propositionsthat” contribute to both design practical development and academic knowledge accumulation. Using a design practice approach, researchers would engage in iterative

prototyping. Sanders and Stappers (2014) highlight the importance of engaging users directly in design research, which allows researchers to gather qualitative data on usability, comfort, and safety. In the case of elderly individuals, Conducting usability tests with elderly users to observe their experience,their feedback would directly inform adjustments to the design. In addition, age-friendly multifunctional beds are designed to address several critical needs.

i. Mobility. Beds designed for elderly users often include adjustable heights and mechanisms to assist with sitting up or getting out of bed.
ii. Safety. Anti-slip materials, ergonomic support, and side rails enhance safety, particularly for individuals with limited mobility or balance issues. Some models also have built-in emergency call buttons or sensors that can alert caregivers or emergency services in case of need.
iii. Comfort. Features like customizable mattress settings and temperature controls help maintain comfort for extended use, especially for users with conditions like arthritis or chronic pain.
iv. Multi-functionality. These beds are equipped with additional features such as integrated lighting, massage functions, or mechanisms to help with daily tasks, such as adjusting positions or reaching nearby objects.
v. Easy Access and Maintenance. The design of these beds prioritizes accessibility and ease of use for both the user and caregivers. Some beds can even be disassembled or folded for easier transportation and storage.
vi. Integrated Health Monitoring. Age-friendly multifunctional beds incorporate health monitoring technology, such as sensors that track vital signs like heart rate, respiratory rate, and sleep patterns.

The credibility of these studies lies in their structured use of design practice as a research method. By documenting the design process, gathering empirical data through user testing, and reflecting critically on the outcomes, the researchers demonstrated how design practice can produce valuable academic contributions. In summary, age-friendly multifunctional beds are designed to address the critical needs of older adults by providing safe, comfortable, and accessible sleeping solutions that enhance their quality of life and promote independence.

b) Using Design Practice Approach Archive RO4 and Answer RQ4

Design practice as a research approach offers a distinctive pathway for achieving research objectives and answering research questions by combining creativity, user-centred design, and iterative problem-solving. The fourth objective of this study is to verify the feasibility and effectiveness of the proposed research questions and objectives through design practice, and to provide basic samples for the extension of the design of age-friendly furniture for nursing homes through the complete design thinking and process. This discussion explores how design practice facilitates the achievement of research objectives and answers research questions by using age-friendly furniture as an example.

The primary objective of research in design practice is to verify the feasibility and effectiveness of the proposed research questions and objectives through design practice, and create solutions that meet specific user needs. In the case of designing age-friendly furniture, to provide basic samples for the extension of the design of age-friendly furniture for nursing homes in the future through the complete design thinking and process. Therefore, The design practice approach is uniquely positioned to meet these objectives by directly involving users throughout the research process, incorporating their feedback, and

continuously refining the designs. Then, answering research questions through design practice. Research questions in design practice focus on identifying and addressing user needs, evaluating the effectiveness of solutions, and understanding the broader impact of design. Through prototyping, user testing, and refinement, design practice generates insights that directly address the research questions while also creating practical solutions.

The design practice approach provides a robust and credible method for achieving research objectives and answering research questions, particularly in the context of age-friendly furniture design. By employing user-centred research, iterative prototyping, interdisciplinary collaboration, and real-world testing, design practice ensures that the developed solutions are practical, functional, and aligned with the needs of elderly users. The design practice approach achieves the research objective of designing age-friendly furniture, and answer research questions through the tangible outcomes of their design work.

c) Design Process for Multifunctional Adaptive Beds

The design of age-friendly furniture for nursing homes is a complex undertaking. In order to construct the framework for design practice, this study takes into account the fundamental physiological and behavioral traits of the elderly, as well as the overall furniture design process. This study adopts a systems science perspective, integrates existing theoretical and practical knowledge, and explores the interrelationships and steps in the design practice of age-friendly furniture in nursing homes. Drawing on survey data and analysis, the study identifies the key factors at different stages of the design practice process, and proposes design principles and methods based on these findings. The research conclusions are subsequently validated through actual design cases.

The practice of designing furniture suitable for ageing individuals in nursing homes can be divided into five distinct stages. These stages are as follows: “Stage 1: Empathize, Needs Assessment Stage,” “Stage 2: Define, Problem Statement and Design Positioning Stage,” “Stage 3: Ideate, Design Conceptualization Stage,” “Stage 4: Prototype and Mock-ups Production Stage,” and “Stage 5: Test, Product Testing and Application & Design Validation Stage.” The validation phase of the design process is also included, and the main contents of these stages are summarized in table 3.4. Each stage is further divided into sub-phases based on the specific tasks involved. In Chapter5, the work content and methodology of each stage will be thoroughly examined.

Table 3.4: Design Practices: Design Thinking for Multifunctional Adaptive Beds

Content factors	Summary of contents
Empathize	● Focus on the physiological and behavioural characteristics of the elderly; ● Insight into the problem feedback and design requirements of elderly nursing home users for existing beds. ● Conducting design needs assessment, intention gathering and feasibility insights for multi-functional ageing beds; ● Face-to-face communication to change designers' problematic cognitive bias.
Define	● Design problem statement for age-friendly beds based on user understanding; ● Design orientation based on research findings on the needs of the elderly population; ● Translation of the problem statement and design objectives : we should (how to design) do (what to design) for (who to design) to achieve (what design objectives).

Table 3.4 continued

Ideate	● Design conception: find design opportunities, complete feasibility analysis and preliminary design; ● Design deepening: the specific conception of the program, the deepening of the design details and the expression of the effect.
Prototype	● Scale model in design format ● Prototype
Test and Implementation	● Rigorous testing of the product with the results and solutions found during the prototyping phase; ● More extensive testing to gain a deeper understanding of the product and its users; ● Implementation: acceptance and delivery → post-use evaluation → maintenance and support → validation of the applicability of research results.

3.5 Chapter Summary

Based on the research review, this study provides a guiding exploration for the design of age-friendly furniture in nursing homes in China. It encompasses the processes of data collection, design practice, and validation. This study adopts literature research method and aims to comprehensively analyse the fundamental theories and established research findings on age-friendly furniture design and related disciplines both domestically and internationally. This helps establish a solid foundation and expand the research ideas for this topic. The questionnaire survey method is mainly used to collect a substantial amount of information and data about the living conditions, physiological and behavioral characteristics of the elderly in nursing homes. In addition to assessing their satisfaction with and design needs for existing furniture in nursing homes, the results highlight the widespread dissatisfaction among the elderly with the current furniture. This further

emphasizes the necessity to enhance the design of furniture for the elderly in nursing homes. The main objective of the interview method is to identify the difficulties and challenges faced by elderly individuals in nursing homes while using furniture, as well as to gather their suggestions for improving the design of age-friendly furniture. Through the sharing of specific design practice cases by relevant scholars, experts, and designers, relevant design suggestions and methods are proposed. The brainstorming method is primarily utilized to identify the keywords of age-friendly furniture design in nursing homes and to discover more innovative ideas and strategies regarding creative solutions for age-friendly furniture design. Finally, by analyzing the current situation of age-friendly furniture design in nursing homes, a case study is conducted on the age-friendly design of multifunctional beds in nursing homes. The researcher summarize the key factors involved in different stages of the design practice process in order to obtain first-hand information on the design of age-friendly furniture in nursing homes. Furthermore, we put forth the pertinent design principles and strategies to provide more targeted guidance to service agencies to carry out the age-friendly product design-related practice.

This study adheres to the academic concept and research methodology of interdisciplinary research and multidimensionally integrates issues emerging in the interdisciplinary fields. The research is divided into two aspects: the investigation of the physiological and behavioral characteristics of the research subjects and the examination of the construction and usage of furniture utilized by the elderly in nursing homes in China. Based on these investigations, solution strategies are proposed and the design of related furniture products is finally completed.

CHAPTER 4

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter serves as the fundamental basis for the entire research conducted in this study. Initially, a substantial amount of information and data pertaining to the quantity of publications, research institutions, research highlights , as well as the developmental and evolutionary paths within the realm of ageing furniture design over the past decade, both domestically and internationally, were gathered, visualized, and analysed through the utilization of the Cite Space software. This process subsequently guided the overall progression of this research endeavour. Subsequently, a large amount of data on the basic personal situation, living conditions and reality of the elderly in different nursing homes across the country were collected through various methods such as questionnaires, observations, and interviews. The acquired data was then subjected to meticulous statistical analysis on a category-by-category basis, enabling a comprehensive understanding of the evolving patterns of daily living habits, behavioral capabilities, and physical functions of elderly individuals within China nursing homes. Consequently, the physiological, psychological, and behavioral traits of the elderly were synthesized.

The researcher believes that the investigation of the design elements, principles and methods of age-friendly furniture in nursing homes is predicated upon an investigation and analysis of the current state of the living environment for elderly individuals within nursing homes, their perception of and contentment with the existing furniture, as well as the design requirements of elderly users. To substantiate this hypothesis, this project examines

the direct interaction between the behavior of elderly individuals within nursing homes and furniture through the implementation of questionnaire 3 and interview surveys.

The methods of data collection and analysis within the research activities detailed in this chapter have been extensively deliberated upon in Chapter 3. Principally, the analysis is focused on scrutinizing survey data derived from literature, questionnaires, interviews, brainstorming sessions, and other relevant endeavours. All research methodologies proposed within this study, as well as the gathered survey data, are aimed at acquiring both qualitative and quantitative data. In order to ensure the accuracy and validity of the research data, various tools such as Cite Space, SPSS27, Nvivo12, and Microsoft Excel were employed to conduct data analysis. The research data were verified through descriptive analysis, response rate and prevalence analysis, and reliability and validity tests, which laid a solid foundation for comprehensive research and analysis of this study in terms of design principles, methodologies, and practical applications of age-friendly furniture within China nursing homes.

4.2 Data Analysis of Literature Review

The analysis of literature review of this study is to utilize the Cite Space software for the visual representation and analysis of the quantity of articles, research institutions, research highlights, and developmental pathways in the realm of furniture design for the elderly, both domestically and internationally, over the past decade. By examining the development of furniture design that accommodates the needs of ageing individuals, conducting a current situation analysis, and identifying emerging trends, we aim to gather, assess, and summarize the data pertaining to the research and development of such furniture designs, both at home and abroad. Through the visual analysis and categorization

of the research trends in this field, both domestically and internationally, it is our objective to identify commonalities and differences among various studies. Concurrently, we will conduct a comparative analysis of the shortcomings and developmental directions within China's research on age-friendly furniture design. Furthermore, we will employ the literature research method to explore a theoretical framework for the design of age-friendly furniture that aligns with the physiological and behavioral characteristics of elderly individuals residing in nursing homes within China.

4.2.1 Analysis of the Volume and Areas of Publications

a) Analysis of the Number of Publications and Research Areas of Age-friendly Furniture from China Journal Database

In this study, the Chinese CNKI journal database was employed as the exploration platform, and the chosen keywords were "age-friendly furniture," "elderly care facilities," and "nursing home furniture design" respectively. The examination spanned a decade and encompassed over 3,000 articles for the purpose of sample analysis. By visualizing the temporal trend of the number of published articles and the distribution of fields in China during distinct periods (Figure 4.1), it becomes evident that the inception of China's age-friendly furniture design occurred relatively late. Prior to 2014, it was essentially in a dormant state, and subsequently exhibited a period of stagnant growth from 2015 to 2021. In 2021, a minor decline was observed, followed by a discernible upward trend in 2023. This trend can be attributed to China's State Council General Office, which initiated the promotion of enhancing the elderly service system in 2016. This signifies that the initial development of age-friendly design primarily catered to the senior care market, gradually garnering attention.

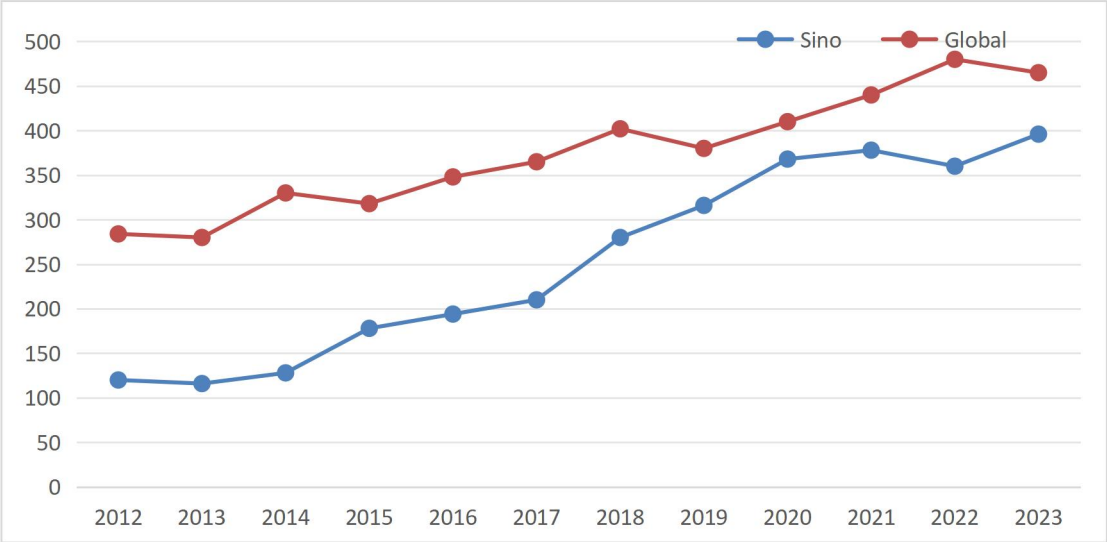


Figure 4.1: Annual Trend of the Number of Literature on Age-friendly at China and Abroad

According to Figure 4.2, the distribution map depicting the fields involved in the study of ageing furniture, the most substantial proportion of articles is contributed by the light industry handicrafts and construction engineering fields, accounting for 64.65% and occupying a clearly dominant position. This observation also reflects the relatively unidimensional progression of the ageing furniture industry, lacking interdisciplinary integration and interconnection.

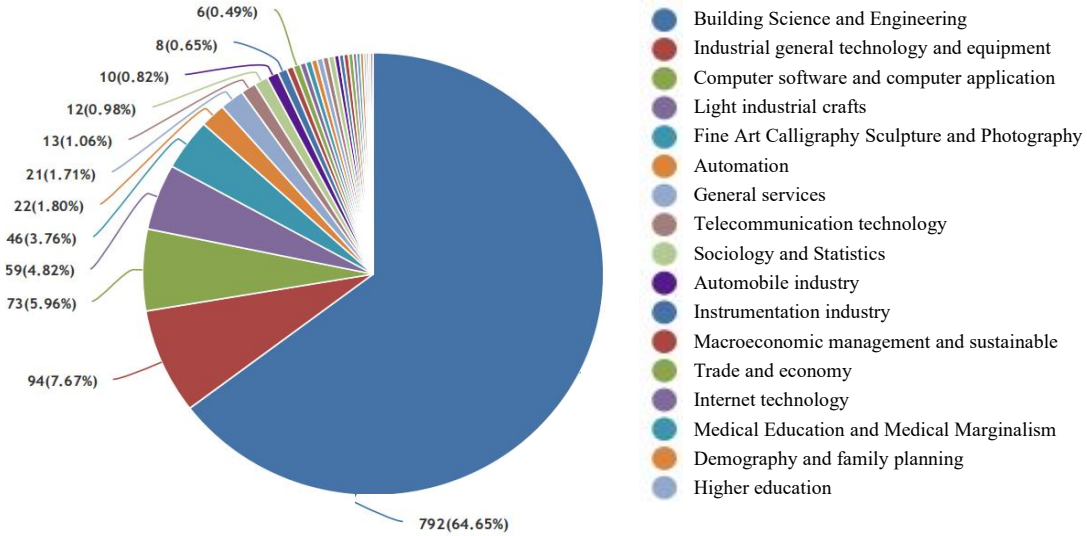


Figure 4.2: Distribution of Relevant Fields of China Age-friendly Design

b) Analysis of International Publications and Research Areas on Age-friendly Furniture

Using the WOS database as the search platform, the designated search terms were "age-friendly design," "age-friendly furniture design," "elderly facility design," and "nursing home furniture design." Additionally, "aged-care facility design" and "aged-care home furniture design" were included. By employing the screening method of "highly cited papers," an approximate total of 5,000 articles were acquired within the specified search time-frame. The number of papers available for sample analysis is nearly 5,000. By visualizing the trend of paper output and the distribution of fields over different time periods, it is apparent that the relevant literature exhibits a gradual growth pattern from 2012 to 2019. However, in 2019, a slight decline is observed, followed by a subsequent increase starting from 2020. Compared with Chinese literature, the number of publications in the international age-friendly design literature was even greater-during the same period.

Furthermore, this international literature demonstrates a minor fluctuation and consistent growth trend, indicating an earlier initiation of foreign research and an overall stage of maturity in development. Figure 4.3 illustrates the distribution of fields involved in the examination of age-friendly furniture. Within this analysis, Geriatrics Gerontology accounted for 10.92% of the total literature, while health care sciences services accounted for 8.5%. Subsequently, behavioral, demography, psychology, physiological, and other disciplines were included. It is worth noting that individual articles often align with multiple disciplines, thereby highlighting the intersectionality and multidisciplinary nature of foreign research on ageing-related studies.

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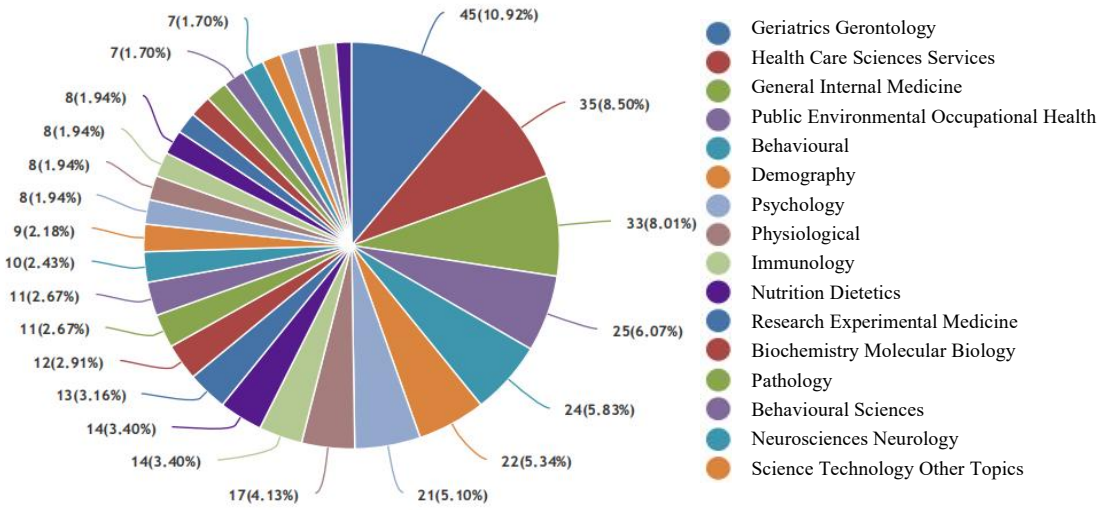


Figure 4.3: Distribution of Relevant Fields of International Age-friendly Design

4.2.2 Research Highlights and Keyword Cluster Analysis

a) Cluster Analysis of Research Highlights and Keywords in China

Based on the CiteSpace software, the processed sample documents from the CNKI journal database are utilized, with keywords serving as nodes, to obtain the co-occurrence mapping of China's keywords to age-friendly design research furniture (Figure4.4). The analysis is conducted on keywords and themes such as "age-friendly" "elderly flats" "furniture for the elderly" "elderly care institutions" "medical and nursingcare" "elderly care facilities" and "healthcare integration" among others, which are identified as the recent hotspots in China's age-friendly furniture design research. In the keyword co-occurrence mapping, the terms "ageing" "furniture for the elderly" and "medical and nursing integration" prominently emerge and are associated with keywords related to public space, interior design, and elderly facilities. This indicates that environmental space

is the primary domain of ageing research in China, with institutional care and ageing being the focal points of research..

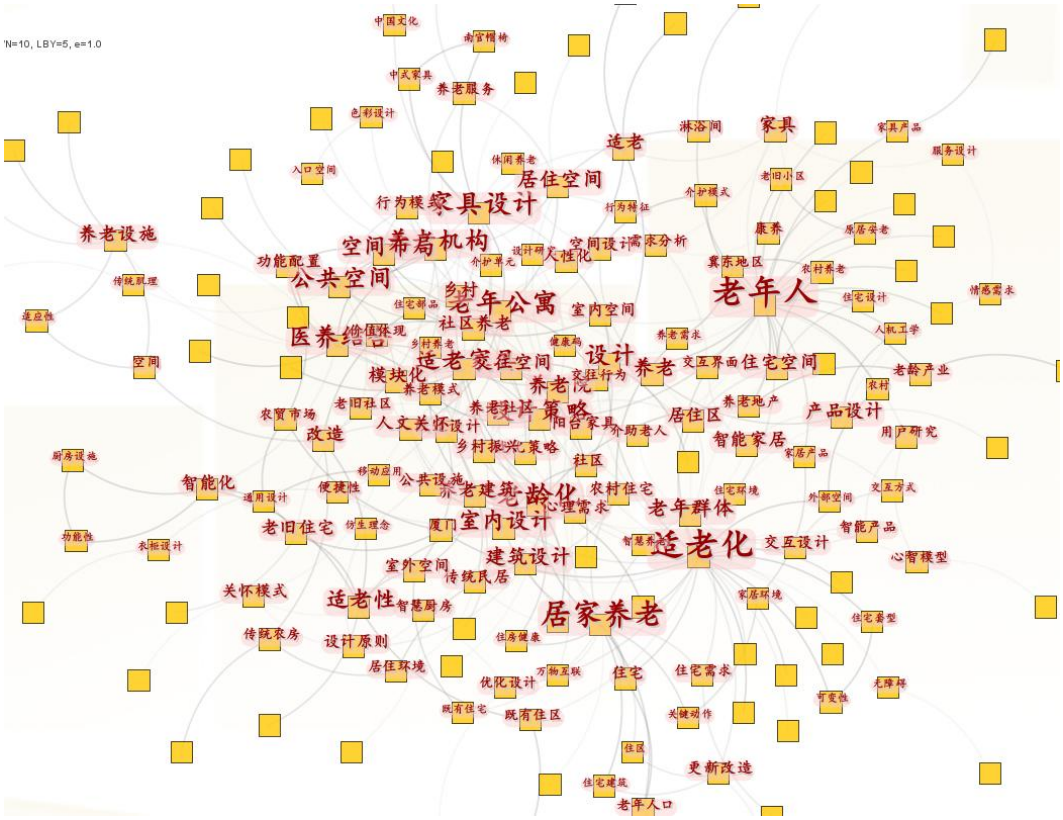


Figure 4.4: Keyword Cluster View of Age-friendly Design Literature in China

The relatively less significant nodes encompass concepts such as “humanisation” “behavioural patterns” “accessibility” “physiological needs” “optimal design” and “design.” Moreover, the relatively minor nodes include “humanisation” “behavioural model” “barrier-free design” “physiological needs” “optimal design," and “service design” which signify a shift in research focus from physical space to the spiritual requirements of the elderly and the service system.

Additionally, terms such as “empathic design” “intelligent design” and “interactive interface” within the clusters suggest a close integration between the field of age-friendly design and technological advancements as well as contemporary developments.

b) Cluster Analysis of Research Highlights and Keywords in International

The keywords of the English sample literature were processed using CiteSpace software to obtain the international keyword co-occurrence mapping for age-friendly furniture design (Figure 4.5). The keywords encompassed terms such as “anthropometry” “health” “physical activity” “physiology” “performance” and “health care”. Moreover, terms like “prevention” “falls” and “embedded system” among others, emerged as key elements in the international realm of age-friendly furniture design throughout the previous decade.

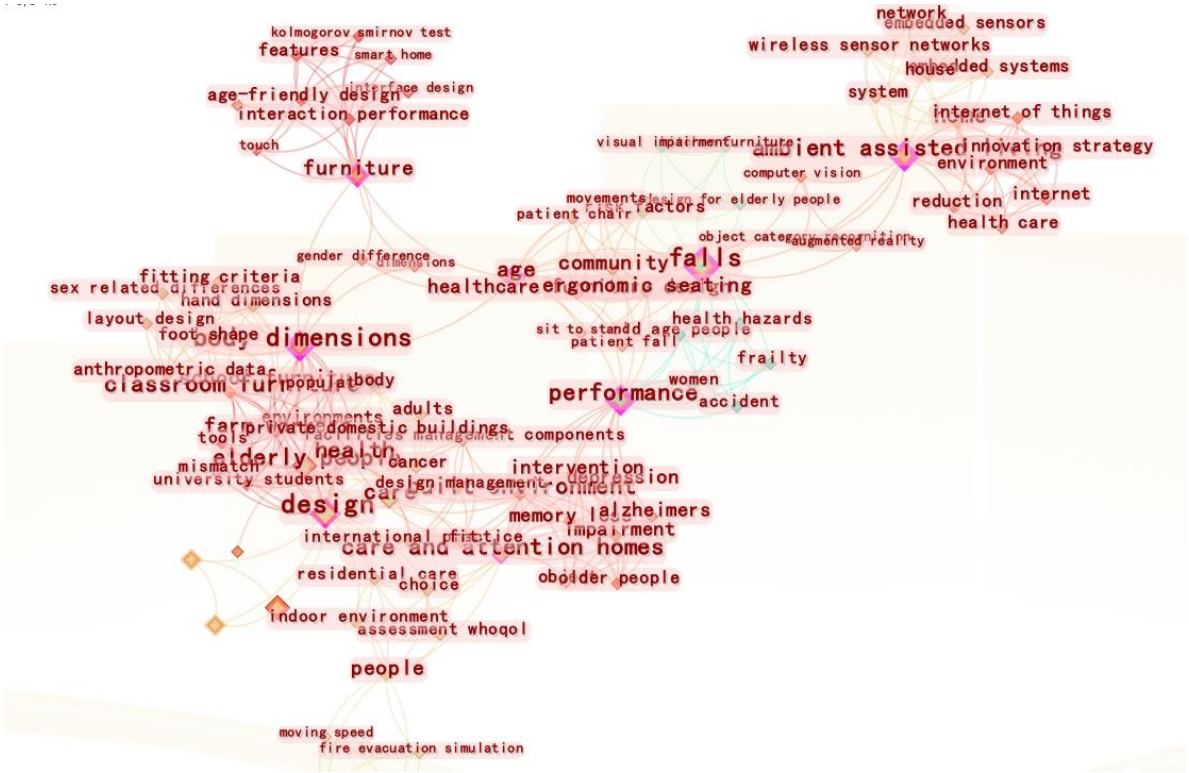


Figure 4.5: Keyword Cluster View of Ageing-friendly Design Literature in International

From this, it is possible to deduce that, within the field of ageing research conducted abroad, the healthcare of elderly individuals holds significant importance. As such, the main areas of research revolve around the health status and quality of life of the

elderly population, as well as risk intervention and assessment. Furthermore, factors like gender differences, characteristics, and the concept of “Intelligent” alongside other related terms, serve to emphasize the design considerations tailored to the needs of the elderly, encompassing their cognitive frailty and psychometric properties. Finally, the presence of keywords such as “environment” further reinforces the significance of foreign investigations into the physical and mental well-being, as well as the living conditions, of the elderly (Zhang et al.,2021).

4.2.3 Analysing the Development of Research on Age-friendly Furniture Design

a) Evolutionary Path analysis of Age-friendly Furniture Research in China

Further utilizing the Cited Reference functionality within Cite Space, a timeline perspective on the co-occurrence of keywords in the realm of age-friendly furniture design in China can be derived for the years spanning 2012 to 2023 (Figure 4.6). This approach allows for an examination of the research themes and evolutionary progression of age-friendly furniture design over distinct time periods.

Through the utilization of keyword clustering and temporal zoning, it becomes apparent that the primary focal points within national geriatric furniture research have shifted since 2012. Initially, there was an emphasis on elderly body scale, visual sensory aspects, functional seating, emotional care, and psychological needs. However, a discernible transition can be observed, whereby the focus has shifted from material scale requirements towards the construction of spiritual and emotional connotations.

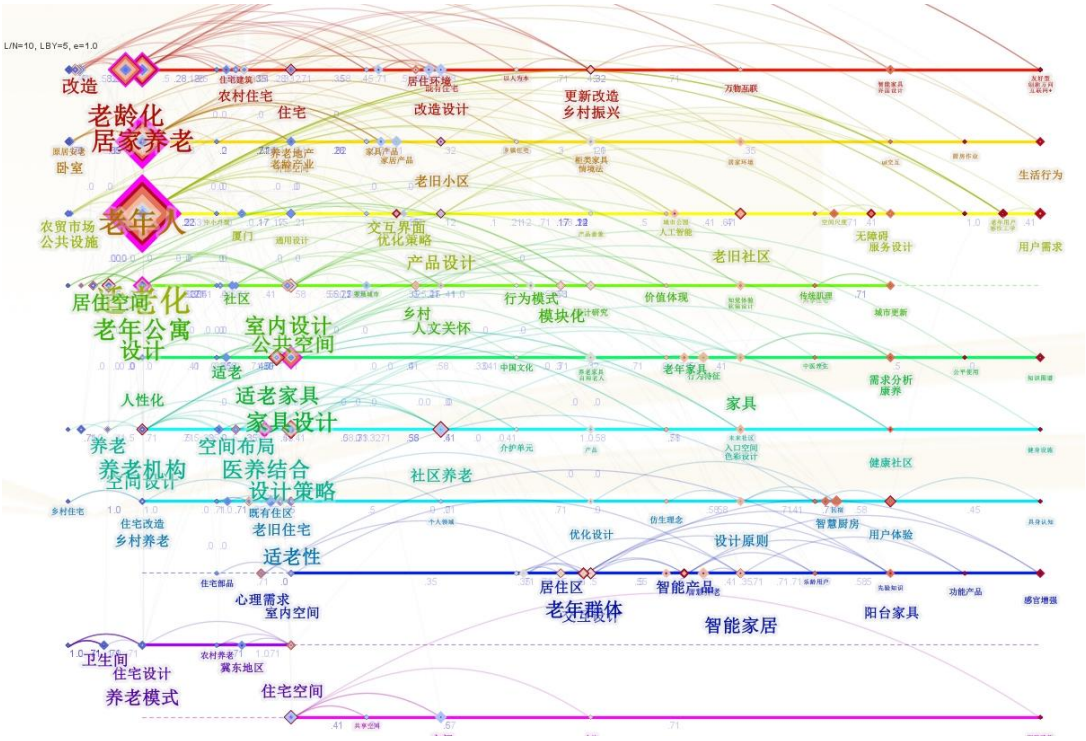


Figure 4.6: Timeline View of Aging-friendly Furniture Research in China

This transition has been occurring during the exploratory growth phase, which spanned from 2014 to 2019. During this phase, researchers began directing their attention towards the elderly population, with a specific focus on the design of furniture catering to their needs. Consequently, there has been a significant increase in the quantity of literature pertaining to age-friendly furniture or elderly furniture as the main subject of research. Furthermore, people are paying more and more attention to universal design, inclusive design, multi-dimensional perception, emotional design, and the application of these theories within the realm of elderly furniture. Additionally, researchers have expanded their investigation beyond the functional aspects of furniture to encompass the physiological, psychological, and emotional needs of the elderly.

Moving forward from 2020, there will be a shift towards exploring behavioral models, modularization, intelligence, and interaction design within the field of age-friendly

furniture. This will be accompanied by an emphasis on the scientific empiricism and interdisciplinary nature of research, as well as a promotion of respect for the values cherished by the elderly population.

b) Evolutionary Path Analysis of Age-friendly Furniture Research in International

This analysis is based on a time zone mapping achieved through keyword clustering of relevant literature published between 2012 and 2023 (Figure 4.7). The examination reveals that the exploration of age-friendly furniture on an international scale commenced earlier, and subsequently, research in the domain of age-friendly furniture design has progressed in a systematic manner. Notably, this research places a greater emphasis on humanization and intelligence, consequently highlighting the imperative need for the fusion of technology and design.

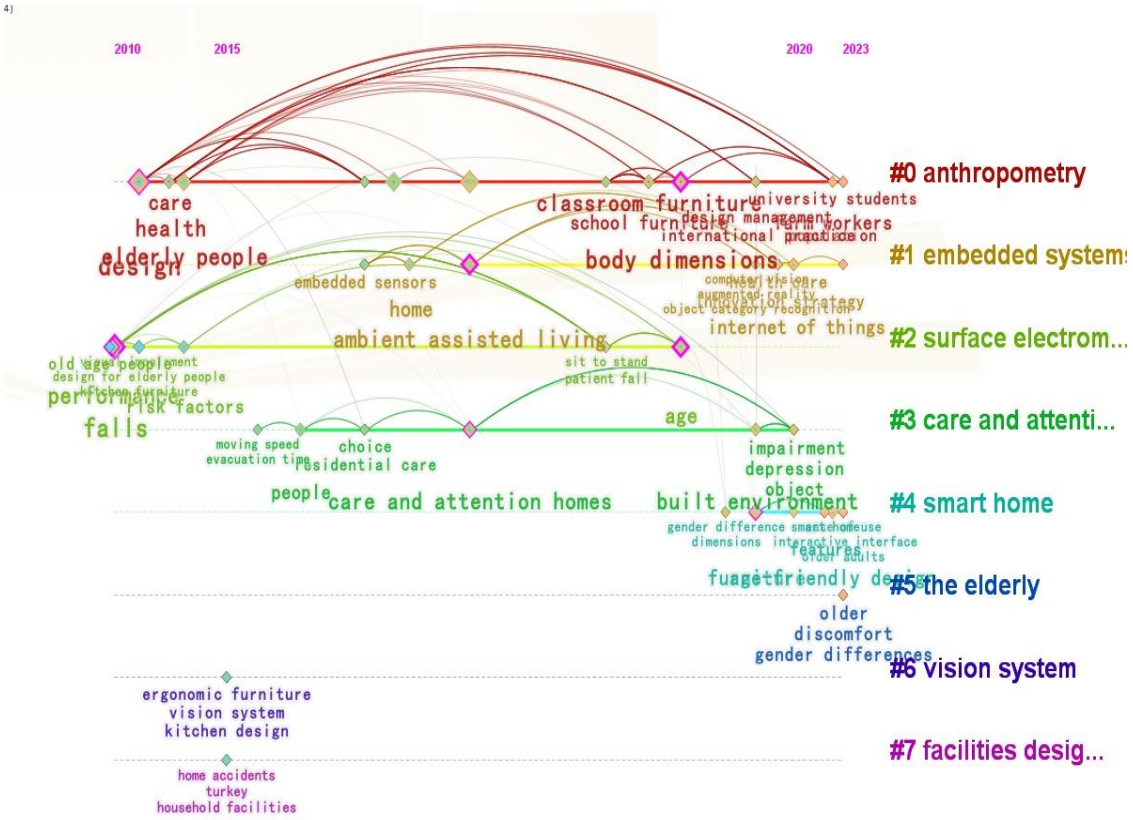


Figure 4.7: Timeline View of International Research on Ageing-friendly Furniture

The period between 2012 and 2016 witnessed the advent of a research stage centred on human-centred design of furniture for the elderly. During this phase, the primary focus revolved around the development of furniture endowed with unique functionalities and features, designed to cater to the diminishing physical abilities of the elderly.

Subsequently, from 2017 to 2020, the research trajectory shifted towards the design of multifunctional assisted furniture for the elderly. International researchers during this period embarked upon a comprehensive investigation that encompassed ergonomics, modern technology, medical experimentation, and other relevant studies, all aimed at enhancing the accessibility and usability of furniture.

Since 2021 and continuing until the present, the focus has shifted towards the systematic exploration of an age-friendly home intelligence system. Through technological innovation, this research aims to facilitate greater convenience and intelligent assistance for the elderly, thereby enhancing their overall health experience.

4.2.4 Summary of Literature Review

In summary, both domestic and international research on furniture design for the elderly have distinct focuses. The collaboration between international institutions, universities, and medical institutions allows for a more precise prediction of the physical function and risk assessment of the elderly, resulting in a substantial amount of experimental data to support the research on furniture design for the elderly in academic settings. China's research in this area started later than international research, but it places emphasis on humanistic care by considering the specific needs of the elderly population. However, China's research lacks cross-disciplinary exchanges and cooperation among

institutions, as well as the necessary data support from relevant experimental demonstrations, resulting in relatively limited research content. In contrast, China's research on age-friendly furniture design is relatively homogenous and possesses certain limitations.

The initial phase of this study primarily employs the literature research method to organize domestic and international literature on the physiological and behavioral characteristics of the elderly, the fundamental concepts of age-friendly furniture, and the current issues. This phase establishes the groundwork for a clear definition of age-friendly furniture design and its fundamental features. Moreover, it systematically analyses the existing problems in relevant fields within China. In the second and third stages of the study, the literature research method serves as an exploratory tool. It guides the collection and analysis of data, as well as a categorization and refinement of research questions 2 & 3. Building upon the survey results and literature, and in combination with preliminary research findings, the design principles and methods are explored. Subsequently, a theoretical analysis is conducted by considering the actual research status and development trends, which further solidifies the research foundation. In the fourth stage of this study, the literature research method is primarily employed to organize the fundamental theories and practical cases in related disciplinary fields. This process provides a basis and reference for the integration and utilization of existing multidisciplinary research results, ultimately supporting the design practice of age-friendly furniture in nursing homes.

In conjunction with the literature research method, China's age-friendly furniture design is categorized into three thematic research directions, representing the current hotspots in this field within China.

In conjunction with the literature research method, China's age-friendly furniture design is categorized into three thematic research directions, representing the current hotspots in this field within China.

i. Research on furniture design for the elderly in the context of specific modes of elderly care focusing on creating an environment that promotes age-friendly experiences. This research primarily targets elderly institutions such as nursing homes, welfare homes, and recreational hospitals, aiming to address the unique physiological and behavioral characteristics exhibited by elderly users. Understanding these characteristics is crucial for developing effective design solutions that cater to the needs of elderly individuals. Consequently, this becomes the primary focus of this research endeavour.

ii. Design research conducted in this field is based on widely accepted theories related to age-friendly design. These theories encompass various design approaches, including intelligent design, barrier-free design, emotional design, ergonomics, and behavioral science. By incorporating these mainstream design theories, the research aims to explore design strategies that can enhance the living experiences of elderly individuals.

iii. The future of furniture design for the elderly lies in the development of experience-based solutions. This involves utilizing modern scientific and technological advancements to adapt furniture designs and transform them into intelligent systems that cater specifically to the needs of elderly individuals. This direction represents the mainstream focus of current research in the field of furniture design for the elderly.

Based on comprehensive data collection, analysis, and review of relevant literature from both domestic and international sources, this study establishes a robust theoretical foundation for the design of age-friendly furniture for China nursing homes. The foundation takes into account the unique physiological and behavioral characteristics of the elderly population in China, providing valuable guidance throughout the entire research process.

4.3 Data Analysis of Questionnaire

A total of 1,200 questionnaires were distributed, of which 1,029 were returned (see Appendix 1 for the original questionnaires). Participants in the survey were not only from cities in the developed coastal provinces of China, but also from key cities in the central and western parts of China and cities in less economically developed regions. The basic details of the geographical distribution of questionnaire respondents in China and the number and proportion of respondents in the major provinces are shown in Figure 4.8.



Figure 4.8: Geographic Distribution and Number of Questionnaire Completors

4.3.1 Analysis of Data from Questionnaire 1: Basic Situation of the Elderly in China Nursing Homes

a) Basic demographic Characteristics of the Questionnaire Sample

The participants of this survey consisted exclusively of individuals of elderly status, surpassing the age of 60, who reside in nursing homes. The total number of respondents amounted to 518 males, which accounts for 50.34 % of the overall participant count, while 511 females constituted 49.66% of the total respondents. Consequently, the male demographic slightly outnumbered the female demographic.

In order to ensure that the survey findings accurately represent various age groups within the older population, the surveyors took care to distribute the questionnaires in a manner that aimed to secure a balanced representation of individuals across different age categories. The outcome of the statistical analysis indicated that 423 individuals, or 41.11% of the sample, belonged to the age range of 60-69 years. Additionally, 310 individuals, or 30.13%, fell into the age bracket of 70-74 years, while 227 individuals, or 22.06%, were aged between 75-79 years. Finally, the remaining 69 individuals, accounting for 6.71%, were 80 years old or older (Figure 4.9).

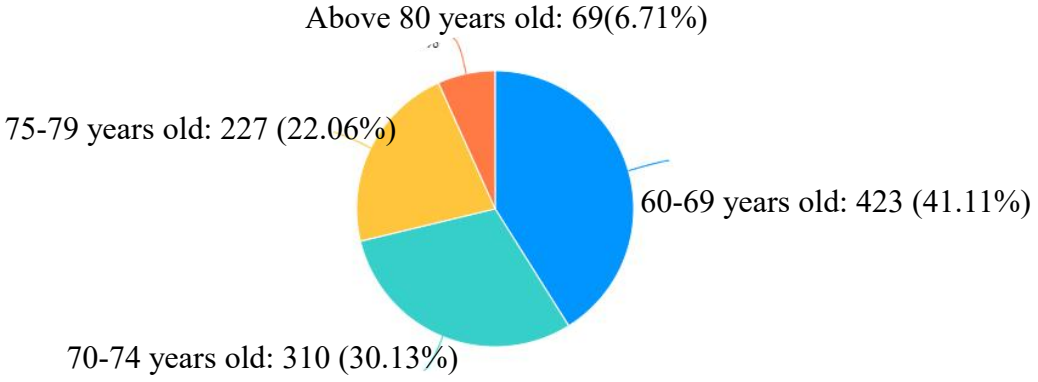


Figure 4.9: Percentage Distribution of the Elderly by Age

The research further revealed that 259 individuals, or 25.17%, had a height that ranged between 156-165cm. Additionally, 429 individuals, or 41.69%, had a height within the range of 166-175cm. Remarkably, this latter group constituted almost half of the total research participants. This observation underscores the significance of the average height of elderly individuals in China and its implications for the development of furniture that caters to the needs of an ageing population, particularly in terms of accommodating the human body's ideal height requirements (Figure 4.10).

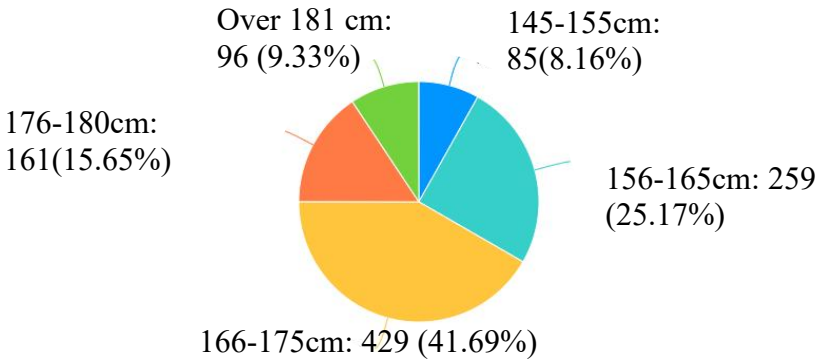


Figure 4.10: Percentage Distribution of Height in the Elderly

b) Classification of Elderly by Educational Distribution, Occupational Background and Economic Characteristics

In order to enhance the inclusivity and purposefulness of the research findings, the distribution of questionnaires was strategically carried out to encompass a wide range of elderly individuals with varying levels of education, occupational backgrounds, and economic incomes. The subsequent comparative analysis of the statistical results is presented in table 4.1, which focuses on the frequency analysis.

Differences in the Distribution of Educational Qualifications. Based on the data derived from the survey results, the elderly participants were categorized into three distinct

groups based on their educational attainment: individuals with primary school education or below, those with middle and high school education, and those with university and postgraduate education. These categories represent individuals with low, average, and high levels of education, respectively. Notably, approximately 85% of the elderly participants in the study had completed primary school education or higher, while only 15% of the study population required assistance in completing the questionnaire. Among this subgroup, the majority had completed education up to high school, accounting for 70.46% of the total sample size, which equates to 725 individuals. Furthermore, more than half of the elderly participants had educational levels corresponding to junior high school or below, constituting 61.81% of the total sample size. Conversely, only 14.09% of the population possessed a university degree or higher.

Diversification of Occupational Backgrounds. The survey results reveal a diverse range of occupational backgrounds among the elderly participants. By analysing the data, it can be observed that approximately 58.21% of the elderly individuals were self-employed businessmen, totalling 599 individuals. Conversely, farmers constituted the smallest proportion, accounting for merely 5.83%, which equates to 60 individuals. Additionally, civil servants, public institutions, those working in public Corporation, and those in private enterprises accounted for 6.8%, 7.48%, 7.87%, and 8.55%, respectively, totalling 316 individuals.

Characteristics of Economic Sources. The questionnaire employed in this study aimed to capture the economic sources of the participants. The survey revealed that the primary source of financial resources for the respondents was personal savings, which accounted for 341 individuals or 33.14% of the total sample size. Meanwhile, income

derived from salary and support Payments from Children were distributed relatively evenly, each accounting for approximately 20% of the total sample size. Personal pensions followed closely behind, with 136 individuals or 13.22%. Lastly, social security payments and other sources constituted a relatively small proportion, both accounting for approximately 6%.

Table 4.1: Frequency Analysis of Educational Qualification, Occupation, Economic Sources and Income

Topic	Category	Frequency	Percentage (%)
Level of Education	Illiterate	159	15.45
	Primary school	239	23.23
	Middle school	238	23.13
	High school	248	24.10
	University	96	9.33
	Postgraduates	49	4.76
Occupation	Civil servant	70	6.80
	Public institutions	77	7.48
	Public Corporation	81	7.87
	Private enterprises	88	8.55
	Self-employed	599	58.21
	Farmer	60	5.83
	Others	54	5.25
Major Source of Income	Pension	136	13.22
	Saving	341	33.14
	Support Payments from Children	209	20.31
	Salary	214	20.80
	Social Security Payment	63	6.12
	Others	66	6.41
Monthly Income Level in Chinese Yuan (¥)	¥1000 and below	51	4.95
	¥1000- ¥2000	306	29.73
	¥2,000- ¥3,000	330	32.06
	¥3,000- ¥5,000	280	27.21
	Above ¥5,000	62	6.07
Total		1029	100.0

Significant Difference in Monthly Income. In terms of the monthly income level of the surveyed individuals, 51 individuals (4.96% of the total sample size) earned ¥1,000 (in Chinese Yuan currency) or less, 306 individuals (29.73% of the total sample size) earned between ¥1,000 and ¥2,000, 330 individuals (32.06% of the total sample size) earned between ¥2,000 and ¥3,000, 280 individuals (27.21% of the total sample size) earned between ¥3,000 and ¥5,000, and 62 individuals (6.07%) earned more than ¥5,000, representing 6.07% of the total sample size.

In relation to their financial circumstances, the older population with middling and lower levels of income (earning less than ¥3,000 on a monthly basis) constituted 66.74% of the sample that was studied, exhibiting fluctuations in the average annual pension in China. Those with middling and higher income levels accounted for 33.28%, thus illustrating the economic attributes of the majority of retired elderly people.

The survey results demonstrate that in this particular questionnaire, the gender distribution is equal between men and women, the age distribution is evenly spread, and the height characteristics are evident. The comparison of the distribution ratios of various degrees of ageing among the elderly in the study sample aligns with the current development of China's ageing society.

Due to unique circumstances, rural communities in China, characterized by their lower economic incomes and traditional belief in raising children to provide for them in old age, predominantly opt to age in their own homes. However, in comparison to individuals from other occupational backgrounds or older individuals living in urban areas, the rural elderly, owing to their higher level of education and relatively stable retirement income, express a desire to pursue physical well-being and engage in recreational activities.

Consequently, they opt for public elderly care institutions or a combination of medical and nursing care. Furthermore, an income disparity exists among individuals with varying levels of education, with the middle-income group constituting more than half of the total surveyed population, causing fluctuations in the average annual retirement salary in China.

4.3.2 Data Analysis of Questionnaire 2: Physiological and Behavioural Characteristics of the Elderlyin China Nursing Homes

a) Analysis of Data from Surveys on the Physical and Psychological Characteristics of Elderly

Physical Health Atatus of the Elderly in Nursing Homes. The majority of the older individuals within the study exhibited a state of well-being classified as "very healthy" totalling 423 individuals, which corresponds to a percentage of 41.11%. Additionally, 32.94% of the participants were observed to possess healthy. Conversely, a mere 21% believed their physical are sub-healthy but controllable. Furthermore, Less than 5% of the remaining respondents considered their physical health to be unhealthy, with 2.24% considering themselves to be very unhealthy (Table 4.2).

Table 4.2: Frequency Analysis of Physical Health Conditions of Elderly in Nursing Homes

Topic	Category	Frequency	Percentage (%)
Physical Health Conditions	Very healthy	423	41.11
	Healthy	339	32.94
	Sub-healthy	218	21.19
	Unhealthy	26	2.53
	Very unhealthy	23	2.24
Total		1029	100.0

Judgement of the Living Situation of the Elderly in Nursing Homes. According to the findings of the survey, the elderly possess their own evaluation regarding their physical state. 49.37% believe they are fully capable of taking care of themselves. Besides, 14.58% believe they can live independently with the help of aids such as crutches and armrests. 15.45% need occasional care from children or other relatives. 15.84% often need care from others. These ratios remain relatively consistent across the three scenarios described above. It is worth noting that only a minute proportion of elderly individuals perceive themselves to be in exceedingly poor health, thus necessitating complete dependence on others for their care (Table 4.3).

Table 4.3: Frequency Analysis of Living Situation of Elderly in Nursing Homes

Topic	Category	Frequency	Percentage (%)
Living Situation	Completely Self-care	508	49.37
	Self-care with the aid of crutches, armrests, etc.	150	14.58
	Occasional need for care by others	159	15.45
	Often needing care from others	163	15.84
	Completely dependent on others for care	49	4.76
Total		1029	100.0

This phenomenon can also be attributed to the historical context of China, a time when the general populace faced concerns regarding basic necessities such as food and clothing, coupled with fatigue from extensive travel. Consequently, it is only natural that individuals experienced varying degrees of illness, thereby requiring assistance from others. Consequently, more than half of the elderly population necessitate a certain level of care from caretakers.

Survey on Physical Problems of Elderly People in Nursing Homes. Figure 4.11 displays that 37.51% of the samples choose based on their eyesight and visual are not good, while 44.90% choose hearing problems with their ears. The distribution of individuals exhibiting disease in their arms and hand accounted for 34.50% of the sample. Furthermore, 18.08% of the sample demonstrated disease in their legs or feet. The percentage of elderly individuals experiencing back pain amounted to 29.74%. Additionally, 30.03% of the participants presented with cervical spine issues, while 28.96% struggled with poor memory and forgetfulness. These statistics comprehensively depict the prevalence of physical problems among the elderly population.

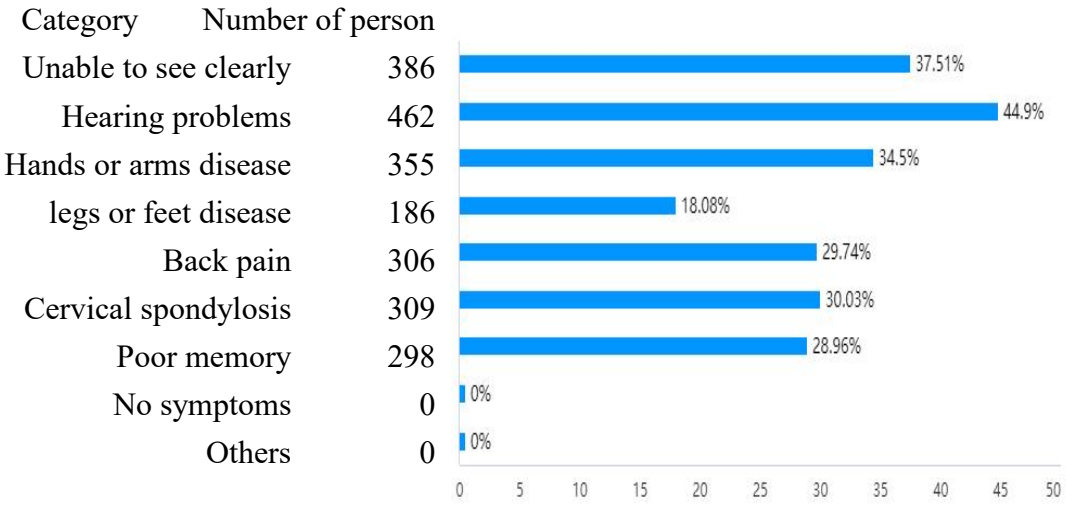


Figure 4.11: Results of Survey on Physical Problems of Elderly in Nursing Homes

The survey data reveals that the elderly population constitutes a distinct group, characterized by the inherent progression of ageing, which in turn leads to a series of physiological and morphological declines. The physical condition survey of the elderly indicates that it is possible to ascertain the most prevalent physiological ailments among different individuals in this age group. Among the surveyed elderly, a significant number

exhibit varying degrees of suboptimal health, primarily concentrated in three common conditions: unable to see clearly, hearing problems, and hands or arms disease.

Survey on the Psychological State of Elderly People in Nursing Homes. It is worth noting that physical changes in the elderly can also induce psychological changes. As evidenced by research findings (Figure 4.12), 38.78% of the elderly population perceive no psychological issues. However, 22.74% of the elderly feel loneliness, 24.98% feel depression, and 23.71% feel disappointment. These data highlight the prevalence of similar conditions among the elderly population in China.

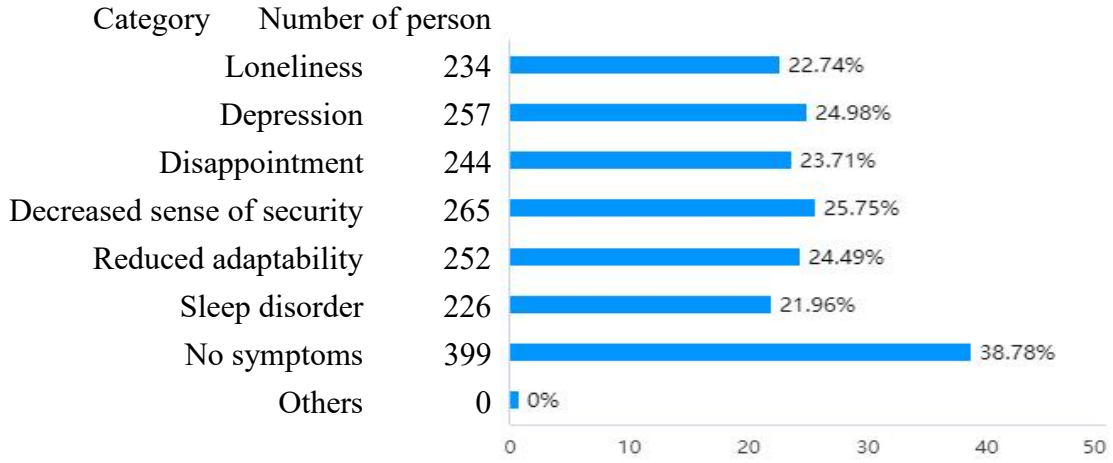


Figure 4.12: Survey on the Psychological State of Elderly in Nursing Homes

b) Analysis of behavioural characteristics survey data

Physical behavioural status of elderly people in nursing homes. Age has a substantial influence on the cognitive capabilities of the elderly, and as they transition into old age, they become more attuned to the consequences of their behavioral actions on themselves. According to figure 4.13, the distribution of the physical behavioral condition of older individuals is evident. The percentage of individuals categorized as having "vulnerable capacity" is 36.05%. Additionally, there are 150 elderly individuals requiring

auxiliary care, accounting for 14.58% of the total. These two data indicate that more than half of the total sample had poor physical behavioral status, which reinforces the need to focus on the behavioral abilities of the elderly when designing for elderly.

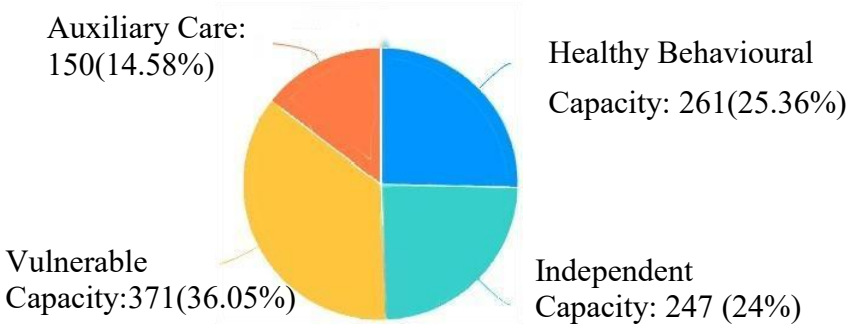


Figure 4.13: Physical Behaviour Survey of the Elderly

Daily Behavioural Activities of Elderly in Nursing Homes. The research data indicates that the majority of elderly individuals engage in reading newspapers and books as their primary daily activities, comprising 50.53% of the total. This is followed by nearly 40% of the elderly who partake in activities such as doing housework and walking. Additionally, approximately 32% of them engaged in activities such as playing their mobile phones, watching television (Figure 4.14). Through the analysis of interviews and questionnaires conducted with the elderly, it becomes evident that recreation and leisure activities hold utmost significance in their daily routines, occupying a substantial portion of their time in nursing homes. However, it is important to note that the specific types of daily activities vary among older individuals with different levels of ageing.

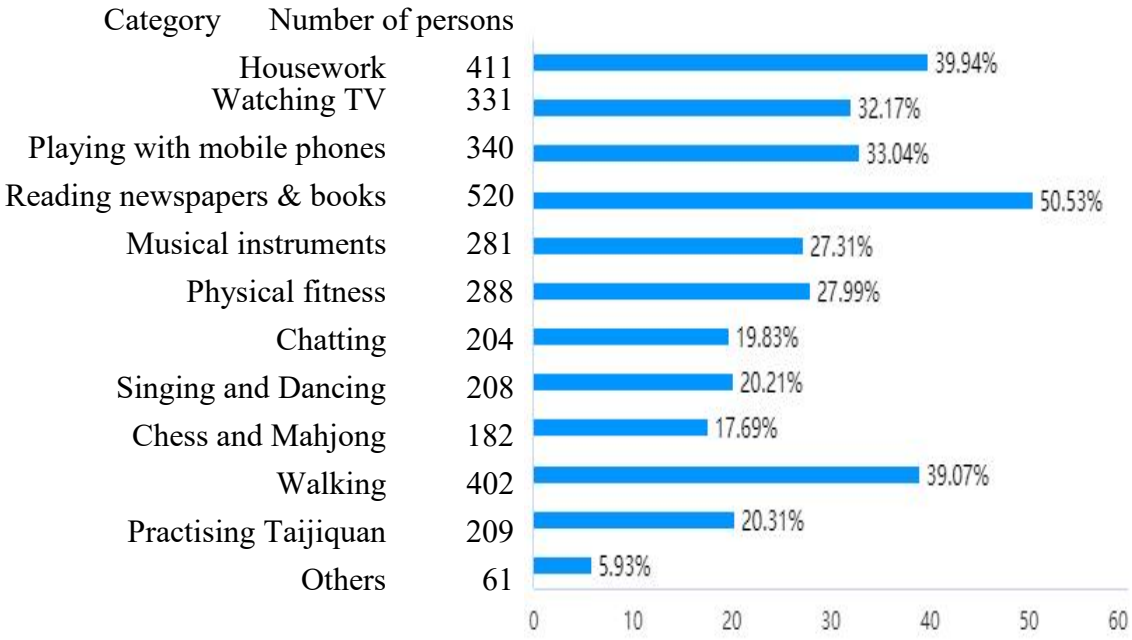


Figure 4.14: Survey of Daily Behavioural Activities of Elderly in Nursing Homes

Venue for Behavioural Accidents in the Daily Lives of Elderly. Based on the findings of the investigation (Figure 4.15), it is evident that the living room continues to serve as the primary location where a significant majority of elderly individuals experience accidents, constituting 55.49% of the overall occurrences. Subsequently, the kitchen, balcony, bathroom, and bedroom emerge as the subsequent most prevalent sites for accidents.

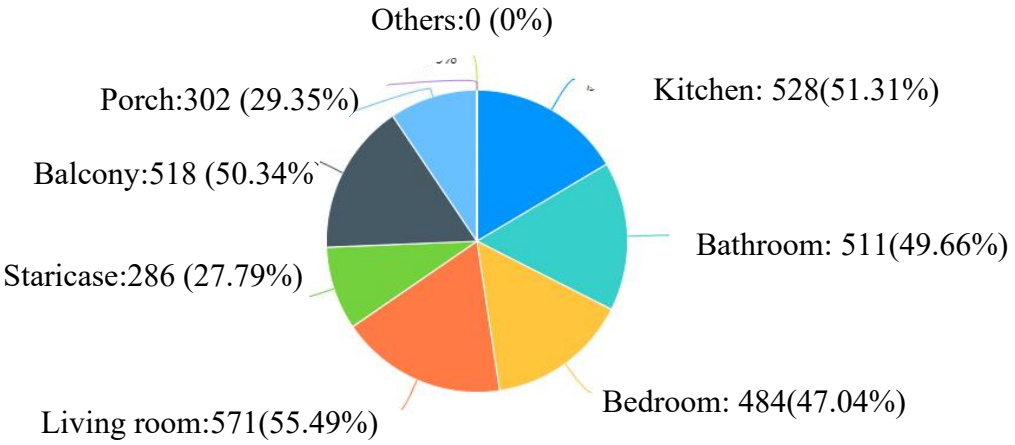


Figure 4.15: A Survey of Venue for Behavioural Accidents in the Daily Lives of Elderly

Behavioural Activity Space Needs of Elderly in Nursing Homes. More than 51% of the individuals surveyed regarding the spatial requirements for behavioral activities of the elderly residing in nursing homes deemed the enhancement of the living room to be of utmost importance to them. The subsequent area of significance was recreational space, accounting for approximately 30%. By examining the data presented in figure 4.16, it can be inferred that the elderly display the highest level of interest in the living room, followed by areas of leisure and recreation, as well as living service spaces. This suggests that the functional necessities of the elderly pertaining to their behavioral activity space are more encompassing.

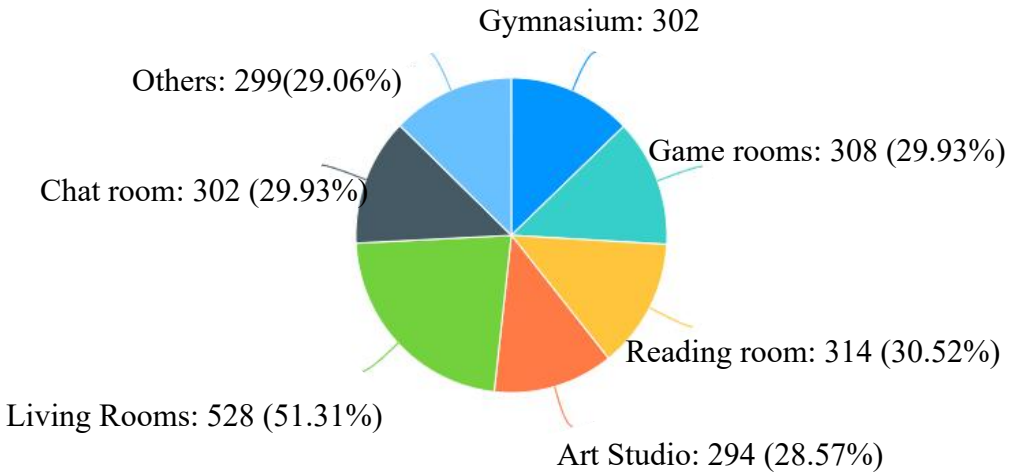


Figure 4.16: Behavioural Activity Space Needs of Elderly in Nursing Homes

c) Multiple Choice Response Rate and Penetration Analysis

The current study utilized the chi-square goodness of fit test for analysis. Based on the results presented in table 4.4 the goodness-of-fit test demonstrates significance (chi=2218.059, p=0.000<0.05), suggesting that there is considerable variability in the proportion of choices for each item. This variability can be further compared through the

use of response rates or prevalence rates. In terms of the specific items “Q4. physical behavior condition” “Q7. physical health condition” “Q10 retirement living plan” and “Q13. communication space” the response rate and prevalence of these four items were notably higher.

Table 4.4: Analysis of Questionnaire 2 Response Rate and Prevalence

Topic	Responsive		Prevalence (n=1029)
	n	Response Rate	
Q1. Living situation	159	10.24%	15.45%
Q2.Sick body parts	23	1.48%	2.24%
Q3.Physical problems	13	0.84%	1.26%
Q4. Physical behavior status	371	23.90%	36.05%
Q5. Major activities in daily life	4	0.26%	0.39%
Q6. Living areas where accidents have occurred	7	0.45%	0.68%
Q7. Physical health condition	423	27.26%	41.11%
Q8.Psychological state	29	1.87%	2.82%
Q9. Aspects of life satisfaction of the elderly	39	2.51%	3.79%
Q10. Retirement living plan	62	3.99%	6.03%
Q11. Reasons for moving into nursing homes	188	12.11%	18.27%
Q12. Indoor spaces where the elderly feel private	38	2.45%	3.69%
Q13. Communication space	17	1.10%	1.65%
Q14.Need most in nursing homes	179	11.53%	17.40%
Aggregation	1552	100%	150.83%
Goodness of fit test: $\chi 2=2218.059$ p=0.000			

d) Validity analysis

Validity pertains to the extent to which the psychological and behavioral characteristics being measured can be accurately gauged by a test or scale instrument, specifically the accuracy and reliability of the test results. This portion of the survey validates the validity using KMO and Bartlett's test. The KMO value is analysed. If this value exceeds 0.8, it implies that it is highly suitable for information extraction. If the value falls between 0.7 and 0.8, it signifies that it is moderately suitable for information extraction. If the value lies between 0.6 and 0.7, it means that information extraction is feasible. If the value is less than 0.6, it indicates that information extraction is challenging. Generally, the lower the significance level of Bartlett's test of sphericity ($P<0.05$), the more likely there is a meaningful relationship between the original variables. If it is $0.000<0.01$, the data's validity is considered good (Chung et al., 2004; Zhou, 2017).

As illustrated in table 4.5 all the research items have a commonality value greater than 0.4, suggesting that the information of the research items can be effectively extracted. Furthermore, the KMO value is 0.604, which exceeds 0.6, indicating that the data is suitable for extraction. Additionally, the variance explained values of the seven factors are 10.562%, 8.669%, 8.256%, 8.203%, 8.189%, 8.161%, and 7.994%, with the rotated cumulative variance explained being 60.033%, which surpasses 50%. This implies that the information content of the research items can be effectively extracted. Lastly, if the absolute value of the factor loading coefficient exceeds 0.4, it signifies a correspondence between the option and the factor.

Table 4.5: Validity Analysis of Questionnaire 2

Topic	Factor Loading Coefficients							Commonality (common factor variance)
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
Q1. Living situation	0.810	-0.050	0.024	0.007	0.043	0.010	0.047	0.664
Q2.Sick body parts	0.036	-0.066	-0.120	-0.156	0.720	-0.130	0.013	0.580
Q3.Physical problems	0.053	0.115	0.139	0.713	-0.157	-0.057	0.197	0.611
Q4. Physical behavior status	0.807	0.033	-0.033	0.045	-0.026	0.041	-0.048	0.660
Q5. Major activities in daily life	0.004	-0.151	-0.011	0.097	-0.043	0.056	0.862	0.780
Q6. Living areas where accidents have occurred	-0.130	0.519	0.057	0.232	-0.078	-0.105	-0.163	0.387
Q7. Physical health condition	-0.156	-0.336	0.496	0.118	0.033	0.059	-0.168	0.430
Q8.Psychological state	-0.024	0.065	0.214	0.276	0.626	0.299	-0.063	0.612
Q9. Aspects of life satisfaction of the elderly	0.026	-0.101	-0.323	0.556	0.219	-0.070	-0.144	0.498
Q10. Retirement living plan	0.060	0.740	-0.006	-0.078	0.032	0.126	-0.024	0.574
Q11. Reasons for moving into nursing homes	-0.101	-0.040	-0.230	0.152	-0.034	-0.654	0.010	0.517
Q12. Indoor spaces where the elderly feel private	0.040	0.137	0.630	-0.062	-0.000	0.037	0.100	0.433
Q13. Communication space	-0.105	0.061	-0.447	0.003	0.019	0.567	0.200	0.576
Q14.Need most in nursing homes	0.060	-0.306	-0.138	0.231	-0.278	0.411	-0.349	0.537
Eigenroot values (before rotation)	1.405	1.175	1.092	1.081	1.063	1.039	1.005	-
Variance explained % (before rotation)	10.033	8.391	7.801	7.724	7.592	7.418	7.181	-
Cumulative variance explained % (before rotation)	10.033	18.424	26.225	33.949	41.541	48.958	56.139	-
Eigenroot values (after rotation)	1.384	1.106	1.104	1.084	1.074	1.069	1.038	-
Variance explained % (after rotation)	9.889	7.900	7.882	7.741	7.675	7.638	7.414	-
Cumulative variance explained % (after rotation)	9.889	17.790	25.672	33.413	41.088	48.725	56.139	-
KMO value	0.604							-
Bart Spherical Values	216.921							-
df	91							-
p Value	0.000							-

Note: If the numbers in the table are colored: blue indicates that the absolute value of the loading coefficient is greater than 0.4, and red indicates that the degree of commonality (variance of the common factor) is less than 0.4.

4.3.3 Analysis of Data from Questionnaire 3: Furniture for the Elderly in China Nursing Homes

a) Evaluation of the Satisfaction of Elderly with the Furniture in Nursing Homes

This study examines the furniture designed for the elderly residing in nursing homes. It assesses the current utilization of age-friendly furniture in nursing homes by gauging the satisfaction levels of the elderly towards the furniture. The survey Questionnaire 3-1 was administered in the form of a Likert scale questionnaire employing a 5-level scale. To evaluate satisfaction, respondents appraised the design of the nursing home furniture using five levels ranging from “very satisfied” to “very dissatisfied”, scored as 1, 2, 3, 4, 5 respectively. The cumulative score of each respondent’s responses represents the intensity or weakness of their attitude within this scale, indicating different states of satisfaction.

i) Matrix Scale Analysis of Satisfaction Evaluation of Age-friendly Furniture in Nursing Homes

According to the data presented in table 4.6, the percentage of individuals who find the age-friendly furniture to be average or essentially dissatisfying amounts to 14.5%, while the percentage of those who are very unsatisfactory is 7.01 %, resulting in a combined total of 34.56%. The average score for the matrix questions in this survey is 3.79. By comparing the data, it becomes apparent that the satisfaction level of the elderly with the age-friendly furniture in nursing homes fails to meet their ideal expectations.

Table 4.6: Questionnaire 3-1 Satisfaction Rating Matrix

Categories	Very Satisfy	Satisfy	Moderate	Unsatisfactory	Very Unsatisfactory	Average score
Comfort	554 (53.84%)	309 (30.03%)	57 (5.54%)	49 (4.76%)	60 (5.83%)	4.21
Function	309 (30.03%)	282 (27.41%)	272 (26.43%)	77 (7.48%)	89 (8.65%)	3.63
Colour	217 (21.09%)	442 (42.95%)	204 (19.83%)	67 (6.51%)	99 (9.62%)	3.59
Size	403 (39.16%)	205 (19.92%)	255 (24.78%)	99 (9.62%)	67 (6.51%)	3.76
Safety	425 (41.3%)	219 (21.28%)	219 (21.28%)	105 (10.2%)	61 (5.93%)	3.82
solid	234 (22.74%)	381 (37.03%)	248 (24.1%)	68 (6.61%)	98 (9.52%)	3.57
Auxiliary	268 (26.04%)	279 (27.11%)	316 (30.71%)	93 (9.04%)	73 (7.09%)	3.56
Accessibility	424 (41.21%)	439 (42.66%)	51 (4.96%)	56 (5.44%)	59 (5.73%)	4.08
age-friendly	277 (26.92%)	289 (28.09%)	297 (28.86%)	85 (8.26%)	81 (7.87%)	3.58
Intelligence	381 (37.03%)	228 (22.16%)	254 (24.68%)	105 (10.2%)	61 (5.93%)	3.74
Affinity	453 (44.02%)	200 (19.44%)	257 (24.98%)	55 (5.34%)	64 (6.22%)	3.9
Artistic	385 (37.41%)	478 (46.45%)	47 (4.57%)	66 (6.41%)	53 (5.15%)	4.05
Total	4330 (35.07%)	3751 (30.38%)	2477 (20.06%)	925 (7.49%)	865 (7.01%)	3.79

ii) AHP Hierarchy Analysis Judgement Matrix

Analytical Hierarchy Process (AHP) enables a more precise calculation of the weights assigned to functional elements, thus providing a quantified measure of their importance at each level. This capability proves beneficial for the subsequent stages of sorting and screening. In order to elucidate the weights assigned to functional elements at each level in the context of suitable furniture for the elderly in nursing homes, the researchers employed the Analytical Hierarchy Process (AHP) as established by Professor T.L. Saaty, an esteemed American operations researcher from the University of Pittsburgh. The research endeavour involved the decomposition, comparison, judgment, and synthesis of the targeted object, thereby enabling the systematic organization, data modeling, and modeling of cognitive results. Consequently, the final output consisted of weight coefficients for each factor. By comparison, the traditional approach of subjectively determining the product function system and its importance pales in comparison, as it fails to uphold the same level of accuracy and scientific rigor (Han et al., 2004 & Tan, 2012).

Within the AHP hierarchical analysis method for calculating the weights assigned to furniture in nursing homes, the researcher initially utilized SPSS software to construct the judgment matrix, as exemplified in table 4.7. Subsequently, the average value of each analytical item was calculated, followed by the employment of this average value for the size of the division to acquire the judgment matrix. Importantly, a higher average value corresponds to greater importance, thus yielding higher weights. Employing the SPSS product method of calculation, the researcher executed the AHP hierarchical analysis study, ultimately obtaining the weights for each indicator (Table 4.8).

Table 4.7: Questionnaire 3-1 AHP Hierarchical Analysis Judgement

Average Value	Categories	1	2	3	4	5	6	7	8	9	10	11	12
1.787	Comfort (1)	1	0.753	0.743	0.796	0.819	0.735	0.732	0.932	0.738	0.791	0.850	0.914
2.373	Functions(2)	1.328	1	0.986	1.058	1.088	0.976	0.973	1.237	0.980	1.051	1.128	1.214
2.406	color(3)	1.346	1.014	1	1.072	1.103	0.990	0.986	1.254	0.994	1.065	1.144	1.231
2.244	Size (4)	1.256	0.946	0.933	1	1.029	0.923	0.920	1.170	0.927	0.994	1.067	1.148
2.182	Safety (5)	1.221	0.919	0.907	0.972	1	0.897	0.894	1.137	0.901	0.966	1.037	1.116
2.431	Solid (6)	1.361	1.025	1.011	1.084	1.114	1	0.996	1.267	1.004	1.077	1.156	1.244
2.440	Auxiliary(7)	1.365	1.028	1.014	1.087	1.118	1.004	1	1.272	1.008	1.080	1.160	1.249
1.918	Accessible (8)	1.073	0.808	0.797	0.855	0.879	0.789	0.786	1	0.792	0.849	0.912	0.982
2.421	Aging-friendly (9)	1.355	1.020	1.006	1.079	1.110	0.996	0.992	1.262	1	1.072	1.151	1.239
2.259	Intelligence (10)	1.264	0.952	0.939	1.006	1.035	0.929	0.926	1.177	0.933	1	1.074	1.156
2.103	Affinity (11)	1.177	0.886	0.874	0.937	0.964	0.865	0.862	1.096	0.869	0.931	1	1.076
1.954	Artistic (12)	1.094	0.824	0.812	0.871	0.896	0.804	0.801	1.019	0.807	0.865	0.929	1
Note: The number in line 1 indicates the number of the analyse item.													

Table 4.8: Questionnaire 3-1 AHP Hierarchical Analysis Results

Categories	Eigenvector	Weight Value	Maximum Eigenvalue	CI Value
Comfort	0.809	6.739 %	12.000	0.000
Function	1.074	8.949 %		
color	1.089	9.074 %		
Size	1.015	8.462 %		
Safety	0.987	8.227 %		
Solid	1.100	9.169 %		
Auxiliary	1.104	9.202 %		
Accessibility	0.868	7.234 %		
Aging-friendly	1.095	9.129 %		
Intelligence	1.022	8.517 %		
Affinity	0.952	7.930 %		
Artistic	0.884	7.370 %		

iii) Reliability Analysis

Reliability analysis entails evaluating the stability, consistency, and dependability of measurement results. In order to ensure the accuracy of these results, it is necessary to analyse the valid data in the questionnaire for reliability prior to conducting the analysis. In the field of social science research in China, the Cronbach α coefficient value, Spearman-Brown folded half reliability coefficient, and Guttman Split-Half coefficient are commonly utilized for such analysis. As an example, a reliability coefficient above 0.9 signifies excellent reliability, while a coefficient between 0.8 and 0.9 indicates very good reliability. Similarly, a coefficient between 0.7 and 0.8 suggests better reliability, and a coefficient between 0.6 and 0.7 denotes acceptable reliability. Conversely, a coefficient below 0.6 implies poor reliability. Additionally, if the value of the corrected item-total correlation (CITC) is less than 0.3, it may be advisable to consider removing the item from the analysis (Eisinga et al., 2013 & Zhou, 2017).

From table 4.9, it can be observed that the reliability coefficient value is 0.952, surpassing the threshold of 0.9. This finding serves as evidence that the data reliability of the study is of commendable quality. In relation to the “CITC value,” it is noteworthy that all the CITC values of the examined items exceed 0.4. This signifies a robust correlation among the analysed items and further attests to the favourable level of reliability. In summary, the value of the research data reliability coefficient surpasses 0.9, thus comprehensively affirming the high quality and suitability of the data for subsequent analyses.

Table 4.9: Cronbach's Reliability Analysis Table

Categories	Correction Term Total Correlation (CITC)	Deleted Alpha Coefficients for Item	Cronbach's Alpha Coefficient
Comfort	0.847	0.945	0.952
Function	0.754	0.948	
Colour	0.788	0.947	
Size	0.744	0.949	
Safety	0.759	0.948	
Solid	0.780	0.947	
Auxiliary	0.732	0.949	
Accessibility	0.830	0.946	
Age-friendly	0.745	0.949	
Intelligence	0.731	0.949	
Affinity	0.711	0.950	
Artistic	0.827	0.946	
Standardised Cronbach's alpha coefficient: 0.953			

iv) Validity Analysis

Based on table 4.10, it is evident that all the research items correspond to a commonality value greater than 0.4, signifying that the information of the research items can be effectively extracted. Additionally, the KMO value is 0.979, which exceeds 0.8, and the Bartlett value is 0.000, which is less than 0.01, indicating that the research data is highly suitable for information extraction (thus demonstrating a very positive response to the validity). Furthermore, the explained variance value for one factor is 65.915% respectively, and the cumulative explained variance after rotation is 65.915%, surpassing 50%, which indicates that the information of the research item can be effectively extracted. The absolute value of the factor loading coefficient exceeds 0.4, signifying a correlation between the option and the factor.

Table 4.10: Validity Analysis Results of Questionnaire 3-1

Categories	Factor loading coefficients	Commonality (common factor variance)
	Factor 1	
Comfort	0.878	0.772
Function	0.796	0.634
Colour	0.827	0.684
Size	0.787	0.620
Safety	0.801	0.641
Solid	0.819	0.671
Auxiliary	0.776	0.603
Accessibility	0.864	0.746
Age-friendly	0.788	0.622
Intelligence	0.776	0.602
Affinity	0.758	0.574
Artistic	0.861	0.742
Eigenroot values (before rotation)	7.910	-
Variance explained % (before rotation)	65.915%	-
Cumulative variance explained % (before rotation)	65.915%	-
Eigenroot values (after rotation)	7.910	-
Variance explained % (after rotation)	65.915%	-
Cumulative variance explained % (after rotation)	65.915%	-
KMO value	0.979	-
Bart Spherical Values	9278.345	-
df	66	-
p Value	0.000	-

Note: If the numbers in the table are coloured: blue indicates that the absolute value of the loading coefficient is greater than 0.4, and red indicates that the degree of commonality (variance of the common factor) is less than 0.4.

b) Respondents' Awareness of Age-friendly Furniture and Design Aspirations

i) Survey of Elder People's Interest in, Reasons for, Awareness of and Concerns about Age-friendly Furniture

According to the findings of the survey, a significant majority of the elderly, amounting to 80.17% have expressed interest in age-friendly furniture， with 25.85% displaying a high level of interest. Conversely, 19.83% of the elderly population has indicated a lack of interest in age-friendly furniture products. This attitude can be attributed to the older generation's inclination to resist unfamiliar products, thereby reflecting their mindset (Table 4.11).

Table 4.11: Frequency Analysis Results of Interest in Furniture Products

Topic	Categories	Frequency	Percentage (%)
Level of Interest in Age-friendly Furniture Products	Not interested	204	19.83
	Interested	559	54.32
	Very interested	266	25.85
Total		1029	100.0

Within the scope of this research, the primary factors influencing' older individuals' interest in age-friendly furniture were identified as material, style, and safety. These elements accounted for 23.62%, 20.21% and 19.05% respectively, collectively exceeding 60%. Conversely, brand, price, and appearance played a relatively minor role, each accounting for approximately 6% (Table 4.12).

Regarding familiarity with suitable furniture for the elderly, it is evident that only about 35% of the surveyed population possesses a basic understanding of such products. Furthermore, within this group, a mere 5.64% exhibit a high level of familiarity. The majority of individuals, however, remain largely uninformed about these types of products. This lack of awareness can be attributed to the limited popularity of suitable furniture for the elderly (Table 4.13)

Table 4.12: Frequency Analysis Results of Reasons for Interest in Age-friendly Furniture

Topic	Categories	Frequency	Percentage (%)
Reasons for Interest in Age-friendly Furniture	Material	243	23.62
	Safety	196	19.05
	Style	208	20.21
	Price	67	6.51
	Function	60	5.83
	Appearance	58	5.64
	durability	64	6.22
	Brand	64	6.22
	Others	69	6.71
Total		1029	100.0

Table 4.13: Survey on Knowledge of Age-friendly Furniture Frequency Analysis Results

Topic	Categories	Frequency	Percentage (%)
Knowledge (or familiarity) of age-friendly furniture products.	Not at all	73	7.09
	Know a little	247	24.00
	Know but not understand	278	27.02
	Basic understanding	303	29.45
	Strong understanding	58	5.64
	Others	70	6.80
Total		1029	100.0

In terms of concerns related to age-friendly furniture, it is noteworthy that 348 individuals emphasized the importance of comfortable, accounting for 33.82%. Additionally, 280 respondents expressed a focus on convenient, constituting 27.21%. Furthermore, 219 individuals highlighted the significance of safety. Conversely, artistic emerged as a relatively insignificant concern for the elderly, comprising only 8.65%. This stark contrast to the “appearance first” mindset observed in modern young people underscores the elderly prioritization of practicality (Table 4.14).

Table 4.14: Survey on Concerns about Age-friendly Furniture Frequency Analysis Results

Topic	Categories	Frequency	Percentage (%)
Aspect of age-friendly furniture are important to you.	Artistic	89	8.65
	Safety	219	21.28
	Comfortable	348	33.82
	Convenient	280	27.21
	Others	93	9.04
Total		1029	100.0

Given that the elderly constitute a distinct demographic, their interests and preferences in furniture differ significantly from those of younger individuals. Notably, age plays a crucial role in shaping the needs and requirements of the elderly regarding furniture. Moreover, variations can be observed between elderly individuals with underlying health conditions and those who are generally healthy. Therefore, the design of age-friendly furniture should align with the overall demands of the elderly population in order to cater to their unique requirements.

ii) Colour, Material, and Style Selection

Colour Selection. In relation to the selection of age-friendly furniture colors, it is evident that elderly individuals possess a pronounced inclination towards warm colors.In addition, older people have a distinct preference for white, presumably because older people usually believe that white symbolizes cleanliness and tidiness (Figure 4.17).

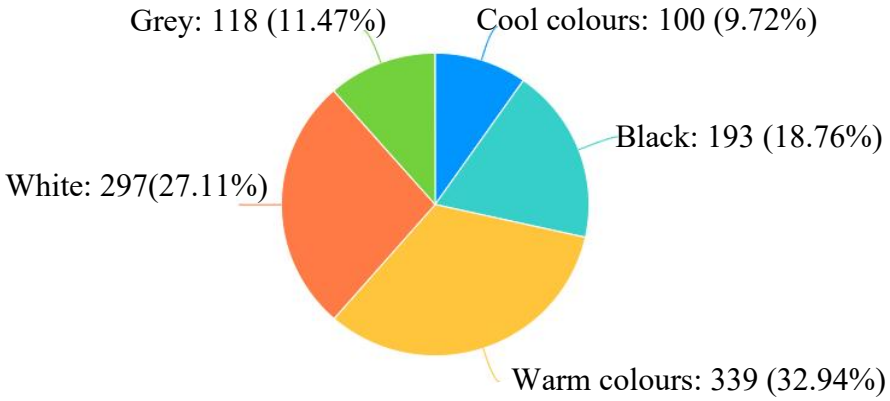


Figure 4.17: Results of Survey on Colour Choices of Elderly

Material Selection. Regarding the choice of materials for age-friendly furniture, a substantial percentage of the population, namely over 37%, expressed a preference for solid wood and MDF chipboard. Conversely, plastic, finish made from rattan, and finish made from bamboo garnered considerably less popularity, accounting for 27.6%, 26.46%, and 25.46% respectively (Figure 4.18). It is advisable for furniture designed for the elderly to be crafted from natural and environmentally friendly materials, thereby exemplifying a preference for green materials, particularly solid wood, fabric, and leather.

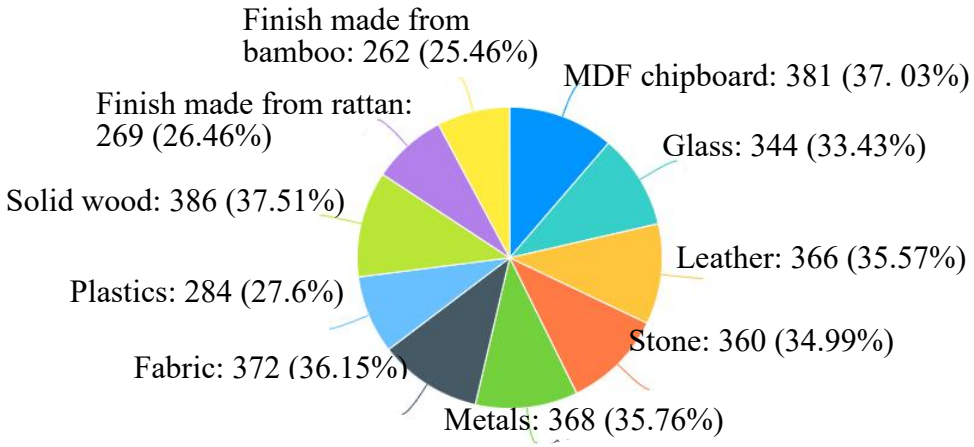


Figure 4.18: Survey Results for Elderly' Material Choices

Furniture Styles for the Elderly. With regard to the selection of furniture styles for the elderly, the Chinese style holds a distinct allure for the older generation, encompassing more than 42.08% of the total share, which significantly surpasses other styles at approximately 7% (Table 4.15). From this data, it becomes evident that Chinese elderly individuals gravitate towards a traditional Chinese living environment. Nevertheless, some individuals also exhibit an affinity for natural and retro styles. In terms of style, the elderly demonstrate an age-friendly refinement and a predilection for tradition.

Table 4.15: Surveys on Style Choices in Frequency Analysis Results

Topic	Categories	Frequency	Percentage (%)
Style of age-friendly furniture preference	American style	70	6.80
	Minimalist style	76	7.39
	Fashion style	71	6.90
	Retro style	90	8.75
	European style	60	5.83
	Chinese style	433	42.08
	Affordable luxury style	70	6.80
	Natural style	84	8.16
	Others	75	7.29
Total		1029	100.0

As individuals advance in age, their physiological functions and cognitive abilities inevitably decline, leading to a diminished sensitivity and discrimination towards colours. Therefore, when designing furniture for the elderly, it is imperative to consider the varied spectrum of colours and material disparities, in order to prevent triggering volatile mood swings among this demographic. For instance, it is prudent to select materials with a green hue that possess a high level of colour purity and brightness. Simultaneously, the chosen

colours and materials should harmonize and integrate seamlessly within the overall indoor space.

iii) Survey of Smart Projects, Improvement Areas and Design Service Areas for Furniture for the Elderly

Smart Project Type Requirements. Research findings indicate that 56.85% of elderly hold the belief that age-friendly furniture for their age group should possess intelligent functions. This enhancement undoubtedly contributes to their overall well-being. Subsequently, the massage function ranks second in importance, accounting for 43.73 %. Additionally, the elderly express a demand for automatic power-off function, emergency call function surpassing 37 % respectively (Figure 4.19).

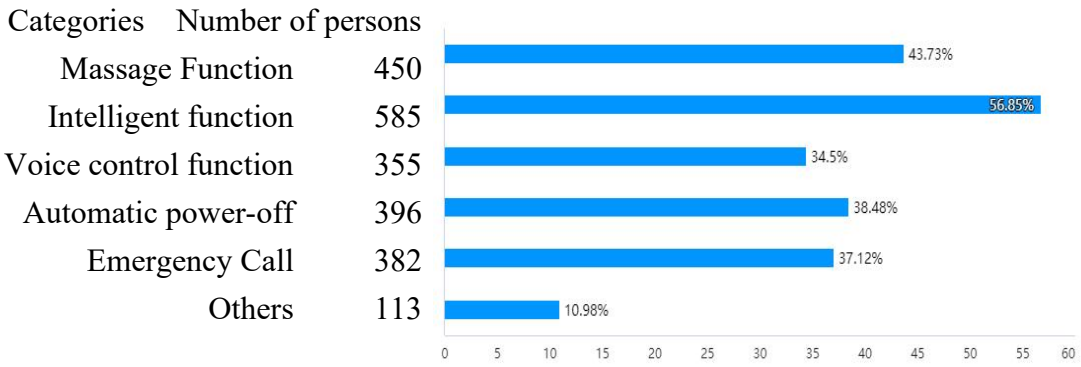


Figure 4.19: Survey Results on Elderly Demand for Age-friendly Furniture Smart Projects

In reality, the advancement of intelligent technology has brought forth elevated levels of design concepts for furniture tailored to the needs of older adults. Consequently, intelligent furniture has gained widespread interest and admiration. Furthermore, with the continuous increase in China's ageing population, the integration of intelligence will significantly expand the design possibilities and application scope of age-friendly furniture.

Furniture for the Elderly Improvement Area. From the research data depicted in Figure 4.20, it is discernible that the size of furniture holds utmost importance for the elderly, as evidenced by 632 senior citizens who firmly believe that this matter necessitates urgent improvement in the present scenario. Subsequently, habits emerge as a key aspect, garnering a support rate of 45.87%, which underscores the imperative need for a profound comprehension of the elderly' way of life to facilitate the creation of more refined furniture products that cater to their specific needs. Styling, with support rate of 38.87%, as the older generation still retains a nostalgic affinity for the traditional Chinese style, given their historical connection with the inception of new China.

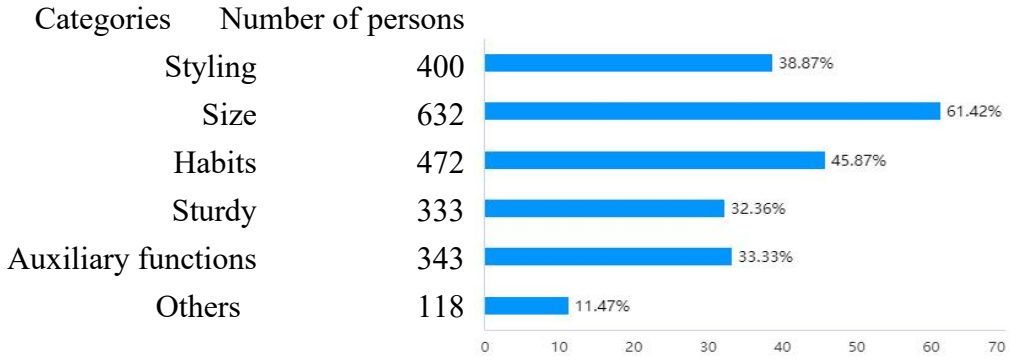


Figure 4.20: Findings on Areas of Improvement in Age-friendly Furniture

iv) Multiple Choice Response Rate and Prevalence Rate

As can be seen from table 4.16, the significance of the goodness-of-fit test is obvious (chi=1643.990, p=0.000<0.05), which means that there is a significant difference in the proportion of choices for each item, which can be compared with the difference through the response rate or the prevalence rate. Specifically, the response rate and prevalence rate of the three items of "interest in age-friendly furniture", "knowledge of age-friendly furniture" and "aspect of age-friendly furniture to focus on" are significantly higher. The response rate and prevalence rate of these three items are significantly higher.

Table 4.16: Summary of Questionnaire 3-2 Multiple Choice Response and Prevalence Rates

Categories	responsive		Prevalence (n=1029)
	n	response rate	
Q1.Interest in age-friendly furniture	559	35.20%	54.32%
Q2.Knowledge of age-friendly furniture	303	19.08%	29.45%
Q3.Reasons for interest in age-friendly furniture	196	12.34%	19.05%
Q4.Aspect of age-friendly furniture to focus on	219	13.79%	21.28%
Q5.Preferred furniture material	7	0.44%	0.68%
Q6.Preferred furniture colour	100	6.30%	9.72%
Q7.Preferred furniture style	75	4.72%	7.29%
Q8.Furniture function	69	4.35%	6.71%
Q9.Aspect most in need of improvement	43	2.71%	4.18%
Q10.Categories needed design for elderly	17	1.07%	1.65%
Aggregation	1588	100%	154.32%
Goodness of fit test: $\chi 2 = 1643.990$ p=0.000			

v) Validity Analysis

Based on table 4.17, the KMO value is 0.693, which is greater than 0.6, thereby implying the suitability of the data for extraction. Furthermore, the variance explained values for the five factors are 11.283%, 10.859%, 10.811%, 10.803%, and 10.351%, while the cumulative variance explained through rotation is 54.107%, surpassing the threshold of 50%. This implies that the research items possess sufficient informativeness that can be effectively extracted. Additionally, the Bartlett value is 0.038, with $p<0.05$, indicating the presence of a significant relationship between the original variables. Moreover, the commonality values (common factor variance) corresponding to the research items exceed 0.4, suggesting the effective extraction of information from the research items.

Table 4.17: Questionnaire 3-2 Validity Analysis Table

Categories	Factor loading coefficients					Commonality (common factor variance)
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
Q1.Interest in age-friendly furniture	0.162	0.076	0.125	0.137	0.759	0.642
Q2.Knowledge of age-friendly furniture	0.082	0.745	-0.038	-0.147	0.214	0.630
Q3.Reasons for interest in age-friendly furniture	0.089	-0.607	-0.090	-0.112	0.227	0.449
Q4.Aspect of age-friendly furniture to focus on	-0.336	0.293	-0.076	0.382	0.024	0.451
Q5.Preferred furniture material	-0.607	-0.125	0.073	0.203	-0.079	0.437
Q6.Preferred furniture colour	0.660	-0.139	-0.000	0.156	-0.017	0.480
Q7.Preferred furniture style	0.396	0.172	0.138	0.215	-0.558	0.563
Q8.Furniture function	0.097	0.003	-0.755	0.273	0.122	0.668
Q9.Aspect most in need of improvement	-0.035	0.070	-0.010	-0.803	-0.014	0.651
Q10.Categories needed design for elderly	0.050	0.042	0.675	0.226	0.168	0.540
Eigenroot values (before rotation)	1.155	1.123	1.079	1.034	1.021	-
Variance explained % (before rotation)	11.552	11.229	10.786	10.335	10.205	-
Cumulative variance explained % (before rotation)	11.552	22.781	33.567	43.902	54.107	-
Eigenroot values (after rotation)	1.128	1.086	1.081	1.080	1.035	-
Variance explained % (after rotation)	11.283	10.859	10.811	10.803	10.351	-
Cumulative variance explained % (after rotation)	11.283	22.142	32.953	43.756	54.107	-
KMO value	0.693					-
Bart Spherical Values	47.847					-
df	45					-
p Value	0.038					-

Note: If the numbers in the table are colored: blue indicates that the absolute value of the loading coefficient is greater than 0.4, and red indicates that the degree of commonality (variance of the common factor) is less than 0.4.

c) Data Analysis of Questionnaire 3-3: Feedback Survey on the Current State of Use and Demand for Existing Furniture in Nursing Homes

i) Problems with the Use of Furniture in Nursing Homes

43.44% of the elderly individuals included in the survey expressed the perception that the existing furniture specifically designed for the ageing population did not present any issues. However, a majority of these individuals still maintained the belief that there was potential for enhancement, as demonstrated by 28.57% have some problems. Additionally, 22.64 % of the elderly participants indicated a desire for their furniture to be upgraded and modified to meet graduation requirements (Figure 4.21). This inclination arises from the fact that the primary consumers of furniture design within the present market are predominantly situated within the middle-aged and young demographics. Moreover, it is evident that most designers have not conducted comprehensive investigations into the requirements of the elderly residing in nursing homes, even in relation to the development of age-friendly furniture products.

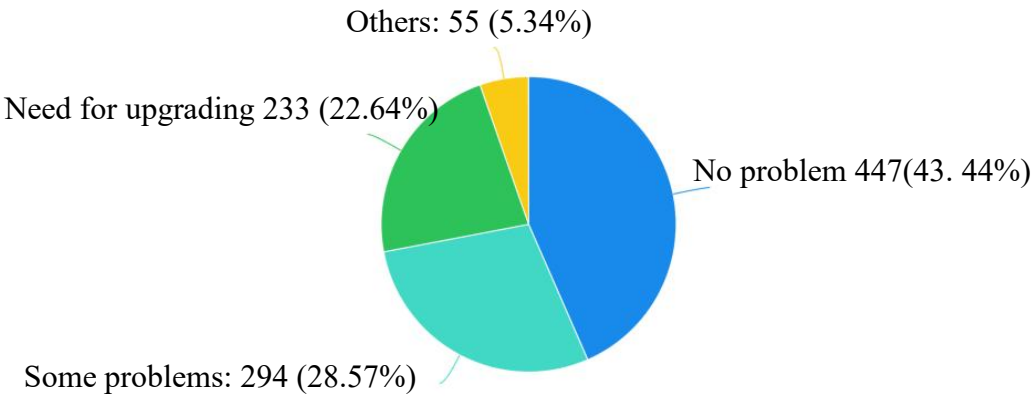


Figure 4.21: Survey of Existing Furniture Usage Problems

ii) Nursing Home Furniture in the Form of Tables and Chairs

Problems with Table Furniture. From the data presented in figure 4.22, it is evident that 41.21% of the elderly individuals included in the sample expressed their dissatisfaction with table top too low. Additionally, a considerable percentage of 33.92% believed that table top too high. Furthermore, 35.28% of the respondents reported that there is insufficient space under table, while 37.51% noted a lack of emotional design. It is noteworthy that these four aspects accounted for a significant proportion of all options and emerged as the most prominent concern.

In general, the sensory encounter with table furniture among older individuals is not particularly favorable, with the height of the table top being a particularly contentious issue. The primary hindrance of this type of furniture for the elderly lies in its inadequate design.

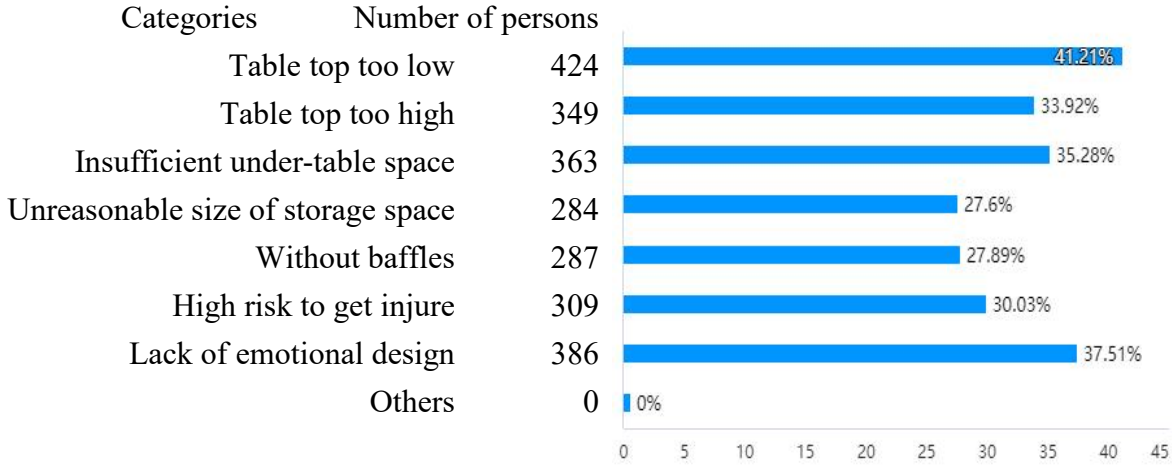


Figure 4.22: Findings of Problems with Table Furniture in Nursing Homes

Problems with seating furniture. From the survey findings, it is evident that there exist complications pertaining to the utilization of seating furniture. A significant majority, namely 60%, of the elderly demographic expressed their belief that the height of the seats

is excessively elevated. Additionally, 52.09 % of respondents opined that the chairs lacked armrests. Furthermore, 48.79 % of participants think that the edges of the seat are sharp and have high risk to get injure (Figure 4.23). In the context of designing appropriate furniture for the elderly, determining the dimensions of these items will undoubtedly emerge as a pivotal concern.

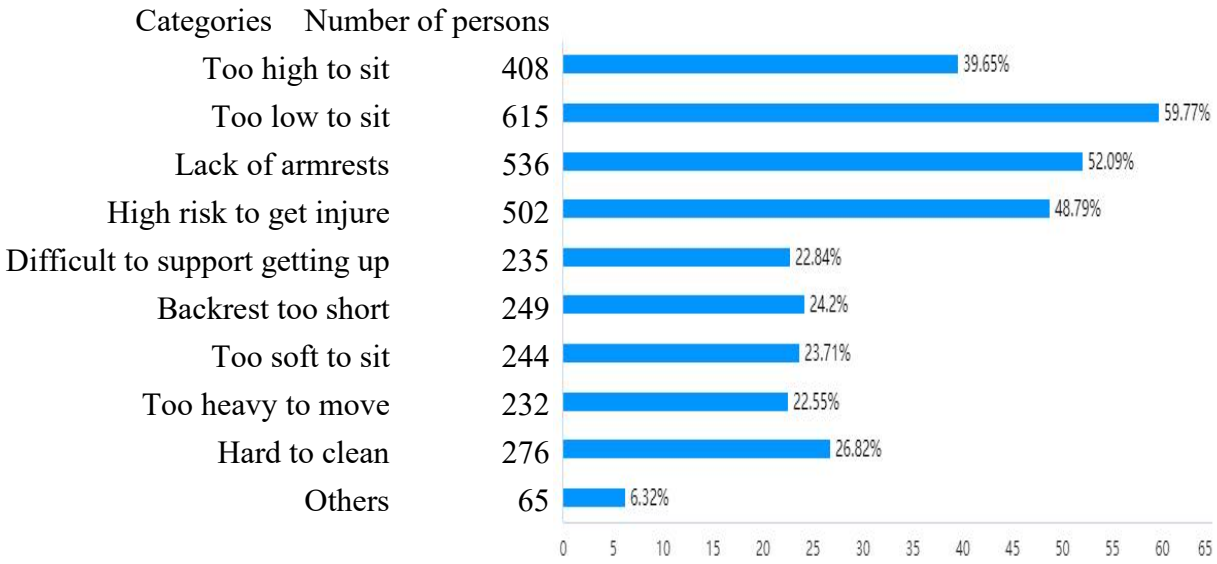


Figure 4.23: Findings of Problems with Seating Furniture in Nursing Homes

iii) Cabinet Furniture

Problems with Cabinet Furniture. From the information illustrated in figure 4.24, it is evident that a majority of the elderly population perceives the storage position is too low to reach, thereby requiring them to bend down. Additionally, 48.98% of the elderly believes that the storage position is too high to reach. Upon careful examination, the main reason for this excessive or obvious contradiction is the obvious aversion of the elderly to low furniture.

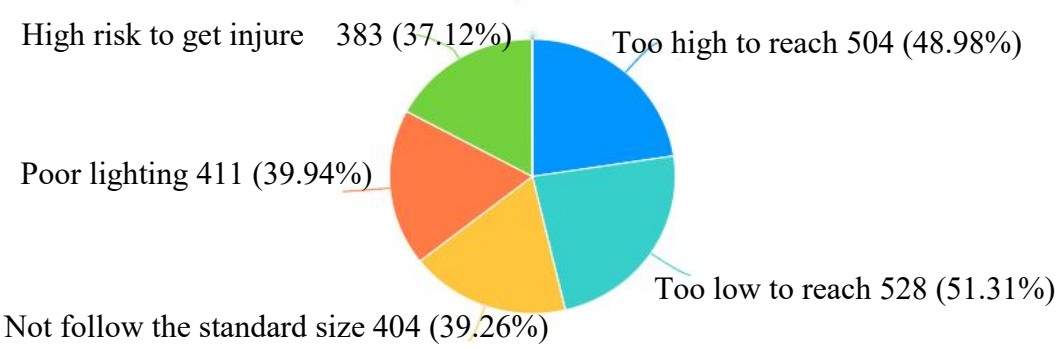


Figure 4.24: Findings of Problems with Cabinet Type Furniture in Nursing Homes

Cabinet Furniture Design Requirements. From the data presented in figure 4.25, it becomes evident that the design of furniture cabinets that cater to the needs of the ageing population greatly favors the incorporation of an auxiliary push-pull device for the cabinet door. This particular feature is embraced by over 50% of the population. Subsequently, the integration of a built-in sensor light strip garners the preference of 47.72% of individuals. The presence of the auxiliary push-pull device enhances the convenience of elderly individuals, thereby facilitating their behavior. Furthermore, the inclusion of a sensor light not only addresses the general public's need for illumination in confined spaces but also assists the elderly in locating objects with ease.

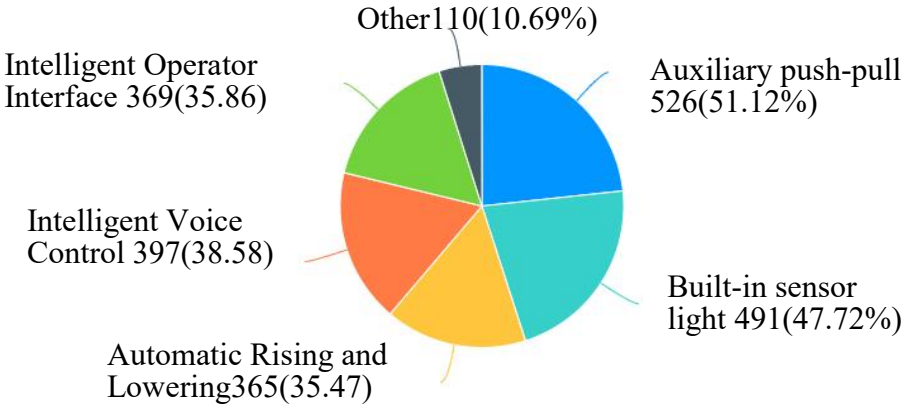


Figure 4.25: Findings on the Design Needs of Cabinet Furniture in Nursing Homes

iv) Bed furniture

Problems with Bed Furniture. From the findings of the survey (Figure 4.26), it has been determined that the mattress was excessively soft, and this particular group of individuals constituted 26.43% of the total sample, which representing the highest overall proportion. Simultaneously, Lack of auxiliary function has emerged as a significant issue for bed, accounting for 26.14% of the respondents. This finding implies a need for enhanced auxiliary design. With regard to bed dimensions, a total of 220 individuals reported concerns regarding the compatibility of bed size with human body proportions and ergonomic considerations. The data clearly indicate that these three categories of problems are particularly prominent, collectively accounting for a share of more than 70%. This suggests that these issues are notably severe and demand immediate resolution through the application of design strategies.

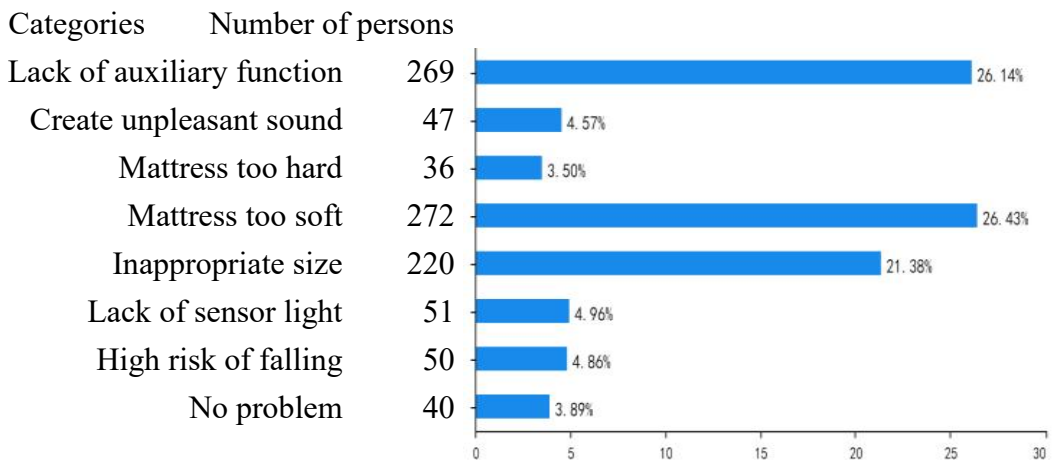


Figure 4.26: Findings of Problems with Bed Furniture in Nursing Homes

Design Requirements for Agd-friendly Beds in Nursing Homes. According to the data presented in figure 4.27, it is evident that the research conducted on the particular functional demands pertaining to the design of beds for the elderly highlights a strong inclination towards the needs of automatic sensory light under the bed and the emergency button at the bedside, constituting 43.96% and 39.07% respectively. The incorporation of automatic sensor light provides the elderly with the convenience of automatically illuminating the area when they disembark from the bed. Furthermore, the emergency button not only serves as a convenient means of summoning family members (or nurses) to attend to the elderly in times of discomfort, but it also functions as a safety mechanism to safeguard their lives. Moreover, the elderly exhibit a heightened interest in intelligent design, as they hold significant expectations for features such as automatic control, intelligent auxiliary function, and other related functions.

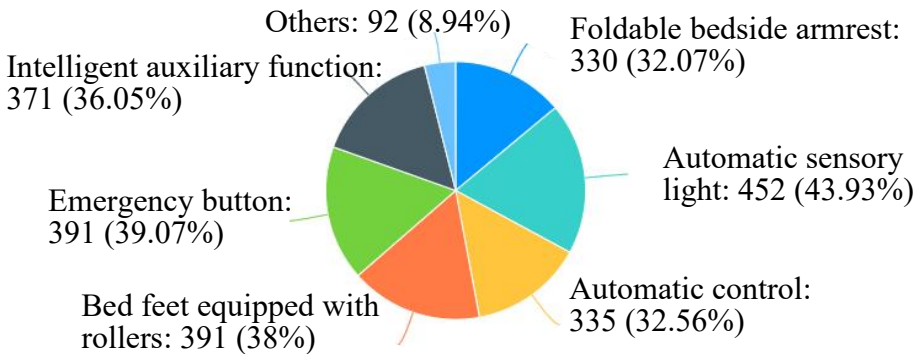


Figure 4.27: Survey Results for Nursing Home Bed Design Requirements

d) Response Rate and Penetration Rate

As evidenced by the data presented in table 4.18, the test assessing the goodness-of-fit demonstrates statistical significance (chi=894.149, p=0.000<0.05), suggesting that there exists a notable degree of variation in the proportion of choices for each individual item. Furthermore, this variability can be specifically compared through the examination of

response rates or prevalence rates. To be more precise, the highest response rate and prevalence rate are observed for the two items “Q1. Existing furniture using problems” and “Q7. Problems of bed”.

Table 4.18: Summary of Questionnaire 3-3 Response and Prevalence Rates

Topic	responsive		Prevalence (n=1029)
	n	response rate	
Q1. Existing furniture using problems	294	36.48%	28.57%
Q2. Problems of bathroom	21	2.61%	2.04%
Q3.Problems of table	16	1.99%	1.55%
Q4. Problems of chair	60	7.44%	5.83%
Q5. Problems of cabinet	44	5.46%	4.28%
Q6. Functions needed for cabinet design	269	33.37%	26.14%
Q7. Problems of bed	28	3.47%	2.72%
Q8. Functions needed for bed design	74	9.18%	7.19%
Aggregation	806	100%	78.33%
Goodness of fit test: $\chi 2 = 894.149$ p=0.000			

e) Validity Analysis

As can be seen from table 4.19, all the research items correspond to a commonality value higher than 0.4, which means that the information of the research items can be extracted effectively. In addition, the KMO value is 0.603, which is greater than 0.6, implying that the data is suitable to be extracted. In addition, the variance explained values of the four factors are 13.428%,13.349%,13.307%,13.062%, and the cumulative variance explained after rotation is 53.146% > 50%. It means that the information content of the research items can be extracted effectively. Finally, the absolute value of the factor loading coefficient is greater than 0.4 means that there is a correspondence between the option and the factor.

Table 4.19: Results of Questionnaire 3-3 Validity Analysis

Topic	Factor loading coefficients				Commonality (common factor variance)
	Factor 1	Factor 2	Factor 3	Factor 4	
Q1. Existing furniture using problems	0.830	-0.141	-0.009	-0.164	0.735
Q2. Problems of bathroom	0.054	0.621	0.116	0.071	0.407
Q3.Problems of table	-0.089	0.181	-0.620	0.128	0.441
Q4. Problems of chair	0.019	-0.653	0.130	0.115	0.456
Q5. Problems of cabinet	0.605	0.265	0.046	0.271	0.512
Q6. Functions needed for cabinet design	-0.068	0.195	0.777	0.072	0.652
Q7. Problems of bed	0.048	0.162	-0.172	0.623	0.447
Q8. Functions needed for bed design	-0.034	-0.262	0.119	0.719	0.600
Eigenroot values (before rotation)	1.132	1.078	1.039	1.004	-
Variance explained % (before rotation)	14.144%	13.472%	12.982%	12.548%	-
Cumulative variance explained % (before rotation)	14.144%	27.616%	40.598%	53.146%	-
Eigenroot values (after rotation)	1.074	1.068	1.065	1.045	-
Variance explained % (after rotation)	13.428%	13.349%	13.307%	13.062%	-
Cumulative variance explained % (after rotation)	13.428%	26.777%	40.085%	53.146%	-
KMO value	0.603				-
Bart Spherical Values	24.071				-
df	28				-
p Value	0.053				-

Note: If the numbers in the table are coloured: blue indicates that the absolute value of the loading coefficient is greater than 0.4, and red indicates that the degree of commonality (variance of the common factor) is less than 0.4.

4.3.4 Summary of the Questionnaire

First and foremost, the initial section of the questionnaire entails a fundamental survey of the elderly residing in China nursing homes. The goal of this section is to investigate the basic demographic and economic characteristics of the sample population. Additionally, it aims to compare the distribution of the level of ageing among the participants with the national distribution ratio of elderly individuals exhibiting varying degrees of ageing.

Subsequently, the second part of the questionnaire aims to analyse the physiological and behavioral data of the elderly in China nursing homes. This specific section is designed to focus on examining the physiological and behavioral characteristics of the elderly within the nursing home environment. Specifically, it seeks to analyse these characteristics by considering the placement of the study within the realm of indoor furniture in nursing homes. The intention behind this analysis is to inform the targeted design of age-friendly furniture.

The third part of the questionnaire pertains to the analysis of survey data concerning issues related to age-friendly furniture in nursing homes. It delves into various aspects, such as respondents' familiarity with age-friendly furniture, their attitudinal intentions, current usage, perceptions, and design aspirations for such furniture. Furthermore, descriptive analysis, response rate and prevalence analysis, as well as reliability and validity tests, were conducted for the survey data obtained from Questionnaire 3-2 and Questionnaire 3-3. The findings from each questionnaire survey were subsequently analysed and summarized in order to provide valuable data references

and evidence for the exploration of targeted design elements, principles, and methods of age-friendly furniture.

4.4 Data Analysis of Interview

This study uses an open-ended interview format, with face-to-face communication as the main focus. The design of the interviews was divided into two parts, as described in Chapter 3.4.3. The first part of the interviews focused on interviews with experts, designers, manufacturers and relevant practitioners in the elderly care service industry, while the second part focused on interviews with groups of elderly people in nursing homes in different regions of China. The interviews lasted between 30 and 40 minutes for each interviewer, and were recorded through written notes and audio recordings, with the final results collated by the researcher. The interviews were recorded through written notes and audio recordings, followed by transcription of the interview transcripts, performed using Verbal Protocol Analysis (VPA), and analysis of the interview data using Nvivo12.

The core task of this work is as part of answering RQ 3 and realising RO 3. In order to realise the purpose of this study and to answer the research questions, in-depth interviews were conducted with experts and older people in different roles in this process, mainly focusing on the key factors, problems, etc. of the traditional head-adapted furniture design method. Then, interviews are conducted to summarise, collect and analyse relevant research data. Finally, the results of the interviews are analysed and summarised as the key point and landing point of the research on the design elements, principles and methods of age-friendly furniture in Chinese nursing homes.

4.4.1 Analysis of Interview 1: Academicians, Designers and Furniture Manufacturers

a) Analysis of Interview Data

In this expert interview, the primary focus revolved around the analysis and identification of the overall structure and composition of furniture design that caters to the needs of ageing individuals. The researcher will create a keyword to assist him in the design development. The key words on attribute are very vital in this study. The aim was to delineate the six attributes of the compositional structure of furniture design in Chinese nursing homes. These attributes serve as the foundation for the thoughts and ideas explored in this study regarding the implementation of age-friendly furniture design in Chinese nursing homes.

The researcher initiated the interview by requesting the experts to share their professional insights on various topics related to age-friendly furniture design, drawing from their own experiences and research. Subsequently, the evaluation of the current state of product design and user feedback regarding existing age-friendly furniture in nursing homes was conducted. This assessment aimed to explore the most crucial design perspectives, influential factors, and underlying reasons pertaining to age-friendly furniture in nursing homes. Additionally, the researcher proposed relevant principles and methods for designing age-friendly furniture in nursing homes based on the findings. Please refer to Appendix C for a comprehensive list of topics. Furthermore, the textual keyword search coding was performed using Nvivo12 , and the detailed analyses can be found in table 4.20.

Table 4.20: Content Analysis of Expert In-Depth Interview Keyword List

No.	Scope of Question	List of interview keywords Interviews:academicians, designers, manufacturers and related practitioners
1	Sensory	Style: theme, leisure, form, simplicity, diversity, individuality, simplicity, fashion elements, features, fashion direction, coordination, nature, rusticity, etc. Form: lightness, aesthetics, harmony, energetic, brightness, cheerful, softness, flexible, attractive, artistic conception, texture, vivacity, light and shadow needs, artistry, etc. Model: folding, anti-collision, rounded corner design, anti-bump, armrests, with wheels, corner anti-collision,novelty, storage type, no sharp corners, seat width, simple styling, smooth lines Decoration: innovation, soft furnishings, subject expression, furnishings, simplicity, aesthetics, fashion, etc. Colour: theme colour, colour matching, warm colour, soft colour, contrast, natural, low saturation, low purity, harmony, etc. Comfort: Ease of use, moderation, coordination, stylistic unity, illumination, sense of hierarchy, texture, curves, height, stability, modelling, convenience, rationality, etc. Perceptual: Participation, creativity, elegance, atmosphere, harmony, hierarchy, warmth, nature, clarity, simplicity, etc.
2	Physical	Technology: easy to move, easy to maintain, easy to dismantle and move, new craftsmanship, resistance to ageing, craft materials, craft technology, etc. Material: quality, antibacterial, flame retardant, moisture-proof, fireproof, natural, waterproof, new material, anti-insect, ecological,

Table 4.20 continued

		material safety, material comfort, etc. • Structure: solid wood, height adjustment, anti-loosening measures, anti-vibration, detachable, stable, adjustable, solid, lifting, combination, reliability, easy to operate, easy to fold and unload, easy to fold and install, structural safety, replacement, supporting structure, etc. • Function: Rehabilitation training, diversification, medical integration, life and entertainment, nursing care, practicality, convenience, storage, medical integration, non-slip, waterproof, lighting, general purpose, functional zoning, constant temperature, medicine storage, massage function, etc. • Ergonomics: body functions, operational comfort, size, height, ergonomics, ageing, proportion, reasonable height, tilt angle, body functions, etc. • Accessibility design: fall prevention, assistance, prevention, safety aid, fall prevention, bump prevention, anti-slip, special design, collision prevention, behavioural habits, etc.
3	**Operational**	• Safety tips: safety precautions, prompts, warning signs, safety signs, eye-catching signs, comprehensibility, signage design, enlarged signs, etc. • Post-maintenance: portable, easy to move, easy to dismantle, easy to clean, standard accessories, high quality, easy to modify, easy to maintain, durable, recyclable, etc. • Rehabilitation guidance: rehabilitation training, assisted training, rehabilitation monitoring, assisted design, intelligent assistance, labour-saving, nursing function, assisted rising, etc.
4	**Social**	• Health and environmental protection: sustainable development, environmentally friendly materials, recyclable, energy saving green, health, plant configuration, energy saving, sustainable, degradability, etc. • Product innovation: design innovation, creativity, convenience,

Table 4.20 continued

		efficiency, modernity, timeliness, popularity • Lifestyle: target market, user characteristics, ease of living, convenience, social acceptance, brand, demand, etc. • Economic: cost optimization, assembly, cost, ease of handling, product profitability, factory inputs, mass production, user requirements, production cycles, material consumption costs, product life, cost control, maintenance, recycling, etc.
5	**Emotional**	• Culture: heritage, unique symbols, elements, inclusiveness, appreciation value, inheritance, humanity, customs, national characteristics, cultural exchanges, value and significance, customs and traditions, cultural history, etc. • Emotional Functions: recreation, communication, diversity, social functions, entertainment functions, memory, crowd interaction, etc. • Emotional transmission: ambient experience, emotional memory, fun, sense of belonging, respect and care, warmth, companionship, intimacy, emotional expression, interaction, dependence, sense of participation, emotional interaction, self-confidence, emotional support, etc. • Psychological: low fallout, psychological characteristics, spiritual needs, charm, personal needs, stress relief, psychological needs, privacy, etc.
6	**Intelligence**	Voice-assisted, intelligent recognition, data collection, health monitoring, security monitoring, automatic alarm, emergency call for help, medical grade, telemedicine, sensors, automated control, remote control, linkage control, risk prediction, monitoring, auto-power-off, Intelligent assistance, monitorable, verbal message alert, intelligent sensing device, intelligent lighting, removable call, entertainment function, emergency assistance, sign monitoring, human body sensing, light linkage, etc.

b) Interview Results

Through the extraction of keywords from the expert interviews and the analysis of the data results, in addition to the guidance of experts in the relevant fields, the researcher has summarized the design attributes of age-friendly furniture in nursing homes and determined the structure of the composition of these attributes. The design attributes are mainly categorized into six groups: sensory attributes, intelligent attributes, material attributes, emotional attributes, operational attributes, and social attributes, which will be investigated in this research (Figure 4.28).

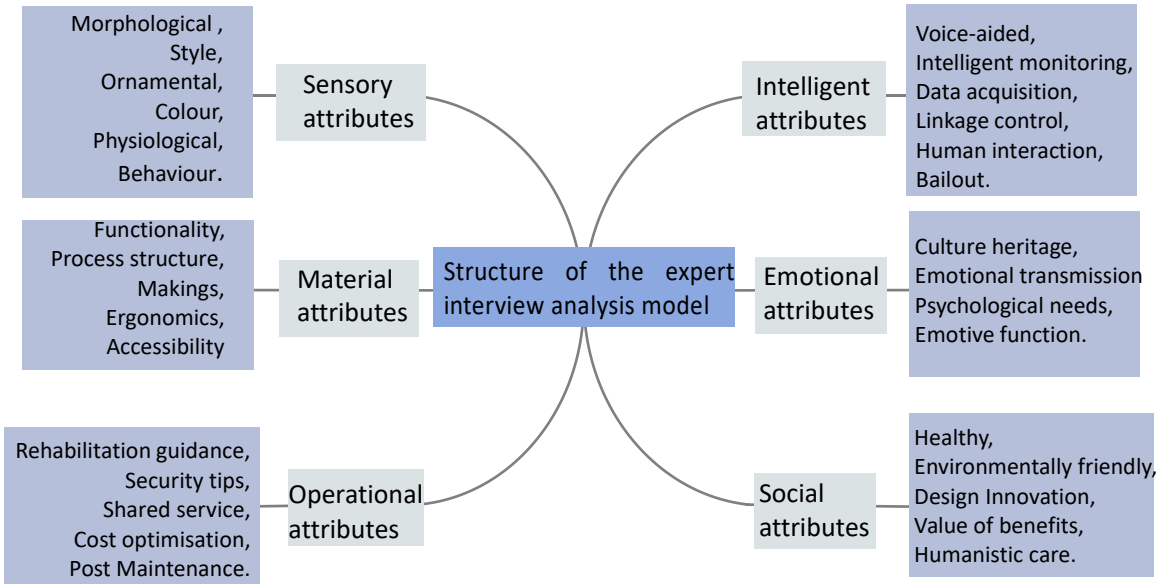


Figure4. 28: Structural Model for Keyword Analysis of Expert Interviews

Sensory Attributes. The incorporation of sensory attributes brings forth novel ideas for the design of age-friendly furniture in nursing homes. The sensory attributes of age-friendly furniture refer to the initial impression of the product in terms of visual perception. With regards to the design considerations of nursing home furniture, the sensory attributes primarily encompass elements such as morphology modelling, style,

decoration, colour, and physiological and behavioural sensations. This is achieved by mobilizing the sensory functions of the elderly body to stimulate emotions, enhance cognition, and subsequently impact the psychology of the elderly individuals, thereby providing them with a more intuitive and authentic experience and emotions. Consequently, this effectively conveys the design concept and emotions of the furniture for the elderly, while also enhancing the sense of identification for the elderly users. Simultaneously, sensory design often integrates multiple senses, such as visual, auditory, and taste elements, thus offering a new experience and sensation to elderly users. Additionally, it grants the purchasing staff an initial impression of the product during the bidding process. Based on the aforementioned interviews and analysis of design requirements, the following design aspects can be further subdivided with regards to sensory design.

Material Properties. The material properties of age-friendly furniture design greatly influence the shape of the furniture and are predominantly determined by the production process and the materials utilized. The physical properties determine the function and utilization of age-friendly furniture. In accordance with the concerns and advocacies of older individuals, older people's furniture can only be acknowledged and accepted if it meets practical needs and functional objectives. This is also the focal point of designing age-friendly furniture, as it aims to cater to the specific needs of the elderly residing in nursing homes. By considering the characteristics of material properties and analysing the daily behaviours of the elderly, we can derive design aspects pertaining to material, function, process structure, human body size, and accessibility design.

Operational Attributes. When designing furniture for nursing homes that caters to the needs of the elderly, it is imperative to not only consider their requirements but also

take into account the market share and economic advantages of the product. In order to effectively operate in the market, the adaptability of the product must be carefully considered, and its design positioning should be precise. Additionally, it is important to determine the specific user group that the product aims to serve, ensuring that their needs are met while also facilitating unified management and maintenance within the nursing home. Key aspects to consider include rehabilitation guidance, the value derived from the product, safety measures, service provisions, and maintenance requirements.

Social Attribute. As China's population continues to age, especially the elderly population, it is exerting a significant and profound impact on various aspects of social and economic development as well as individuals' lives. Consequently, the design of age-friendly furniture will become the prevailing trend in future designs, offering greater convenience to the ageing population. As a distinct branch of furniture products, the design concept and program determination of age-friendly furniture must align with the fundamental laws of social development and the guiding principles of art and culture. These principles encompass what is commonly referred to as the social attributes of goods.

Emotional Attributes. The emotional sensitivity of older individuals tends to surpass that of younger people, and after retirement, they have ample time to express their heightened emotions. However, the interplay between their sensitive emotions and the gradual decline of their senses can lead to the emergence of undesirable emotions and feelings among the elderly. This, in turn, affects their mental well-being. Functional emotional design of furniture for the elderly entails incorporating humanistic care into the design, with a focus on meeting their physiological needs. When designing furniture for the elderly, emotional attributes play a vital role in all considerations, and the design must

cater to their emotional needs and characteristics. It is crucial to combine this approach with research on the physiological, psychological, and emotional traits of the elderly.

Intelligent Attributes. As scientific and technological advancements continue to progress, research in the field of intelligence is constantly evolving. Leveraging high-tech methods to enhance and perfect the functionality of furniture can promote the optimization and development of furniture for the elderly. These advancements help mitigate the inconveniences and challenges faced by the elderly due to factors such as declining physical function and cognitive abilities. The intelligent attributes of age-friendly furniture design involve addressing the deficits in physiological function and behavioural abilities of the elderly through intelligent assistive design. Additionally, it involves exploring how furniture can be utilized as a comprehensive health monitoring system for the elderly. Intelligent design plays a pivotal role in enhancing the living environment and quality of life for the elderly population. The intelligent design of furniture that caters to the needs of ageing individuals aims to mitigate the decline in their physical and cognitive functions caused by ageing, while also promoting their ability to live independently.

4.4.2 Analysis of Interview 2: Elderly in China Nursing Homes

a) Analysis of Interview Data

The researcher conducted an interview study with elderly residents in six nursing homes, utilizing conversational communication as a means of engaging with them. Through these interviews, the researcher gained insight into the physiological and behavioural aspects of the elderly, as well as the primary challenges and obstacles they face in using furniture. Additionally, the subjective perspectives of the elderly were analysed to identify their potential requirements for furniture products. Moreover, the

elderly were graciously requested to share their valuable opinions on furniture design, thereby enabling the researcher to gain a deeper understanding and first-hand experience from the elderly's standpoint. This ultimately facilitates further exploration in the realm of suitable furniture design for the elderly in nursing homes.

Throughout in communication with the elderly, comprehensive information was gathered regarding the current state of furniture usage among elderly residents in nursing homes, as well as their psychological needs. The genuine requirements of the elderly for furniture, along with their specific ideas and suggestions for age-friendly furniture, were documented. Through the analysis of age-friendly furniture in nursing homes, redundant or overlapping needs were identified and consolidated. Subsequently, the data obtained from the interviews were compiled, resulting in the creation of an analysed list of interview information (Table 4.21).

Table: 4.21 Content Analysis of Interviews Elderly in Nursing Homes

No.	Scope of questions	Subject of Assessment: Suzhou Fuhai Nursing Home, Hangzhou Dejia Nursing Home, Suqian Ren'ai Nursing Home, Nanning Liugang Xianyuan Nursing Centre, Changsha Xiehe Nursing Home, Guangzhou Taining Nursing Home
1	Physical and behavioural conditions	✓ Descriptions decline of physiological functions of the elderly people. For example, sensory system, nervous system, memory, cognition, immune system, muscle strength and bone firmness. ✓ Physiological changes in the elderly bring psychological pressure and mood swings to the elderly, who are psychologically prone to feelings of inferiority, loss, loneliness, impatience and depression. ✓ Elderly people have low endurance, are easily fatigued, and

Table 4.21 continued

		experience difficulties when engaging in prolonged standing or physical labour; Older people have weakened audio-visual and tactile abilities, with a concomitant decrease in sensitivity to colour and light, weakened ability to recognise sound, and a slowed ability to respond to heat and cold. Elderly people are less adaptable, less receptive to new things and prone to resistance.
2	Evaluate the use of existing nursing home furniture	Some of the shapes are not in proportion to the body size of the elderly and the inappropriate size puts pressure on the body. Lack of functional aids for older people. The furniture is bulky, not easy to move and not flexible enough. Cabinet Furniture: not enough storage space, inconvenient to get things, often can't find things. Bed: Difficulty getting up in bed, easy muscle pain, improper size of bed, uncomfortable sleeping position. Dining table and chairs, leisure chairs: dining chairs lack armrests, it is inconvenient to get up, dining table and chairs with a low degree of cooperation most of the lack of support body.
3	User's Requirements and preferences	Comfort, assistance, convenience, safety features, intelligence, voice prompts and operation, the Stable structure, warning signs, prompt function, accessibility, soft colour, easy to store, easy to clean, easy to start, multi-functional combination, behavioural habit cultivation, educational entertainment, rehabilitation training, protection device, personal customization, low cost of operation error, practicality, visual stability, cultural allegory, reasonable decoration, and so on.
4		Design more furniture with armrests or places to grip. Furniture should be strong and durable and not easily

Table 4.21 continued

	Design requirements and recommendations	damaged. • The furniture should not have sharp edges because it may injured the protect. • Therapeutic design that promotes physical and mental health and mitigates cognitive decline in the elderly. • Specific design and health improvement roles. • Humanistic care, complementary therapeutic aspects. • Furniture for leisure activities adapted to the behavioural barriers of older people. • The dimensions of the furniture and the its dimensions of the components must be suitable to the old people. • The proportions of furniture must appropriate to the human size and function.

b) Analysis of Interview Results

Given that elderly individuals residing in nursing homes belong a distinct group, their design needs differ from those of the general population in terms of furniture size, colour, shape, and function. Analysis of the interview results pertaining to elderly nursing home residents and their inquiries revealed that these individuals possess a unique perspective on furniture design. Consequently, furniture design tailored to the needs of the elderly should centre on nursing home furniture that caters to their daily lives. Based on the analysis and observation of interviews with elderly individuals in domestic nursing homes, preliminary principles for age-friendly furniture design can be summarized, encompassing the following aspects:

Firstly, the dimensions of furniture should be in harmony with the physiological decline experienced by elderly users. This entails considering both the ergonomic needs of the elderly and the dimensional relationship between the components within a furniture

product. Proportionality extends beyond the matching of components within the furniture; it also includes the furniture's structure, materials, and other factors. The modelling proportions of age-friendly furniture must be aligned with the scale and functionality of the elderly's bodies, and the compatibility of the human-machine dimension with the physical characteristics of the elderly becomes a key area of research.

Secondly, cognitive design for elderly users is of utmost importance. The cognitive abilities of the elderly play a crucial role in their utilization of furniture, impacting their behavioural and psychological activities. In this regard, it is imperative to develop suitable furniture models, incorporate auxiliary designs, and utilize appropriate materials that align with the behavioural characteristics of the elderly in contemporary times. Additionally, it is essential to consider the psychological aspects such as perception, attention, and memory in order to cater to the needs of the elderly.

Thirdly, it is crucial to address the emotional and aesthetic functional requirements of elderly users. The interaction between older adults and furniture products, along with the accompanying perceptual and cognitive processes, can significantly influence their emotional well-being. Hence, the design of furniture for nursing homes should encompass various aspects, including form, shape, material, and colour, to satisfy the aesthetic preferences and emotional needs of the new generation of elderly individuals.

Fourthly, ensuring the safety of older users is of paramount importance. age-friendly furniture, specifically designed for the elderly, should prioritize the sensory perception and tactile experiences of older individuals, as these factors strongly shape their initial impressions. It is essential to create a visual sense of stability and safety in order to instil a sense of trust and security in the elderly when it comes to age-friendly furniture.

Fifthly, it is crucial to cater to the behavioural habits of older users. Understanding and accommodating the behavioural patterns of the elderly is fundamental in designing furniture that serves as a supportive tool for their daily activities. For instance, furniture should provide adequate support when the elderly are standing. Considering that entertainment, reading newspapers, and communication are integral parts of the daily lives of the elderly, the design of furniture in nursing homes should aim to enhance convenience and comfort in carrying out these activities.

Finally, the integration of intelligent assistance is worth considering. Elderly users prefer furniture that does not require specialized knowledge to operate. However, they do expect furniture to possess functions such as body monitoring, intelligent reminders, and entertainment options. Therefore, the design of furniture should incorporate intelligent voice assistants, monitoring systems, emergency assistance features, and reminders to ensure the safety and convenience of the elderly in their daily lives.

4.4.3 Summary of Interviews

The aforementioned outcomes indicate that the elderly residing in nursing homes face numerous challenges pertaining to the utilization of furniture in their daily lives. These challenges encompass not only the physical and behavioral hindrances arising from the deterioration of their own physical functions, but also the discontentment and emerging functional requirements of the elderly due to the flawed design of the furniture. This includes the stress caused by inappropriate body size, the absence of functional aids for the elderly, as well as the neglect of the intellectual and emotional aspects of the elderly. Hence, it is imperative for researchers to investigate the behavioral activities of the elderly in their daily lives, and subsequently summarize the needs and principles for designing

suitable furniture for the elderly residing in nursing homes, with the aim of enhancing the quality of life for this demographic.

Through interviews and analyses, the design aspects for the elderly have been categorized into four dimensions. The first is basic design aspect, including safety, comfort, and convenience. Secondly, the functional design aspect includes not only the basic usage function, but also rehabilitation guidance, intelligent service, and health monitoring, among other diverse functions. Third, aspects of physiological and behavioral design aspect for the elderly. This involves giving full consideration to the physical functions and behavioral characteristics of the elderly, and conducting design practices based on the physiological and behavioral traits of those who have already entered or are about to enter the elderly stage of life. Lastly, there is the personalized design aspect. For instance, due to changes in the individual bodies of the elderly, it becomes necessary to incorporate auxiliary functions to facilitate communication and interaction, as well as accommodate other personalized needs. The design of furniture for the elderly in nursing homes should adhere to the concept of “elderly-oriented” design, deeply understand the perspective of the elderly, address their distinct needs, and prioritize their physiological and psychological requirements, thereby providing maximum convenience for their daily lives and activities.

The researcher conducted interviews and analyses involving experts and groups of older individuals residing in nursing homes, and subsequently derived firsthand design information through generalization. This was done in order to gain further insights into the elements of feasibility in design practices for age-friendly furniture in nursing homes. Furthermore, all interview data and findings were utilized to support the brainstorming activities conducted subsequent to the interviews.

4.5 Data Analysis of Brainstorming

In order to answer RQ 4 and achieve RO4, the researcher organised brainstorming activities with experts and designers in related fields. Based on theoretical research and analysis of the physiology and behaviour of the elderly population, this study divides the brainstorming activity into three stages: in the first stage, important keywords for age-friendly furniture design are identified; in the second stage, the functional hierarchy model of multifunctional age-friendly bed design is identified; in the third stage, based on the keywords and the functional hierarchy model, an analysis is done to draw a mind map of the design of the age-friendly multifunctional bed and to determine the design practices. In the third stage, based on the keywords and the functional hierarchy model, analyse and draw a mind map for the design of multifunctional ageing beds and identify design practices.

To offer improved guidance for the design of multifunctional beds suitable for ageing individuals in nursing homes, the researcher organized three brainstorming sessions, all of which were conducted in a team format and aligned with the three phases of the activity's objectives and content. The specific topics of the three brainstorming sessions can be found in Appendix D.

The three phases of the brainstorming process are designed to inspire participants to think creatively, generate as many ideas as possible, and form systematic design solutions to solve problems. The creative process requires experts and designers in relevant fields to brainstorm on what could be done to promote the design benefits of age-appropriate furniture, while put forward ideas and design suggestions to address the needs and problems of the elderly in nursing homes.

After the brainstorming, the results of the brainstorming are then selected and summarised. The primary design process in this phase is whether the selection criteria contribute to RQ 4 and RO 4, followed by whether they create new social benefits while solving their own problems. After selecting the best ideas and content based on the above criteria, the results of the brainstorming and analysis will be presented in Chapter 5 design practice.

4.5.1 Brainstorming 1 Analysis: Identifying Keywords for Age-friendly Furniture Design

a) Scale of Application of the Brainstorming Model of Creative Stimulation

In the first phase, a fun and creative brainstorming exercise was conducted to identify current keywords suitable for nursing home furniture design and practice from the designers' point of view.

A total of 30 designers were invited to participate in this activity, and in terms of grouping, there were fixed groups and they were divided into three separate groups, with the usual number of participants in each group being around 10. From the basic information of the interviewees' experience in brainstorming, it is clear that all of them have rich experience in brainstorming.

b) Random Word Brainstorming

One of the main goals of a brainstorming session is to generate novel ideas. A highly effective method to accomplish this is to identify the key terms that come to mind when discussing a specific topic or theme. Random word brainstorming is an excellent technique to achieve this precise outcome.

During this activity, the facilitator provides the participants with a designated reading strategy and a specific set of necessary tools. Drawing upon their expertise and knowledge, the participants compose a list of 80 keywords that they perceive to be the most crucial elements or principles in the design process of nursing home furniture that caters to the needs of ageing individuals. Simultaneously, the combinations are ranked in terms of sensory attributes, intellectual attributes, physical attributes, emotional attributes, operational attributes, and social attributes, with the heaviest being given the highest priority.

Furthermore, the participants are instructed to choose 30 keywords from a provided pool of 300 keywords. They are then required to perform a weighted permutation and combination, followed by data analysis and statistical examination. The resulting data, which is both reliable and practical, serves as a valuable reference for resolving design-related issues (please refer to Appendix E for further details).

c) Results and Analyses of Activities

Random word brainstorming methods are very fast and usually very effective in solving specific problems. All keywords contribute to the design practice. In the process of collecting and organising the brainstorming data from the participants, the researcher used the Analytical Hierarchy Process (AHP) to code and analyse the keywords (Xu et al., 2019). As a result of the first` phase of the brainstorming activity, a total of 50 keywords were selected for weighting and analysing in this study (Table 4.22), which is an important source of data reference for conducting the second phases of the brainstorming activity, as well as the later stages of the design practice. The research use “code” on a reference to participant involvement.

Table 4.22: List of Keyword Weights Extracted from Brainstorming Session 1

Code 1	**Code 2**	**Code 3**	**Code 4**	**Code 5**
Ergonomics	Anti-fall & Anti-bump	Structural Stability	Physiology & Behaviour	Intelligently
Code 6	**Code 7**	**Code 8**	**Code 9**	**Code 10**
Environmentally Friendly	Comfortable Material	Voice Reminder	Medical Assisting	Emotional Resonance
Code 11	**Code 12**	**Code 13**	**Code 14**	**Code 15**
Easy to Store	Rehabilitation	Easy Cleaning	Usability	Surety
Code 16	**Code 17**	**Code 18**	**Code 19**	**Code 20**
Pragmatic	Functionality	Colour	Appreciating	Perceptual
Code 21	**Code 22**	**Code 23**	**Code 24**	**Code 25**
Respect &Care	Technology	Moulding	Hairstyle	Sizes
Code 26	**Code 27**	**Code 28**	**Code 29**	**Code 30**
Anti-fouling &Wear-resistant	Manufacturing Costs	Personalised	Logo Reminder	Participatory
Code 31	**Code 32**	**Code 33**	**Code 34**	**Code 35**
Adjustability	Material	Emotionally	Humane	Green design
Code 36	**Code 37**	**Code 38**	**Code 39**	**Code 40**
Arts & Crafts	Barrier-free	Morphological	Visually	Comfort
Code 41	**Code 42**	**Code 43**	**Code 44**	**Code 45**
Configure	Cost Control	Rounded Corner	Convenience	Framework
Code 46	**Code 47**	**Code 48**	**Code 49**	**Code 50**
Special Needs	Without sharp corners	Adjustment Function	Modularization	Post Maintenance

4.5.2 Brainstorming 2 Analysis: Identifying Design Keywords and Functional Hierarchy Models for Age-friendly Multifunctional Beds

The second phase of the brainstorming activity was organised in the same way as the first phase, with the aim of collecting, arranging and determining keywords for the functional hierarchy model of the design practice of multifunctional age-friendly beds for

nursing homes. This information will be used on a solution for the bed design practice where the research will design a bed for elderly people. The generated results were used to answer RQ4 and to make data reference for the design practice programme of age-friendly furniture in nursing homes. It is mainly divided into the identification of keywords and structural models.

a) Identify Keywords for the Design of the Multifunctional Age-friendly Furniture Bed

Based on the analysis of the interview data in 4.4.1 and the results of the keywords from the Stage 1 age-friendly furniture design Brainstorming. A brainstorming group was formed with two design experts and four senior designers as key participants for close to three hours. Participants were asked to share their ideas based on the expertise and practical experience of the experts by recording and organising until the list of keywords as shown in table 4.23.

Table 4.23: List of Keyword Weights Extracted from Brainstorming Session 2 for the Bed Design Practice

Code 1	**Code 2**	**Code 3**	**Code 4**	**Code 5**
Basic functions of the bed	Structurally sound	Intelligent monitoring	Protection device	Multifunctional mattress
Code 6	**Code 7**	**Code 8**	**Code 9**	**Code 10**
Bed adjustment function	Accessibility	Health care	Rehabilitation guidance	Medical aid function
Code 11	**Code 12**	**Code 13**	**Code 14**	**Code 15**
Rehabilitation function	Bed shifting function	Intelligent lighting	Tip function	Gather up & Conclude
Code 16	**Code 17**	**Code 18**	**Code 19**	**Code 20**
Intelligent voice	Bedside table board	Aid station facility	Angle adjustment	Easy to install and dismantle
Code 21	**Code 22**	**Code 23**	**Code 24**	**Code 25**
Sizes	Recreation functions	Pragmatic	Lifting function	Comfortable

b) Functional Hierarchy Model of Age-friendly Multifunctional Beds

In order to clarify the weights of functional elements at each level, the Analytical Hierarchy Process (AHP) proposed by Professor T.L. Saaty of the University of Pittsburgh, an American operations researcher, was used to carry out the analysis. The hierarchical relationship and weights of product functions are integrated, and then based on the importance of functional elements at each level, the functional hierarchy model of age-friendly multifunctional beds is constructed at the quantitative level (Figure 4.29), which serves as a few important design criteria for age-friendly furniture.

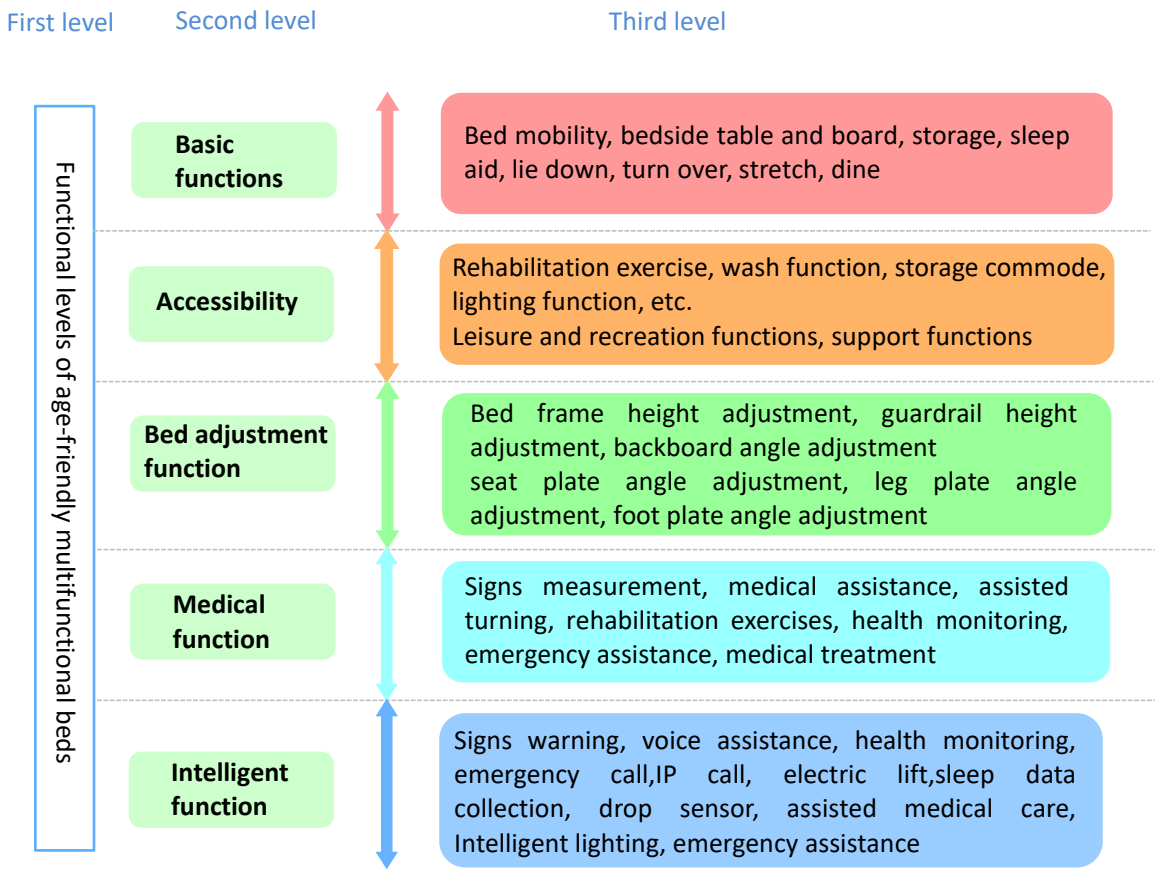


Figure 4.29: Functional Hierarchy Model for Age-friendly Multifunctional Bed

4.5.3 Summary of Brainstorming Activities

Brainstorming is a creative thinking technique that aids in generating new ideas and solving problems. It enables the team to develop feasible solutions for the target problem. Overall, this brainstorming activity proves to be effective and engaging. It stimulates the generation of original ideas for age-friendly furniture design as well as the improvement of multifunctional age-friendly furniture beds. The quantity and quality of ideas, as well as the mode of idea stimulation by team members and the resulting outcomes, have all yielded significant results.

The research in this phase basically focuses on two aspects. Firstly, it involves the study of keywords related to age-friendly furniture in nursing homes. Through the random word brainstorming method, 50 important keywords for age-friendly furniture design were identified. Secondly, it involves the collection and organization of keywords for the design practice of multifunctional age-friendly beds, resulting in the identification of 30 keywords. The design and validation of a functional hierarchy model for these beds were also systematically explored. Lastly, the design thinking and strategies for age-friendly multifunctional beds in nursing homes were identified based on the sharing and analysis of participants' input from the first two activities. Furthermore, the criteria and principles for designing age-friendly furniture in nursing homes were further developed.

The two brainstorming activities conducted in this study have addressed several practical concerns that were summarized in the aforementioned interview research. Additionally, it introduces an element of enjoyment throughout the entire process, boosts the motivation and sense of accomplishment among the participants, and effectively

resolves various issues that may arise during the design of age-friendly furniture for nursing homes.

4.6 Chapter Summary

The main focus of this chapter is to analyse the results of the data survey to discuss and summarize the elements, principles, and methods involved in designing age-friendly furniture for older individuals in nursing homes.

The first section applies Cite Space software to visually present and analyse relevant literature, and at the same time elaborates on the development context, current situation analysis, and future trends in age-friendly furniture design. The researcher contends that there is a dearth of research on age-friendly furniture design in China, and underscores the importance of establishing a theoretical framework for designing such furniture in nursing homes that aligns with the physiological and behavioral characteristics of elderly Chinese individuals. This theoretical framework serves as a vital guide throughout the research process.

The second section collects a substantial amount of data on the basic living conditions, physiological and behavioral characteristics of the elderly in nursing homes, as well as their satisfaction with furniture and design requirements. This is achieved through the utilization of questionnaire surveys. The collected data is subsequently meticulously counted and analysed. The study's findings reveal that the elderly individuals are not highly satisfied with the existing furniture, and that there are numerous issues and ample room for improvement in this regard. This underscores the significance of studying the physiological and behavioral characteristics of the elderly, as it serves as a crucial foundation for designing suitable furniture for nursing home residents.

The third and fourth sections summarize the design aspects of age-friendly furniture through analysis and summary of the interview data. Specifically, they explore the six design attributes of age-friendly furniture in nursing homes and their constituent structures. Furthermore, the theoretical foundation of this study is established through two brainstorming activities aimed at addressing practical problems identified in the interview research.

To sum up, Chapter 4 presents a comprehensive exploration of the design practice of age-friendly furniture for nursing homes, including data analysis, design thinking, underlying framework, principles, and methodologies. Subsequently, Chapter 5 then provides an in-depth discussion of the design practice of age-friendly multifunctional furniture that incorporates the physiological and behavioural characteristics of elderly individuals residing in nursing homes as crucial design variables.

CHAPTER 5

THE DEVELOPMENT AND EVALUATION OF AGE—FRIENDLY MULTIFUNCTIONAL FUNITURE THROUGH DESIGN PRACTICE

5.1 Introduction

This chapter primarily relies on the analysis of survey data from chapter 4 and proposes the user requirements, design elements, design principles, and design methods of elderly furniture in Chinese nursing homes. The objective is to validate these findings by applying them to the design of multifunctional beds for the elderly in nursing homes. The target users of this design are middle-aged and low-aged elderly individuals who possess basic self-care abilities, as well as those who require nursing care due to mobility issues, slow reaction time, and old age. The move aims to provide comfortable and secure living services for the elderly in nursing homes in China, enhance their self-care abilities, provide a convenient and comfortable bedside living environment, reduce the workload of caregivers, improve care-giving efficiency, and ensure the safety of the elderly.

During the design practice, the researcher initially utilizes the results of the preliminary data survey and analysis as a foundation. This is combined with literature research to explore the convergence and integration between existing theoretical research outcomes and the ageing furniture found in nursing homes. Additionally, the rationale behind the selection of case study is reviewed. Subsequently, the design features of the multifunctional age-friendly bed are discussed based on the user requirements refined in Chapter 4. Following this, the researcher focuses on the design practice of an ageing bed in a nursing home, integrating the design thinking and process from Chapter 3 to complete the design practice of the ageing multifunctional bed. Lastly, the product is tested and

evaluated through the use of mock-ups and prototypes, generating research results to address the fourth research question.

5.2 Rational of Furniture Design: A Case Study

The ageing society in China has given rise to a new social phenomenon, wherein the development of institutionalized elderly care has gained significant momentum. Consequently, there is an urgent need to adopt a more comprehensive and rigorous approach to the design thinking, principles, methods, and practices of nursing home furniture for the elderly. The selection of nursing home beds for the elderly holds immense importance and cannot be overstated. Hence, this study serves as a case study focusing on the design of beds for the elderly in nursing homes. The study takes into account various factors, including the national conditions of China, bed functions, physiological and behavioral conditions of the elderly, and their physical and mental health conditions and other rational considerations.

5.2.1 From China’s National Conditions

Regarding the design of furniture for the elderly in nursing homes, China is currently at the initial stage of both theoretical research and design practice. In addition to drawing insights from foreign experiences, it is imperative to align the design research with the actual needs of the elderly in nursing homes. The design should not only cater to the daily needs of the elderly but also facilitate the daily care of staff. Hence, the preference in Chinese nursing homes is to opt for multifunctional beds. Consequently, through the examination of the theories and practices of elderly furniture design both domestically and internationally, it is evident that China's elderly furniture industry requires a more comprehensive and rigorous set of theories, standards, and practices to

guide the design of multifunctional beds for the elderly in nursing homes. This serves as the starting point for the selection of this case study.

5.2.2 From the Bed's Own Functions

According to the Shuo Wen Jie Zi: "Bed, the sitter of the body." The term "bed" signifies stability for the body. In other words, a bed serves as a tool for sitting and lying down rather than solely for sleeping. It is a place of great significance for modern elderly individuals, providing a space for activities such as reading, watching TV, and socializing. This is especially true for elderly individuals requiring nursing care, as many aspects of their daily lives, including meals, exercise, and medical treatment, may be carried out on the bed.

The bed is one of the oldest and most frequently used pieces of furniture for the elderly, playing a crucial role in their sleep quality and overall safety. Integrating concepts of intelligence, emotion, human function, and accessibility design into the creation of age-friendly multifunctional beds is advantageous in enhancing the self-care capabilities of the elderly and ensuring their safety.

5.2.3 From Research on the Physiological and Behavioural Conditions of Elderly in Nursing Homes

Through conducting market research on furniture designed for nursing homes that caters to the needs of the elderly, as well as analysing the results of questionnaire surveys and interviews with elderly individuals residing in nursing homes, it has been discovered that as individuals age, they inevitably experience the effects of ageing on their bones, visual and mobility abilities, as well as the deterioration of their nerve and muscle tissues. These physiological characteristics not only hinder the daily activities and range of motion

of the elderly, but also significantly increase the amount of time they spend indoors. According to statistical data, elderly individuals spend anywhere from 8 to 14 hours a day in their beds within their bedrooms, underscoring the direct impact that the comfort and usability of their beds have on their overall quality of life and health. Consequently, this has led to a growing interest in the development of multifunctional beds and other lying products that cater specifically to the needs of the elderly.

Taking into consideration the physiological conditions and behaviors of elderly individuals within nursing homes, we have undertaken an analysis of their specific behaviors related to entering, engaging in daily activities, and exiting their beds. This analysis lays the foundation for exploring the principles and methodologies of elderly furniture design in nursing homes, while also considering the China's unique national conditions. The aim of this research is to establish design standards and practices for domestic furniture enterprises to utilize in the design and development of age-friendly furniture products, thereby contributing to the advancement of the age-friendly furniture industry.

5.2.4 From the Perspective of the Physical and Mental Health of Elderly in Nursing Homes

The results obtained from surveys indicate that a significant portion of elderly individuals experience varying degrees of insomnia symptoms. The quality of sleep directly impacts various aspects of an individual's physical well-being, including their immune function. Insufficient sleep can lead to immune dysfunction and increase susceptibility to various diseases. This is especially important for the elderly, as sleep deprivation makes it challenging for them to adapt to the changes in day and night. Hence, it is particularly important to provide a comfortable and warm multifunctional bed for the

elderly in nursing homes becomes paramount. Such a bed not only serves medical care purposes, but also offers intelligent assistance, sleep monitoring, and emergency assistance. Additionally, it carries positive psychological implications for the elderly, enabling them to experience improved sleep quality through a state of psychological comfort and muscle relaxation. This, in turn, greatly contributes to the overall physical and mental well-being of elderly individuals residing in nursing homes.

5.3 Design Feature: Multifunctional Bed Design Specifical

However, the decline in cognitive, perceptual, and operational abilities among the elderly will pose significant challenges when using highly integrated products, resulting in reduced efficiency and accuracy in their operation. The current research and design of age-friendly furniture face difficulties in effectively filtering and extracting core functions from the multitude of redundant, fragmented, and trivial functions, with the aim of simplifying product functions and achieving advanced functions. The design of basic functions, analysis of core functions, and prioritization of advanced functions should be approached by studying diverse user needs, selecting and screening multiple product functions. Furthermore, considering the characteristics and structure of the product, as well as the transformation of user behavior and experience, intelligent design methods or technologies should be employed to optimize the functional design of furniture products. Lastly, adopting a modular design concept, each function should be optimized to obtain corresponding module products based on demand, thus reducing production costs and maximizing economic benefits.

5.3.1 Intelligent Design

The intelligent design of nursing home beds for the elderly primarily involves real-time

collection of various signals through sensors, utilizing modern digital information processing and communication technology. Subsequently, the collected signals are processed by the controller according to predetermined procedures, encompassing recording, logical judgement, and information feedback. The controller then performs specific information processing and reports it to the information management platform (YU et al., 2019), followed by providing corresponding feedback through actuating and transmission devices to meet user needs (Figure 5.1).

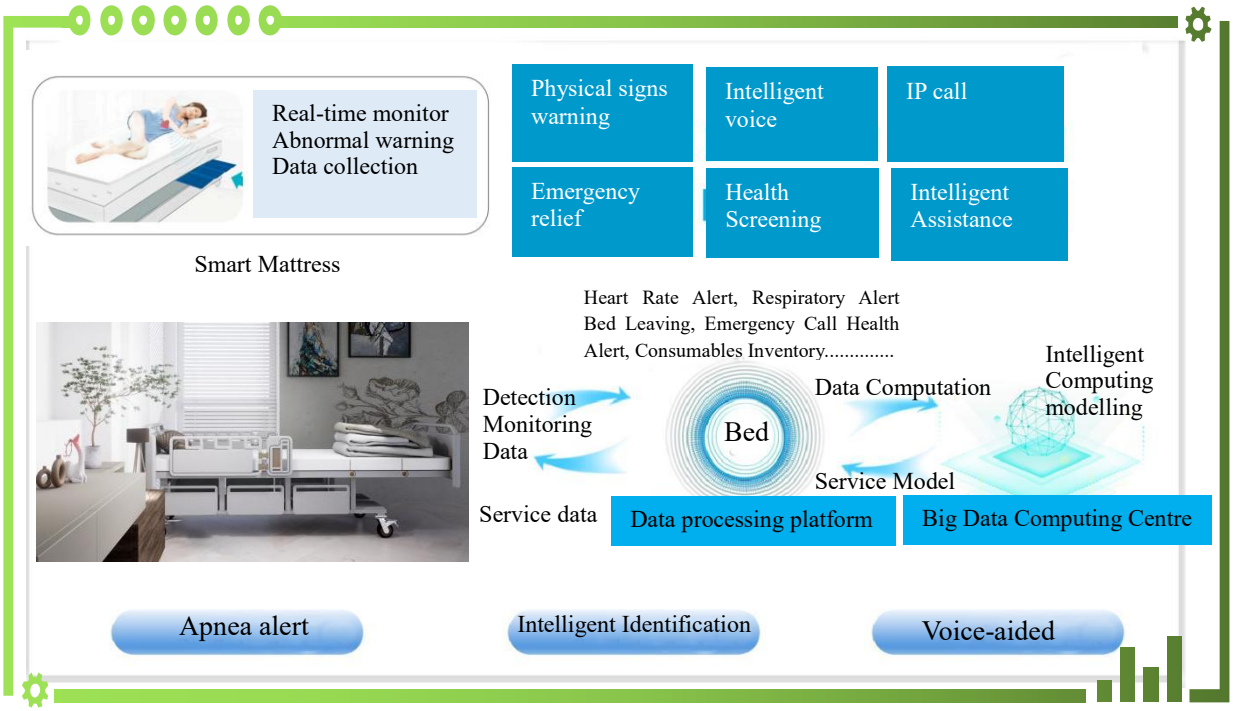


Figure 5.1: Multi-functional Bed Intelligent Monitoring Service Design Platform System

When designing intelligent furniture for the elderly residing in nursing homes, two aspects need to be considered. First, it is crucial to address compensatory measures for the elderly physiological limitations and facilitate their ease of use. Additionally, the furniture serves as a comprehensive health condition monitoring system for the elderly. Therefore,

the functions of intelligent furniture suitable for nursing home use by the elderly are mainly categorized into intelligent recognition, intelligent adjustment, health monitoring, and intelligent prompts and recent assistance.

a) Intelligent Adjustment Design

The multifunctional bed has an intelligent adjustment function, which enables the furniture to be intelligently modified based on the user's body structure and usage habits in order to fulfill the user's requirements. This adjustment mainly includes modifications in bending, height, scale, lighting, and temperature.

b) Health Monitoring

Intelligent adjustment functions involve integrating sensor devices into furniture products, particularly smart mattresses, to monitor various aspects of the elderly physical condition, such as sleep patterns, blood pressure, and heart rate. Furthermore, this function conducts basic health analysis and provides recommendations based on the health data of the elderly, which is then transmitted to the health data centre of the partner hospital. Additionally, the smart mattress consists of an array of pressure sensors that can determine the posture and sleeping conditions of the elderly while lying on the bed.

c) Intelligent Tips

The assisted living function, which relies on intelligent recognition, seamlessly integrates environmental control and monitoring, intelligent control of home appliances, and entertainment features, such as audio and video capabilities. This function is then connected to the control panel of the multifunctional bed, which is equipped with a voice assistant to provide reminders to the elderly regarding daily matters, such as weather forecasts, time alerts, entertainment options, medication reminders, and exercise prompts.

d) Health Information Data Feedback Design

Sensors are utilized to detect the bodily functions of the elderly and gather a substantial amount of relevant data. This aids the elderly in understanding their health status and facilitates the timely detection of health issues, disease prevention, and pain relief. For example, a smart mattress with a built-in electric heat regulator can record changes in the body temperature of the elderly during sleep, providing a realistic overview of these fluctuations. The smart bed armrests are designed to help seniors use their upper body strength to aid mobility. Through the pressure sensor, changes in the relationship between the pressure used by the elderly and the time taken can be analysed to determine improvements or deterioration in the user's strength and body balance.

e) Intelligent Assistance and Emergency Care

Most nursing homes in China typically have a limited number of caregivers, resulting in the utilization of one-to-many service care, which often leads to inadequate attention. Furthermore, elderly individuals who require nursing care or have mild dementia must strive for self-care.Various safety technologies have been developed to detect the presence of the elderly in their living spaces, such as smart sensors, audio and video surveillance, and smart wearable products. However, there is a scarcity of smart technologies specifically tailored to the living environment of elderly individuals in nursing homes. Consequently, the design and analysis of these technologies must be consistent with the behavioral patterns of the elderly. Special consideration is given to the distinctive characteristics of the spatial environment in nursing homes and the elderly’s reliance on their beds. As a result, the intelligent assistive and emergency care settings of the ageing bed can offer timely and precise services to both the elderly and their caregivers.

f) Intelligent Voice Design

As individuals age, their hearing, memory, and other cognitive functions naturally decline. Consequently, the use of single-channel voice interaction can exacerbate the cognitive load experienced by elderly users. The voice user interface of the aging-adapted smart bed employs voice as the primary mode of information interaction and supplements it with visual information to enhance the interaction experience for elderly users(Wei Chen,2022). This approach promotes the multi-channel perception of the voice interaction system among the elderly.

When designing voice user interface assistants that are tailored to the needs of the elderly, it is important to incorporate personification design elements to foster a sense of dependence and trust among elderly users. Additionally, emotional voice interactions can be achieved. For instance, when the voice interaction system detects that an elderly user is experiencing sadness or a low mood, it will use a calm and gentle voice to talk to the user. The system also actively prompts the elderly user to utilize certain system functions through voice commands, such as making video or voice calls with their children, or listening to music or theater performances.

5.3.2 Diversified Functional Requirements of Users

Through the findings obtained from the collection and analysis of data using a combination of research methodologies including initial literature review, questionnaires, interviews, and brainstorming sessions, the primary focus of the design and development of multifunctional beds in nursing homes lies in addressing the needs of elderly households. These beds are specifically designed to align with the principles of age-friendly design and prioritize physiological and behavioral features. Moreover, it also aims to meet the diverse

functional requirements of elderly residents in nursing homes, encompassing aspects related to psychology, safety, living environment, spirituality, and emotions. These multifunctional beds are categorized into three main types: basic, core, and advancement functions, as illustrated in figure 5.2 .

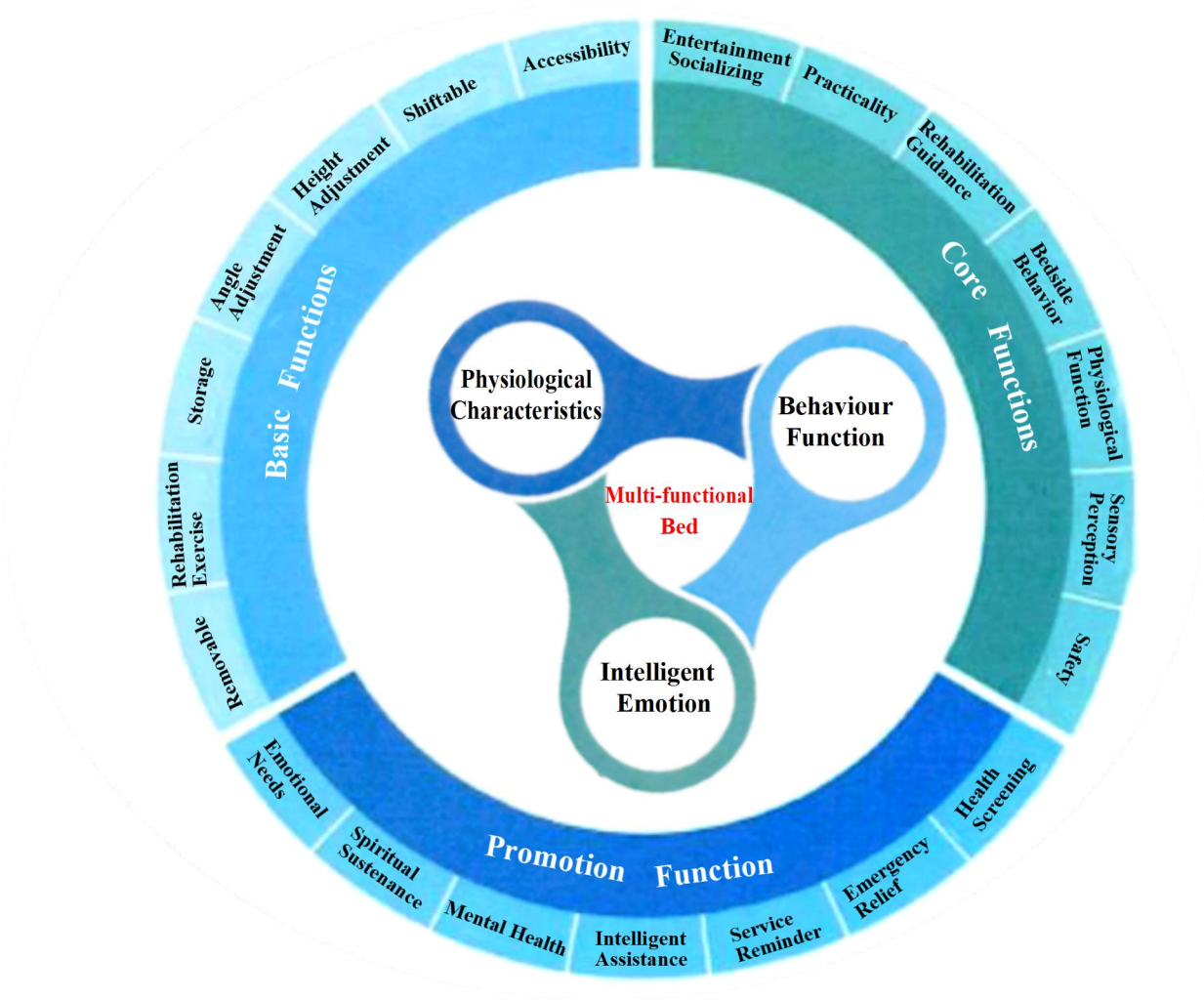


Figure 5.2: Diversified Functional Needs Map for Elderly in Nursing Homes

a) Basic Functions

Survey results indicate that elderly individuals exhibit greater interest in the various functions offered by multifunctional beds, including movement, lighting, backboard adjustment, turning over, and rehabilitation exercises. Consequently, the design of these beds should incorporate features such as bed mobility and fixation mechanisms, as well as bedside lighting. Furthermore, by incorporating linkage and hinge structures, the bed can be adjusted within a specific range of sizes and angles, thereby enhancing its practicality. Additionally, it is crucial to consider the needs of physically challenged elderly individuals and provide them with removable devices to promote accessibility. Simultaneously, the design should also address aspects of fall prevention, slip resistance, collision avoidance, safety assistance, and prevention. Moreover, the product's functionality can be expanded by selectively incorporating general or additional functions.

b) Core Functional Elements

Firstly, from a physiological standpoint, it is crucial to meet the visual needs of the elderly, enhance their perceptual capabilities, and consider their physical and motor abilities(Xu, Z,et al.,2019). Secondly, in terms of behavioral aspects, efforts should be made to simplify the length and complexity of behavioral operations as much as possible. This can be achieved by incorporating various auxiliary designs to ensure safety, accessibility, and ease of use. Furthermore, the level of softness and hardness of the furniture should also be taken into account.

In order to achieve functional ease of use, versatility, and convenience for the elderly, the functional design should prioritize practicality and multi-purpose functionality of the bed. It should also cater to the social, recreational, and massage needs of the elderly.

Furthermore, rehabilitation guidance should be provided to help the elderly develop positive habits and behavior, enhance their practical abilities through the design of puzzle pieces, and facilitate appropriate rehabilitation training. Safety tips should include warning signs for risky behaviors to prevent the elderly from getting hurt, while also guiding them on proper bed use. This will help instill a sense of safety and prevent any risks associated with its use. The core functional design of the ageing bed should address the physiological and behavioral characteristics of the elderly in nursing homes, and enhance their overall user experience.

c) Promotion Function

In terms of promoting functionality, researchers primarily focus on two key aspects: intelligent design and emotional design of multifunctional beds. The continuous advancements in science and technology have allowed for the integration of high-tech features to enhance and optimize the functionality of furniture for the elderly. This helps compensate for the limitations brought about by the decline in physical and cognitive abilities. Moreover, intelligent information fusion and monitoring design ensure effective supervision and protection of the elderly health and safety within their living environment. These aspects have been discussed in detail in the previous section.

In the design of beds that are suitable for older individuals, it is essential to prioritize the emotional well-being and mental state of the elderly residing in nursing homes. It is crucial to meet their expectations of life to the greatest extent possible. One approach to achieve this is through the implementation of emotional design, which can enhance the overall sense of happiness and contentment among the elderly in nursing homes. This could help alleviate the pressures experienced by elderly individuals in China

in their later years and reduce their sense of social exclusion. For instance, incorporating features that are considerate of the elderly aesthetic and psychological needs, such as the use of humane functions, shapes, and forms, can be beneficial. Furthermore, it is crucial to take into account the emotional requirements of the elderly. This can involve ensuring that they feel a sense of warmth and support at an emotional level, thus reducing or eliminating feelings of loneliness. Additionally, it is important to provide spiritual care and support for the elderly, allowing them to find solace and guidance in their spiritual beliefs.

5.3.3 Transformation of User Behaviour and Experience

The focus on the alteration of user behavior and experience represents a comprehensive enhancement of the physiological, behavioral, psychological, and emotional dimensions of the experience of older individuals when utilizing multifunctional beds. Behavior can be understood as a series of actions undertaken by users in pursuit of a specific objective. Therefore, in the context of designing multifunctional beds for the elderly in nursing homes, it is necessary to investigate all the behavioral processes related to bedside activities conducted by the elderly. This implies that a thorough examination of the experiences associated with entering and exiting the bed, as well as daily activities performed in bed, is required for elderly individuals in nursing homes (Figure 5.3). Consequently, adopting an experiential perspective in the design of multifunctional beds in nursing homes provides a clear direction and framework for this research and design practice.

Drawing upon the physiological and behavioral aspects of the design of multi-functional ageing beds, the overall enhancement of the design's experience is contingent upon the formation of user behavior. Achieving this necessitates the consideration of

various aspects in the design of the bed's appearance, functionality, and interactive interface. Additionally, the physiological, psychological, and emotional characteristics of elderly users must also be fully considered. Furthermore, the design should prioritize experiential factors related to various perceptual perspectives such as vision, hearing, touch, cognition, and memory.

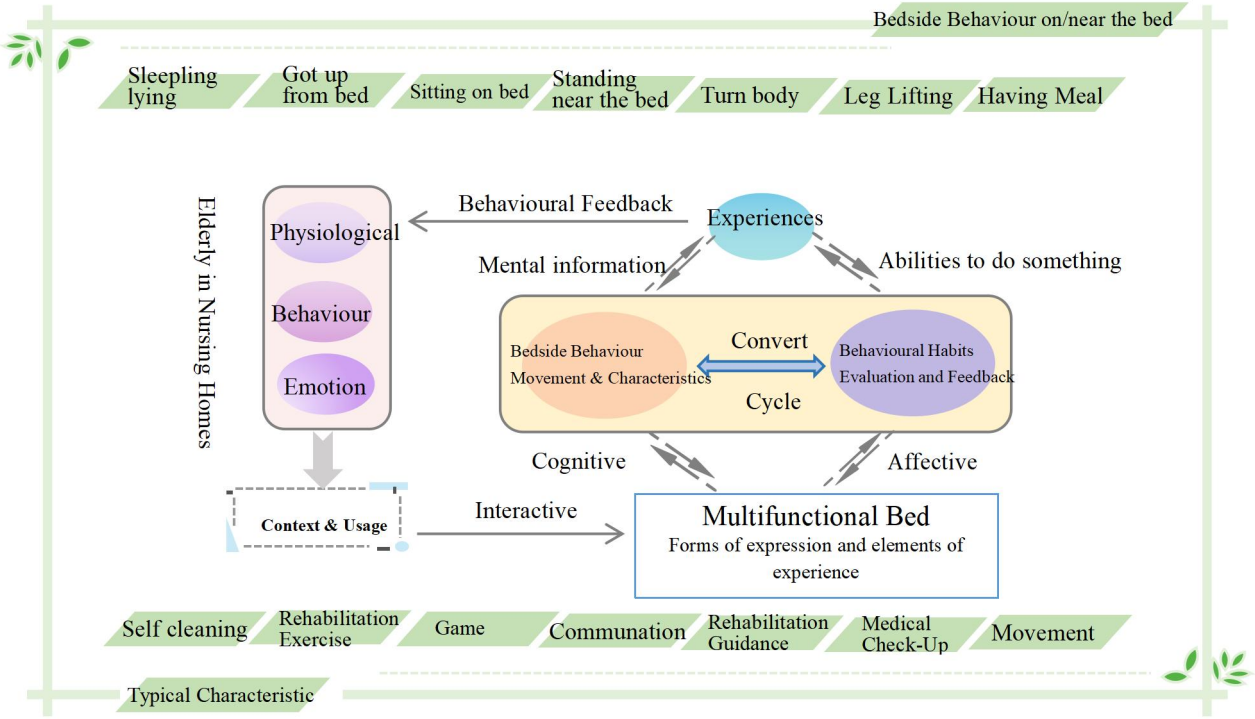


Figure 5.3: Transformation Map of Behavior and Experience of Elderly Users in Nursing Homes

The process of generating behavioral experiences revolves around the transformation and cyclical nature of behavior and experience. This transformation mechanism comprises three components: the user, the product, and the context. The fundamental sequence of behaviors performed by users of ageing multi-functional beds is extracted at the operational level and then decomposed based on specific tasks. This

includes activities such as getting in and out of bed, daily care, eating, toileting, cleaning, reading, entertainment, sleeping, and rehabilitation training. Subsequently, the corresponding behaviors are summarized, filtered, and integrated to derive typical user behavioral characteristics.

In order to enhance the user experience, the design of product functions should align as closely as possible with user behavioral characteristics. Therefore, incorporating user behavioral design into the development of age-friendly beds, with the aim of enhancing the user experience, is of utmost importance in promoting the acceptance of the product among the elderly. In order to comprehensively and accurately explore the changes in behavior and experience in the design of multifunctional beds in nursing homes, the authors attempt to draw a diagram depicting the transformation of behavioral experiences among elderly users in nursing homes. This diagram, as shown in Figure 5.4 below, conveys the design concept, positioning, and ideology of multifunctional beds for the elderly, thus indicating the design approach and direction.

5.3.4 Application of Modular Design

The utilization of modular design is derived from the aforementioned functional hierarchical design approach. To achieve a seamless alignment between the supplemental functions and the fundamental functions, it is imperative to optimize the modular design of each function and subsequently integrate it into the comprehensive care furniture system to obtain the corresponding module products based on the demand. The term “module” refers to a typical versatile independent unit that can be amalgamated into a system with a specific defined function and interface structure.

a) **Modular Design**

This study, grounded in the principles of sustainable development and the designer's sense of social responsibility, employs the concept of modular design in the creation of age-friendly furniture products for nursing homes, with functional analysis serving as the foundation. It primarily encompasses two aspects: the functionality of age-friendly beds determined by the requirements of elderly users in nursing homes, and the technical principles adopted by enterprises to fulfil the functional requirements of users.

b) Market Perspective Analysis

In order to adapt to the swift development of China's nursing home market, ageing beds undergo updates and iterations, employing modular design to divide multifunctional ageing beds into distinct functional modules for design and combination. The modular design of multifunctional ageing beds features standardization, which involves standardizing the design of each module unit and subsequently combining and layering them in a standardized manner.

The modular design of multifunctional ageing beds is manifested through the method of combination, wherein a single module unit can be combined, as can combinations of larger units. Consequently, this approach not only shortens the product design cycle and production costs, but also caters to the individual requirements of elderly users in nursing homes, and also facilitates the maintenance of furniture products.

c) Modular Design Application

In accordance with the modular elements, the multifunctional ageing bed is divided into four major modular parts for production: the bed frame, the bed base, the intelligent mattress, and the information service platform system, as illustrated in figure 5.4. Among

these, the bed frame is located beneath the mattress and is a metal automated instrument device utilized to facilitate various changes in body position alongside the mattress. The bed base, enclosed with new materials, offers individuals a close and natural sensation in terms of its appearance. The selection of intelligent mattresses for bedding pertains to the utilization of sensor devices integrated into furniture items via intelligent mattresses to astutely monitor various aspects of the physical condition of the elderly, including sleep patterns, blood pressure monitoring, and heart rate monitoring.

The information service platform of the multifunctional elderly bed mainly relies on sensors and uses modern digital information processing technology to collect massive and diverse signal types in real time. Subsequently, in accordance with pre-established procedures for recording, logical assessment, and information feedback, among other processes, this data is conveyed to the information management platform. The design of multifunctional beds within nursing homes serves as the core, incorporating intelligent devices, the user, and the control interface or voice-activated assistance, thereby facilitating human-computer interaction.

Furthermore, the base of the multifunctional bed is equipped with four casters, making it effortless to move and controlled through a smart remote control device. The casters can be automatically locked to ensure security.

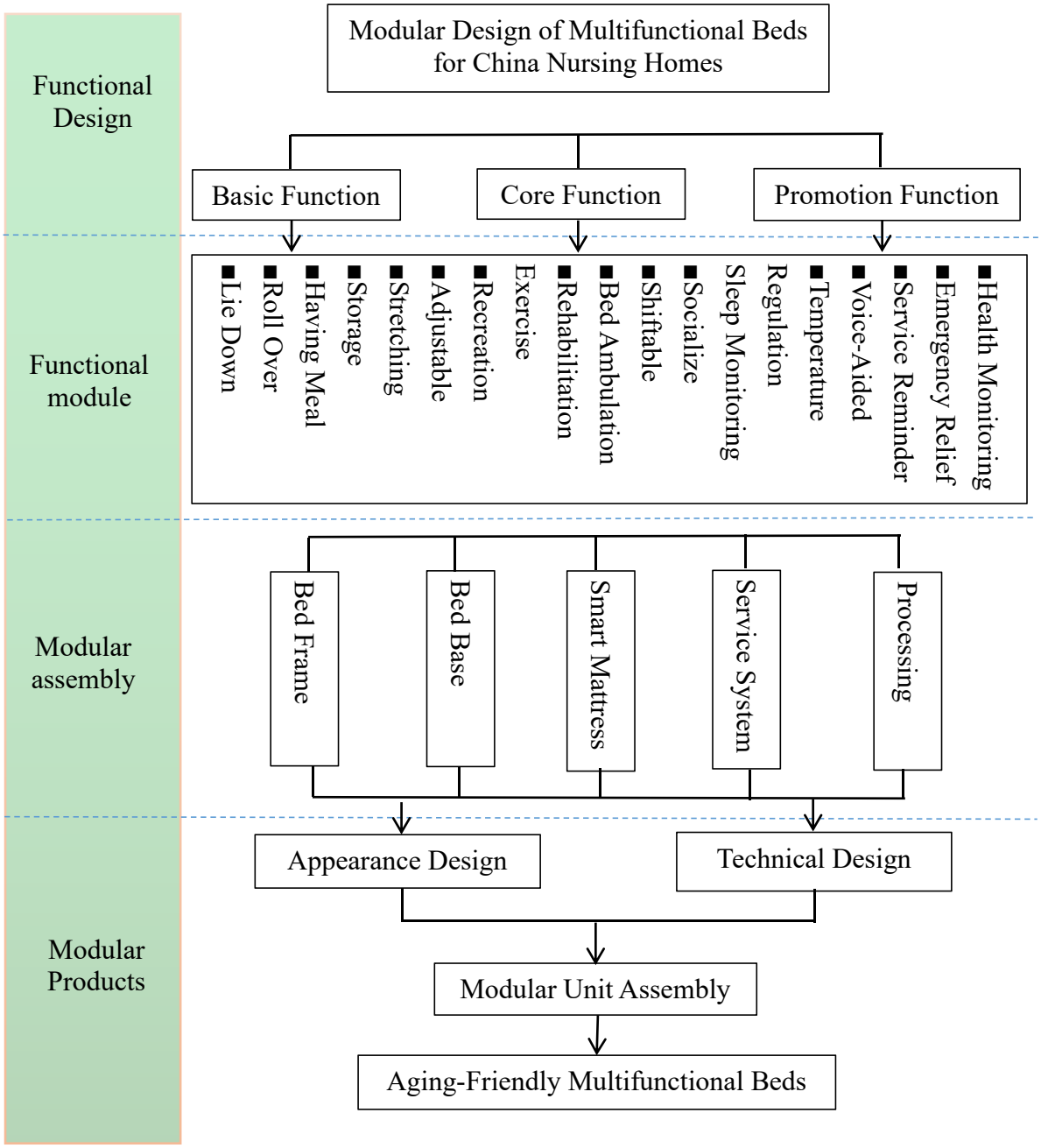


Figure 5.4: Modular Design of Multifunctional Beds in Nursing Homes

5.4 Design Ideation

5.4.1 Design Thinking and Process Framework

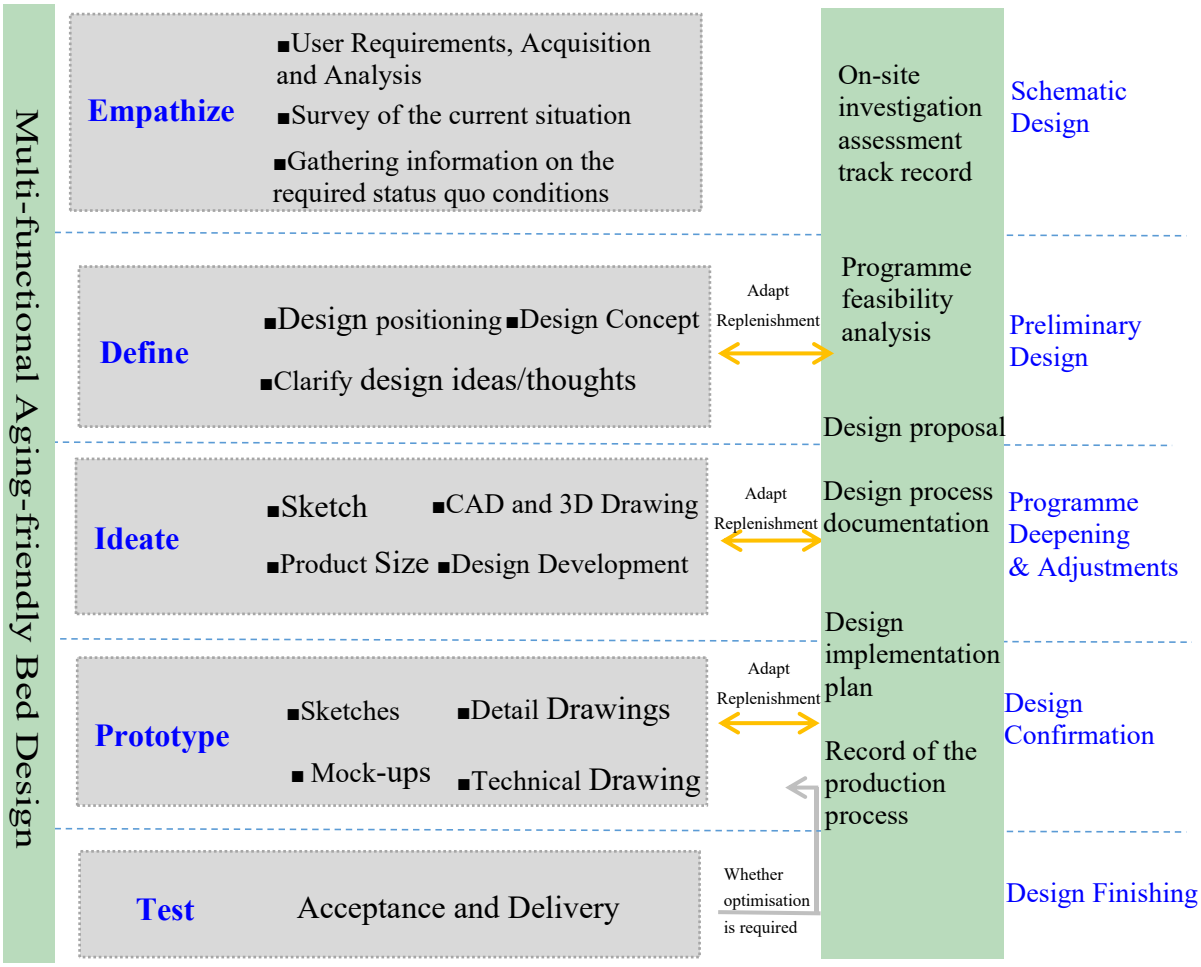


Figure 5.5: Multi-functional Age-friendly Bed Design Thinking and Flow Chart

5.4.2 User Requirements Acquisition Analysis and Design Opportunities

a) User Requirements Acquisition and Analysis

The design of the multifunctional ageing bed is centred around emphasizing the analysis and design thinking related to the genuine requirements of elderly users in nursing homes. Some of the principles and methods used are based on the findings from the

researcher's initial literature review, questionnaires, interviews, and other data. Researchers have summarized the design needs of multifunctional beds in nursing homes into six major aspects, including physiological and behavioral, psychological, safety, living environment, spiritual, and emotional needs. From these aspects, the “pain points” of the elderly users’ needs were examined and explored. Subsequently, a comprehensive assessment and analysis of the pain points of elderly users' needs in nursing homes were conducted. The ultimate objective is to design multifunctional beds that can fulfill the comprehensive needs of the users.

b) Design Opportunities

By means of questionnaire surveys and in-depth interviews, the researcher has analysed that there are numerous significant issues with the furniture for the elderly in China nursing homes at present. For instance, the majority of nursing homes purchase low-quality and inexpensive regular furniture. There are also hindrances and safety risks to the functionality of the furniture. Moreover, there is no obvious distinction in terms of the furniture's form, which cannot reflect its suitability for the elderly. Additionally, there is a lack of consideration for the psychological needs of the elderly in terms of the colour of the furniture, and so on. The elderly spend a vast majority of their rest time in bed. Therefore, the choice of bed is of utmost importance for the physical and mental health of the elderly in nursing homes. Consequently, the design of multi-functional ageing beds summarizes the needs of the elderly and the challenges they face, and explores design opportunities based on them.

5.4.3 Design Concept and Positioning

a) Design Concept

The design plan adheres to the concept of "nursing home for the elderly as the fundamental," focusing on the elderly perspective, the elderly physiological and behavioral characteristics as the research foundation, and the specific requirements of the elderly for nursing home furniture as a guiding principle. Moreover, an in-depth understanding of the various needs of the elderly is obtained through a household survey of the elderly in nursing homes. The design aims to accommodate the physiological and behavioral characteristics of the elderly in nursing homes and set up multi-functional elderly beds. Simultaneously, it strives to provide maximum assistance to the elderly who experience ageing-related physiological decline and behavioral disorders, thereby offering the utmost support for their daily life in nursing homes.

In terms of the design concept and thought process, the bed's function and the physical and mental attributes of the elderly are combined for contemplation, and its overall style should be uncomplicated and abundant. Additionally, it should possess intelligent operation, voice-guidance, simplicity, and convenience in usage. The colour scheme must exude tranquillity and softness, while preserving its liveliness and dynamism. By means of the functionally emotional design of the ageing multi-functional bed, the physiological and psychological comfort of the elderly can be enhanced. The design fully consider the physical functions and behavioral characteristics of the elderly to satisfy the daily life and behavioral requirements of those who have entered old age or are about to enter old age.

b) Design Positioning

Product Name: Multi-functional beds for ageing in nursing homes

Using Institutions: Nursing homes, care centres, community care centres, elderly apartments and hospital care centres, and other institutional care centres.

Target Users: Elderly individuals who possess basic self-care abilities and those who experience mobility issues, delayed reaction time, advanced age, and reliance on assistive devices. Their physical condition and lifestyle habits are as follows: they are generally capable of attending to their own needs and possess a heightened awareness of their physical well-being; their motor skills are declining, resulting in slow movement and dependence on crutches to alleviate discomfort in the waist and legs; their primary sources of entertainment include television viewing and reading newspapers;they are receptive to novel experiences.

c) Product Positioning

This proposed design is rooted in the physiological and behavioral attributes of the elderly population, aiming to introduce a multifunctional bed design specifically tailored to the needs of nursing home residents. By enhancing its functionality, this design seeks to enhance the quality of life for elderly individuals residing in nursing homes, improve their personal conduct, preserve their fundamental dignity, enhance their overall well-being, alleviate the burden on home caregivers, and reduce the cost of social services. This research focuses on the practical design of the nursing home bedroom, highlighting its primary function as a sleeping space that meets the safety requirements and ease of operation for the elderly population, while also accommodating their ergonomic comfort dimensions. Furthermore, in terms of innovative features, the design will incorporate

intelligent assistance, voice-activated systems, health monitoring capabilities, and emergency assistance for the elderly. The researcher will delineate the multifunctional bed product design for nursing homes by considering design elements, principles, functional divisions, and user needs, as illustrated in figure 5.6.

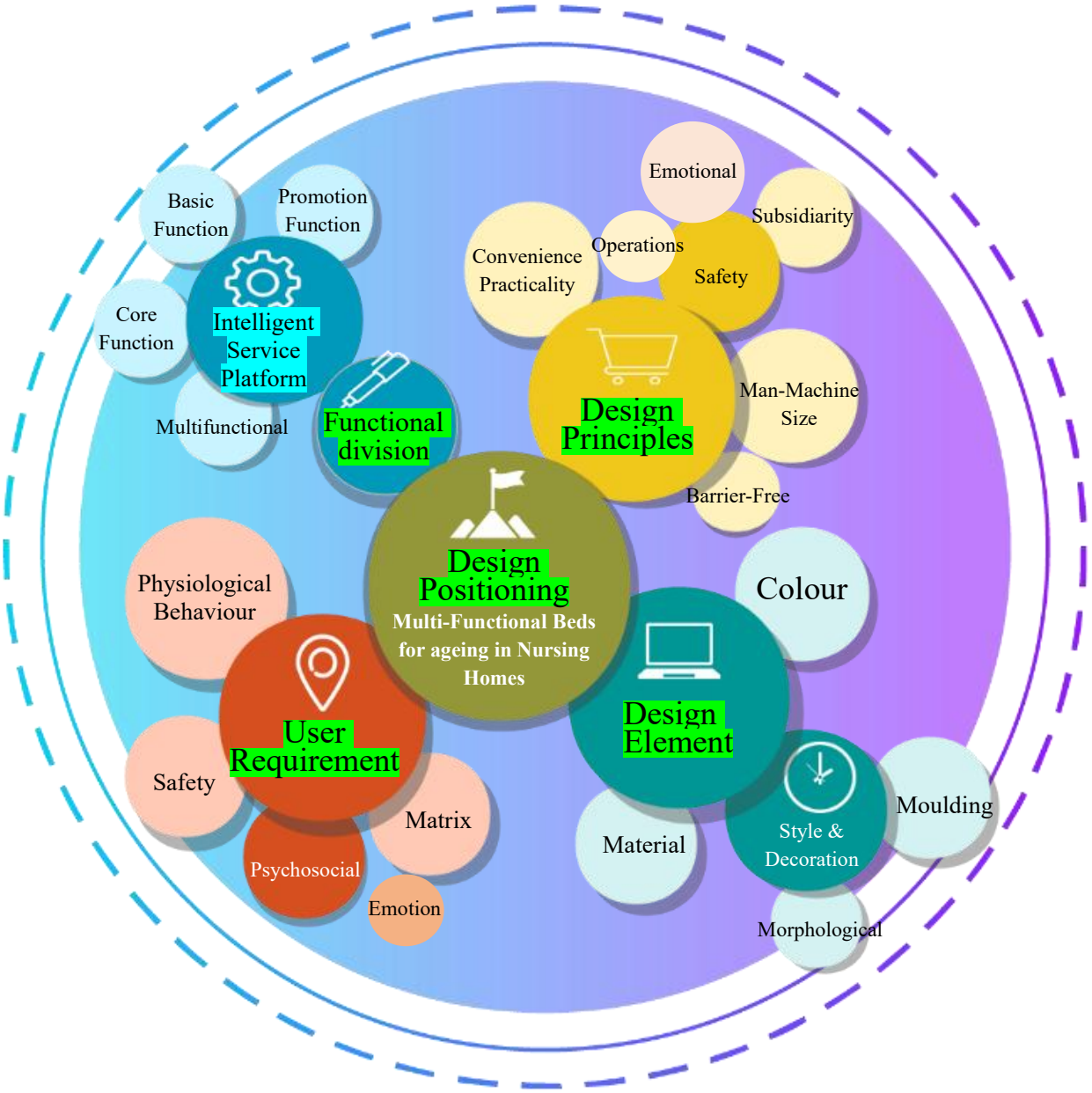


Figure 5.6: Design Concept and Positioning Diagram for Aging Multifunctional Beds in China Nursing Homes

5.4.4 Design Ideas

From the strategic importance of concentrating on the ageing population of China, this project identifies a practical case for the creation of a multifunctional bed for the elderly in a nursing home. This is done through extensive research and advice from tutors and experts. The research follows a basic concept of problem identification, analysis, design, solution, and practical application.

Initially, the researcher conducted a survey on the main issues related to age-friendly furniture in China nursing homes and the current living conditions of the elderly. They also examined the design of age-friendly beds available in the market. Subsequently, the specific needs of the elderly in nursing homes and the challenges faced by caregivers were thoroughly investigated. This helps to identify the shortcomings of existing nursing home bed designs and provides a foundation for design research on multifunctional age-friendly beds for the elderly in nursing homes. By analysing the needs of elderly users in nursing homes and identifying design opportunities, the goal of this design project was determined to be the provision of convenient, safe, comfortable, and intelligent design services for the elderly.

The various activities performed by the elderly in nursing homes, such as sleeping, getting in and out of bed, nursing care, dining, health monitoring, reading, recreation, and rehabilitation training, were analysed. The challenges faced by the elderly were also examined, and corresponding solutions were provided for the unique difficulties they encounter. This involved linking the needs of elderly users with the functions of the bed to create a comprehensive design for the multifunctional bed system in nursing homes.

In Chapter 4, the design elements, principles, and methods are applied to extract the

design elements for this proposal. These elements are conceived at four levels: physical sensory, behavioral interaction, emotional connection, and intelligent assistance. The design elements are then put into practice and applied accordingly.

The multifunctional bed for nursing homes consists of components such as protection, support, movement, operation, and intelligent assistance. Therefore, the user's physiological and psychological needs must fully considered during design, with a focus on auxiliary functions and intelligent design. Attention is also given to the comfort of the bed, with the environment being designated as a nursing home bedroom.

To meet the needs of the elderly in terms of function, form, color, material, intelligence, and humanization, the design of the bed is simple and warm, with added care functions. The design practice for the multifunctional bed in nursing homes should always concentrate on the components and details of the bed's design concept.

5.5 Design programme

5.5.1 Design Sketches

The composition of the ageing multi-functional bed for nursing homes primarily consists of two components: the design of its appearance and the design of its functionality. In relation to these two aspects, the project team has conducted a series of scheme design. The design sketch scheme for the appearance and function of the multifunctional bed is illustrated figure in 5.7-5.8. Subsequently, by means of continuous optimization, a conceptual model was ultimately established.

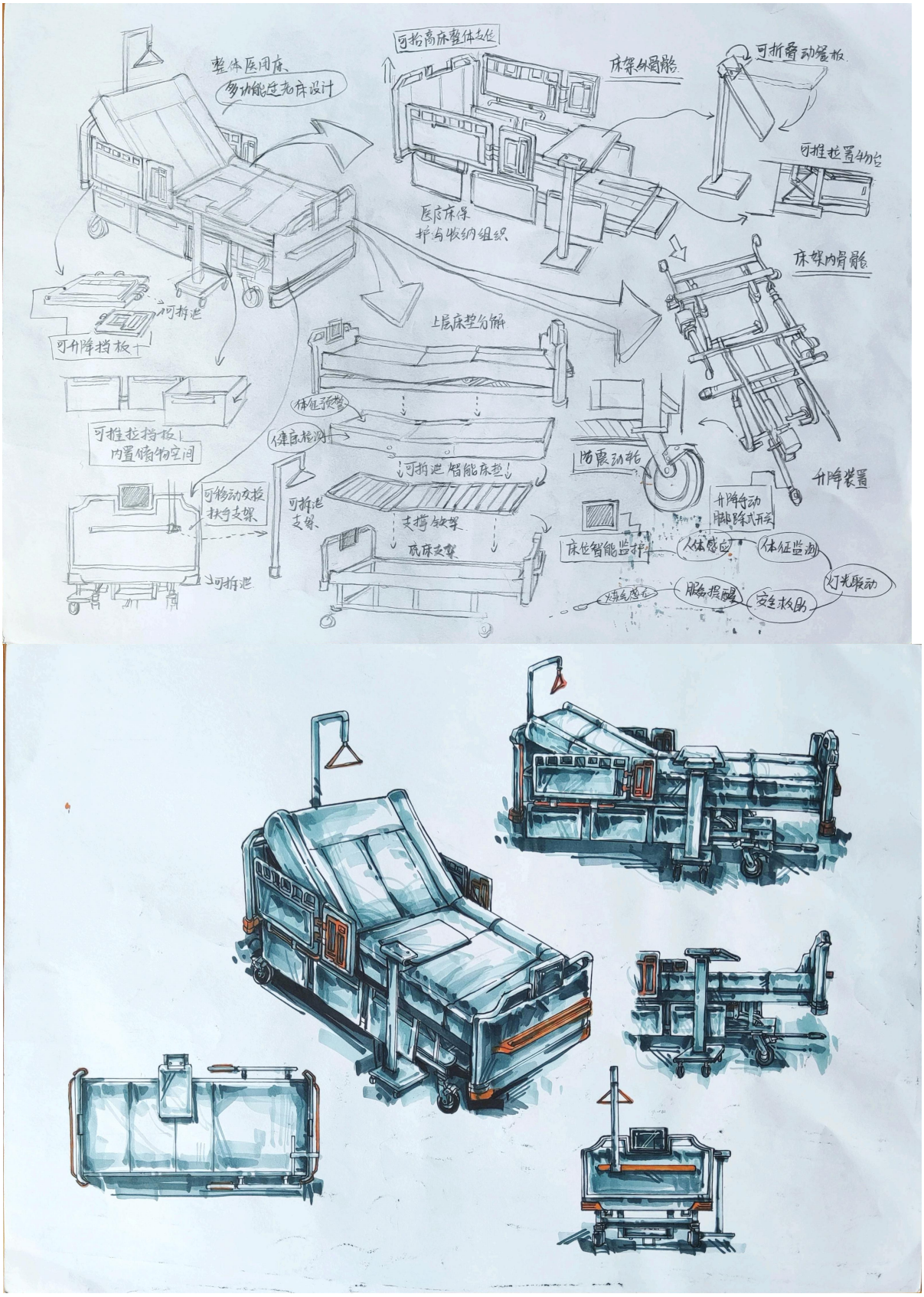


Figure 5.7: Functional Design Sketch for Age-friendly Multifunctional Bed 1

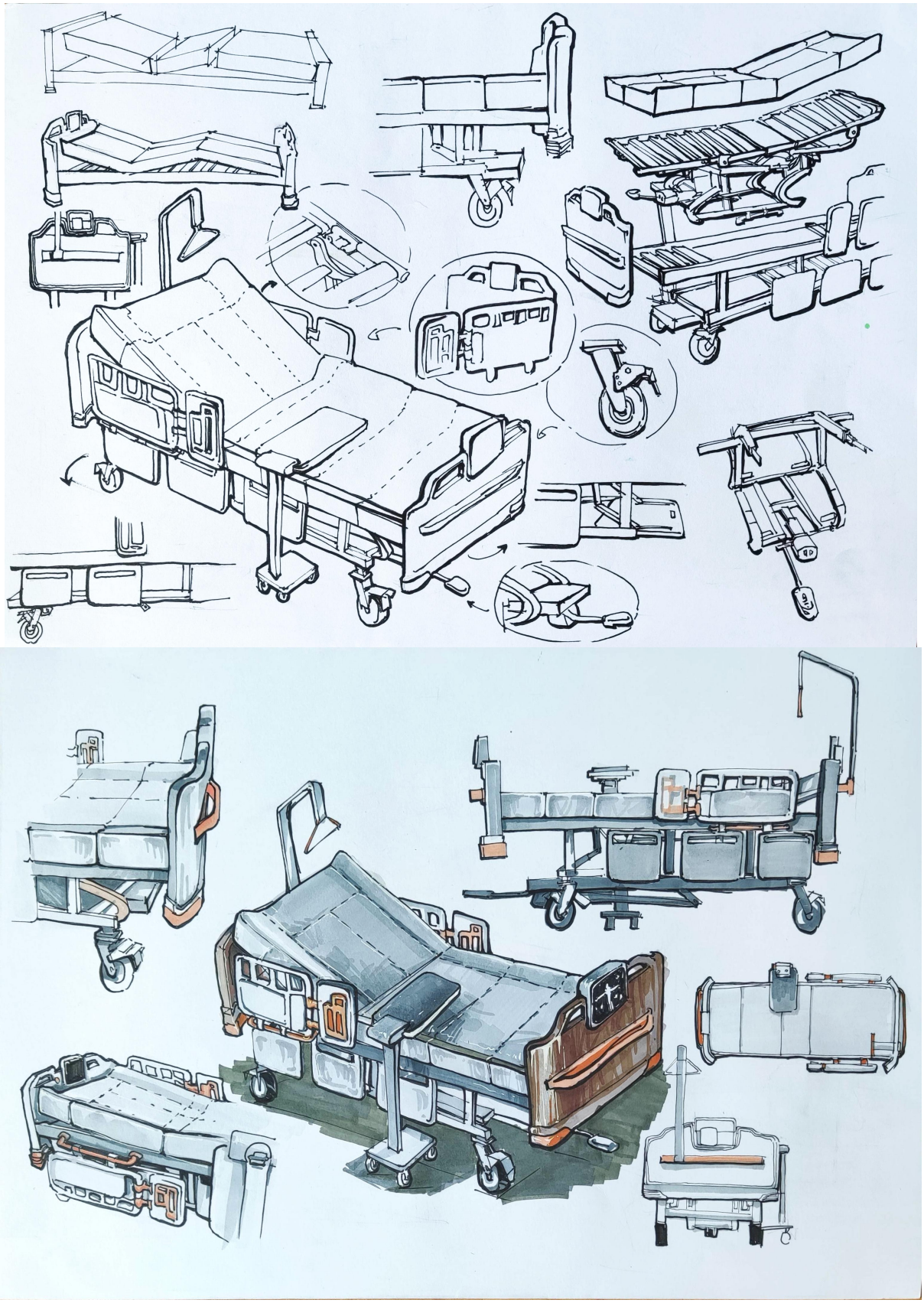


Figure 5.8: Functional Design Sketch for Age-friendly Multifunctional Bed 2

5.5.2 Computer-generated Renderings

In previous times, the workspace of a designer typically consisted of numerous rows of drawing boards and sketchbooks. However, there has been a transformation in this regard and nearly all designers now heavily rely on computers. The inclusion of computers has facilitated better control and flexibility in the realm of drawing activities. A growing array of design and drawing software packages have surfaced in the market, such as AutoCAD, 3D Max, SketchUp, and Rhino. Nevertheless, it is imperative to have a comprehensive understanding of how to effectively utilize the software, comprehend its capabilities, and acknowledge its limitations as a tool for drawing and visualization.

Within this investigation, the researcher employed computer-generated drawing in the design process, as this technique allows for the incorporation of lifelike shading and lighting effects, colors, and textures to the design objects. The principal objective of utilizing computer-generated drawing tools to present ideas is to generate a visual representation of the design object that is as authentic as possible, can be manipulated in real time, and can be observed from any vantage point (Table 5.1). This serves as the foundation for acquiring more intricate drawings and models that are essential for the subsequent phase of the design process. Often, duplication is avoided by using computer-generated drawings. Consequently, new attributes can be appended to drawings created early on in the design process (such as altering colors, introducing new materials, suggesting different textures, etc.).

Table 5.1: Computer Rendering Modelling



5.5.3 Real Detail Drawings

a) Colour Scheme and Materials

According to the findings in the fourth chapter of the research on the needs of the elderly, it can be observed that the elderly have a preference for warm and vibrant color combinations, such as yellow and orange, which symbolize a positive connection in terms of color. As a result, when selecting the primary structure for the multifunctional bed in a

nursing home, it is advisable to opt for pleasant warm colours. Additionally, the use of a black and white gray system for colour selection helps to balance the overall colour scheme, thereby ensuring that the multifunctional bed appears calm and steady while still exuding vitality. This visual effect and the cohesion of colours align with the elderly's inclination towards empathetic colour choices that cater to their needs.

When it comes to material selection, it is important to prioritize natural and harmless materials, as well as skin-friendly and breathable soft linen materials. This choice is based on the stability and durability of the materials, ensuring that they do not easily deform over time. Moreover, cotton and linen materials are more suitable for the elderly in terms of breathability and softness, enhancing their tactile experience. The specific colours and materials of the multifunctional bed are illustrated in Figure 5.8.



Figure 5.9: Multi-functional Bed Colour Scheme and Material Map

b) Modelling and Functional Breakdown Diagram

Through the results of the survey data related to the elderly in nursing homes and the analysis of the design requirements in Chapter 4, it can be seen that the elderly have special design requirements for ageing-friendly furniture due to their physical functions and behavioral characteristics such as mobility, weakened muscle strength, reduced eyesight, poor sleep quality, health monitoring needs, etc., which leads to higher requirements for the comfort, convenience, safety, and intelligence of beds in particular. According to a number of surveys on the needs and preferences of the elderly, the design needs of multifunctional ageing beds are mainly reflected in the needs for safety, comfort, ease of operation, and personalization and intelligence.Therefore, multifunctional age-friendly bed design needs to be optimized in terms of form and function for these specific needs in order to improve the quality of life and autonomy of the elderly

Design styling. Multifunctional ageing bed design and modeling should take into account the beauty and practicality, with simple, smooth lines, avoiding too many complex decorations, in order to reduce the safety hazards in the life of the elderly.Taking into account the physical characteristics and behavioral habits of the elderly, the design pays special attention to the principles of ergonomics, and the bed usually adopts a solid frame structure to ensure that the bed is both stable and comfortable.In addition, by adjusting the height of the bed, older people are able to get in and out of bed more easily, reducing the risk of falls.The height, width and tilt angle of the bed can be adjusted according to the height, size and needs of the elderly, while the mattress is able to provide personalized support according to the shape and pressure points of the elderly, reducing pressure on the joints and back. Considering that the elderly have limited mobility and are prone to

collisions, the edges and corners of the bed are rounded to minimize the risk of injury in the event of a collision and increase the safety of use.

Functional Breakdown. The design of the age-friendly multifunctional bed is centred around comfort, safety and functionality, and incorporates actual survey data to ensure that the design solution is highly compatible with the needs of the elderly. This design not only improves the quality of life of the elderly, but also provides more convenience for nursing care.

Adjustment function.Through the intelligent control system, automatic adjustment of bed height and angle, as well as personalized adjustment of mattress softness and hardness are realized. For example, surveys show that more than half of the elderly have the need to adjust the height of the bed to facilitate the adjustment of the height according to the needs of different activities (e.g., rest, care, daily activities). Therefore, the bed design is equipped with electric or mechanical adjustable functions to help the elderly easily adjust the height of the bed to meet the needs of different scenarios.

Back rising and sitting functions. Observations show that older people often need different sitting postures to support their bodies when performing daily activities in bed. By adjusting the angle of the head of the bed, it helps the elderly to realize semi-sitting, sitting or tilted sitting postures, which facilitates activities such as eating, reading and watching TV. This feature is designed to significantly enhance the convenience and comfort of the elderly.

Assisted living functions. Elderly people need a variety of assistive devices to help them accomplish some basic physiological activities in their daily lives. The design of these assistive functions can reduce the burden of the elderly and improve their quality of

life. Such as mobile functional tables and stools, convenient for the elderly to eat and drink and so on.

Storage and auxiliary lighting features. Hidden storage cabinets underneath the bed make it easy for seniors to store their daily belongings and reduce the number of times they have to get up to find them. A low-brightness night light is integrated into the side of the bed to facilitate nighttime activities for older adults and reduce the risk of falls. About 43.93% of seniors would like the bed to be illuminated to provide a sense of security at night.

Safety protection function. Ensure the safety of the elderly in the process of use, to prevent falls, collisions and other accidents. Such as non-slip design, the use of non-slip materials to increase friction to prevent the elderly from slipping. Emergency call button is set at the head of the bed, which is connected to the monitoring centre of the family or the elderly institution, so that timely help can be sought in case of emergency.

Intelligent health monitoring function. According to survey data, older people are more concerned about their health, and the intelligent health monitoring function can detect potential health problems in a timely manner and provide personalized wellness advice for older people. Through smart mattresses, smart monitoring platforms and other devices, real-time monitoring of the elderly's sleep, heart rate, blood pressure and other physiological indicators, and data transmission to the cloud for analysis. Elderly people are prone to fall and other accidents due to the decline of their physical functions. Intelligent safety monitoring function can reduce the occurrence of accidents and improve the safety of the life of the elderly. Utilizing devices such as smart cameras and automatic fall alarm

systems, we can monitor the living status of the elderly in an all-round way, and discover and deal with potential safety hazards in a timely manner.

The initial consideration in designing a multifunctional bed for nursing homes that caters to the needs of the elderly is whether its shape aligns with their physiological and behavioral characteristics. Once the basic ergonomic requirements for the elderly have been addressed, further design of functional structures can be pursued (Figures 5.9 and 5.10). At the technical level, modular integration can be achieved by comprehending the specific shape, main functions, and sub-functions of the multifunctional bed, and subsequently merging the functional modules

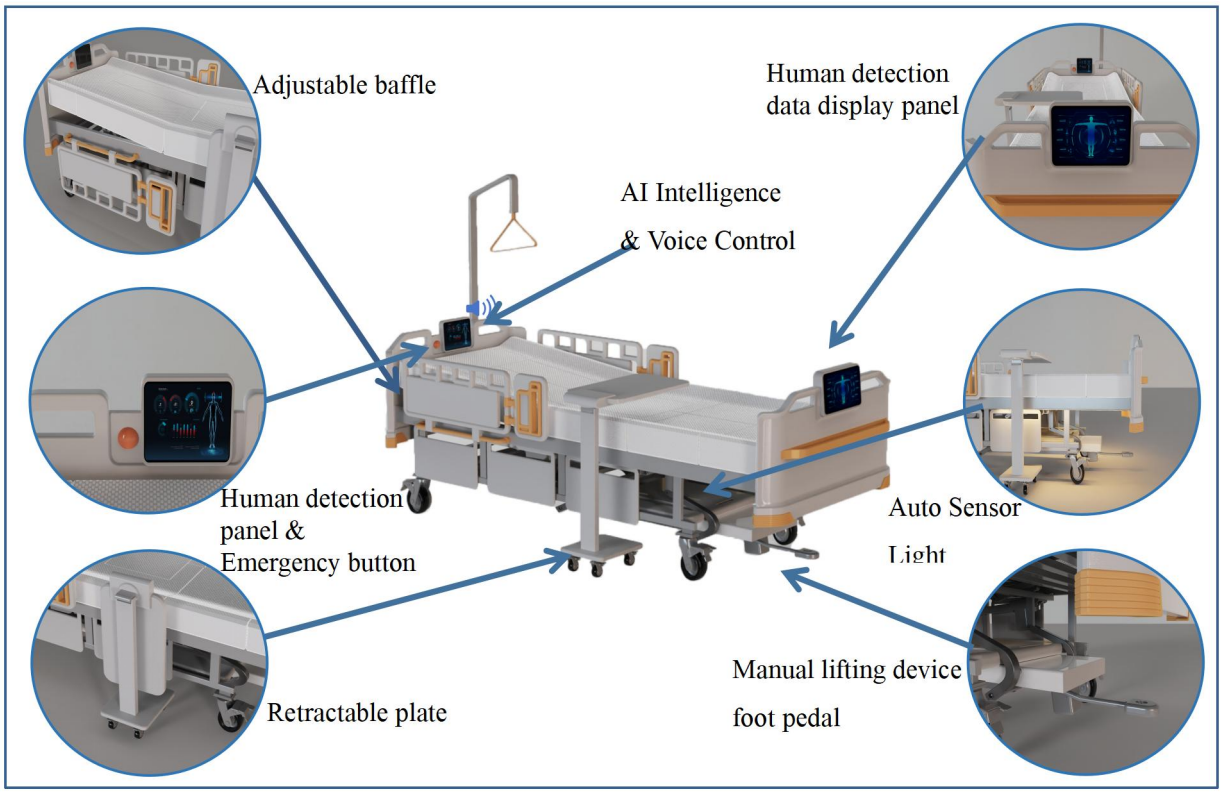


Figure 5.10: Functional Breakdown Schematic 1

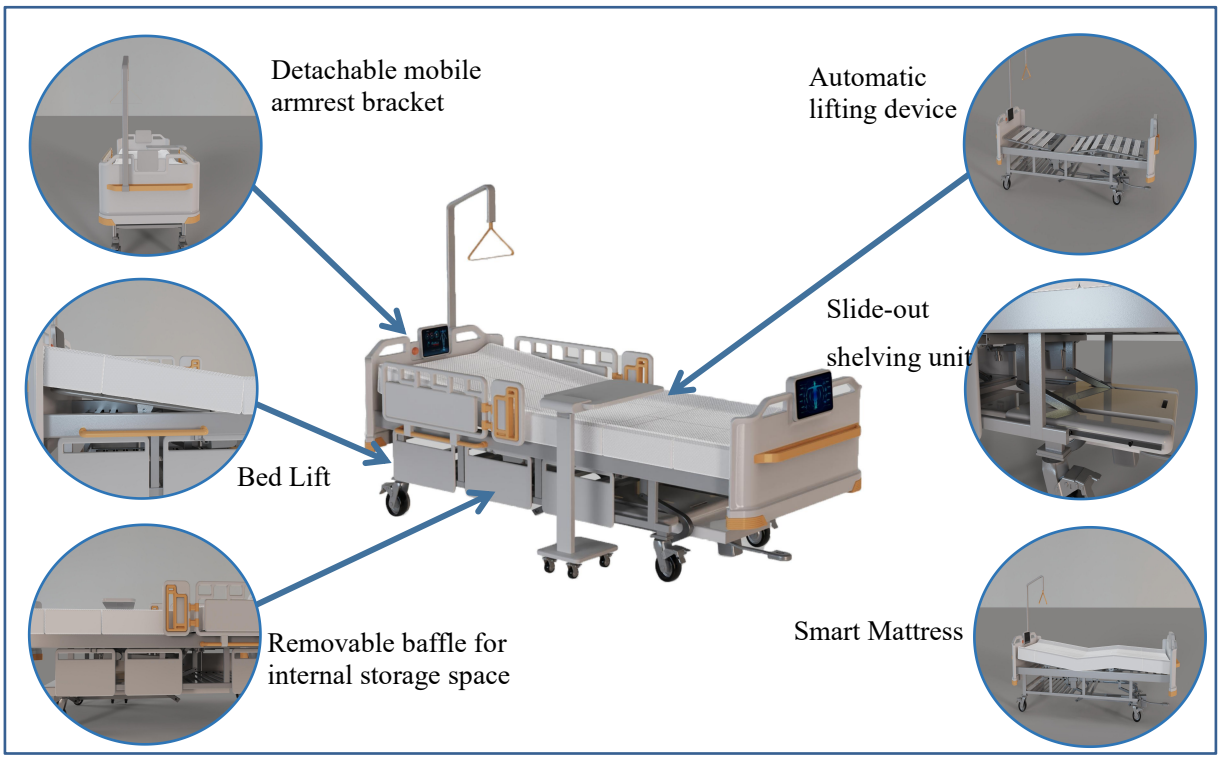


Figure 5.11: Functional Breakdown Schematic 2

5.5.4 Final Drawing

Computer-generated illustrations have the potential to assist researchers in generating more lucid product information in comparison to conventional hand-drawn methods.

Following extensive contemplation, conjecture, and deliberation regarding the draft plan, the ultimate plan was refined, finalized, and the Rhino model was constructed. figures 5.12-5.14 visually elucidate the distinct perspectives of the eventual design implementation.



Figure 5.12: 3/4 View of Multi-functional Bed 1



Figure 5.13: 3/4 View of Multi-functional Bed 2

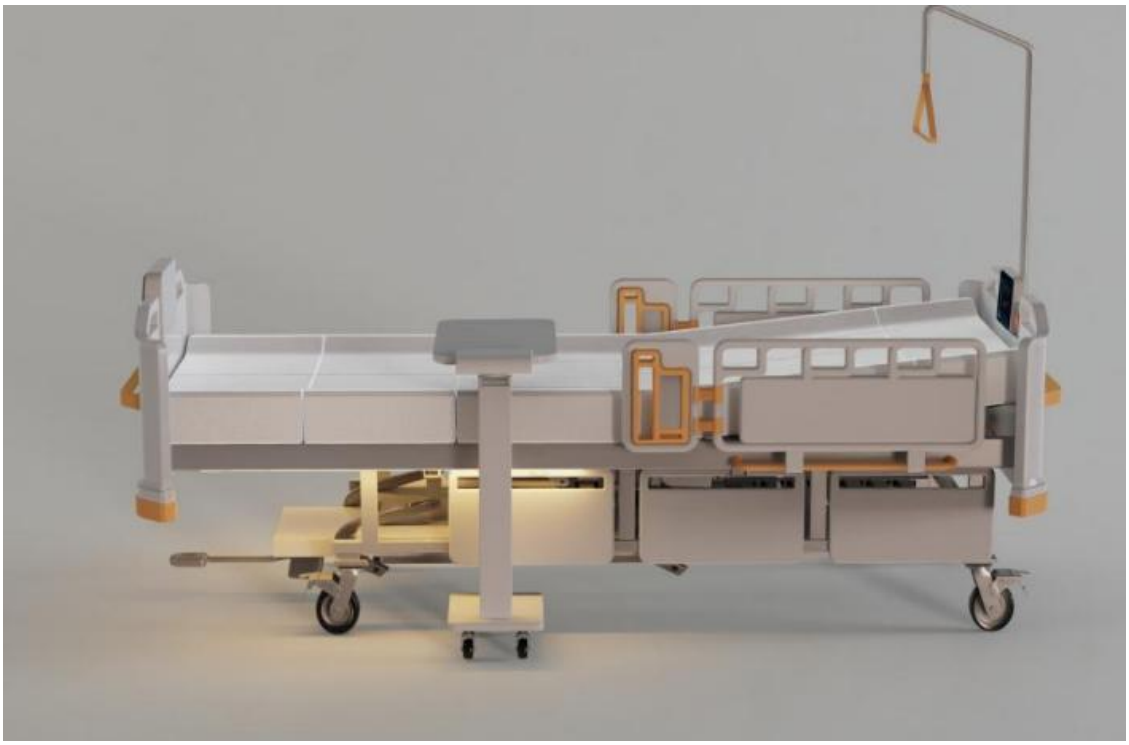


Figure 5.14: Side View of Multi-functional Bed

5.6 Prototype

The difference between the whole and the part is common in the prototype design of multifunctional beds. The design of the information architecture, including the functional structure, lifting device, bed frame, intelligent mattress, and information service platform system, receives more attention in the overall aspect. In turn, the functional interaction design of the mattress, such as the emergency button, lifting plate, voice assistance, automatic sensor light, and the overall display of the local module, is given greater consideration in the partial aspect. From a design perspective, the process of gradual refinement from total to sub is deemed more appropriate for design realisation.

To begin with, it is essential to establish the comprehensive structure of the product. During the requirement analysis, the main function points identified in Chapter 4 are condensed to form the initial functional structure of the product. Subsequently, in section 5.3.2 on User Diversified Functional Requirements, the functional modules of the product are determined. Modularisation of the function involves dividing the program into various functional modules, each of which accomplishes a specific sub-function. Then, in section 5.3.4, modular design is employed to standardise the design of each module unit. This enables the gradual determination of the prototype design content and the subsequent combination of these functional modules to form a cohesive whole that approximates the display style of the final product. An example of prototyping is required at this stage.

The prototyping process for the age-friendly multifunctional bed for nursing homes is explained by the researcher through the following steps: Technical Drawing (CAD), Technical Nodes and Main Structure Breakdown, Recommendation of Prototyping Specifications and Parameters, Mock-ups, Product Testing, and Feedback.

5.6.1 Technical Drawing (CAD)

By considering the requirements and selection of human body size standards in the preliminary design conception, the specific dimensions of the CAD technical drawings for the age-friendly multifunctional beds for nursing homes are finalized. These drawings typically encompass three views of the product: the front view, the side view, and the top view. Refer to figure 5.15 - 5.18 for visual representation.

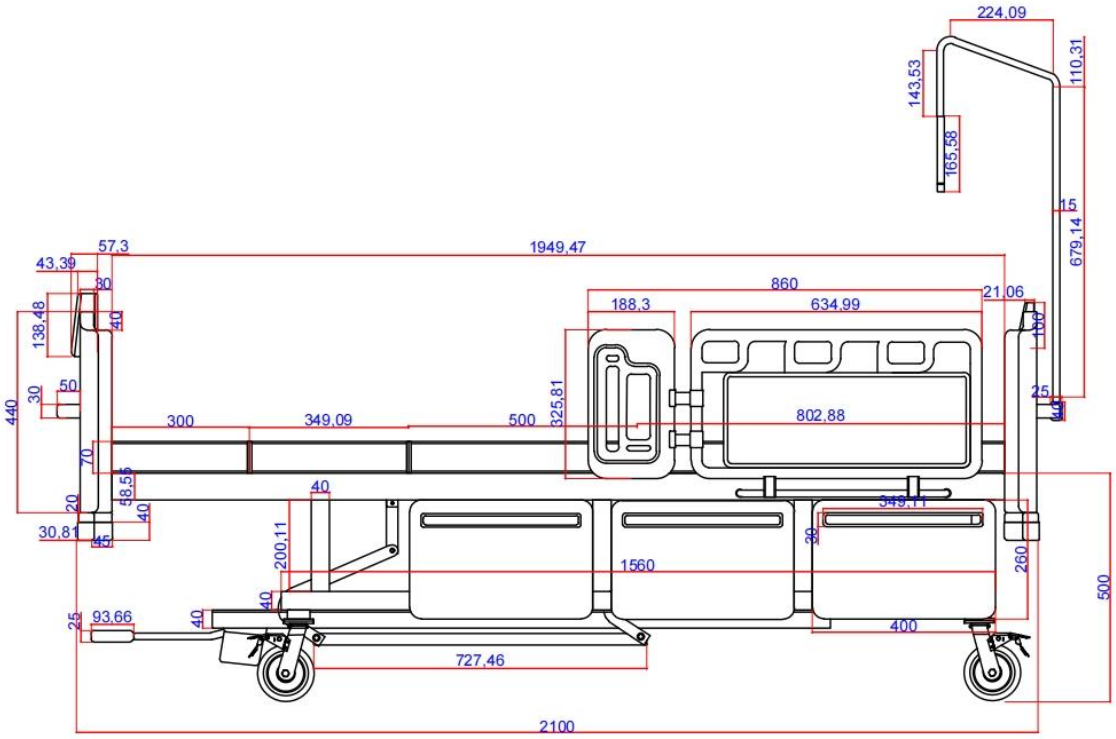


Figure 5.15: Front View of the Bed Design

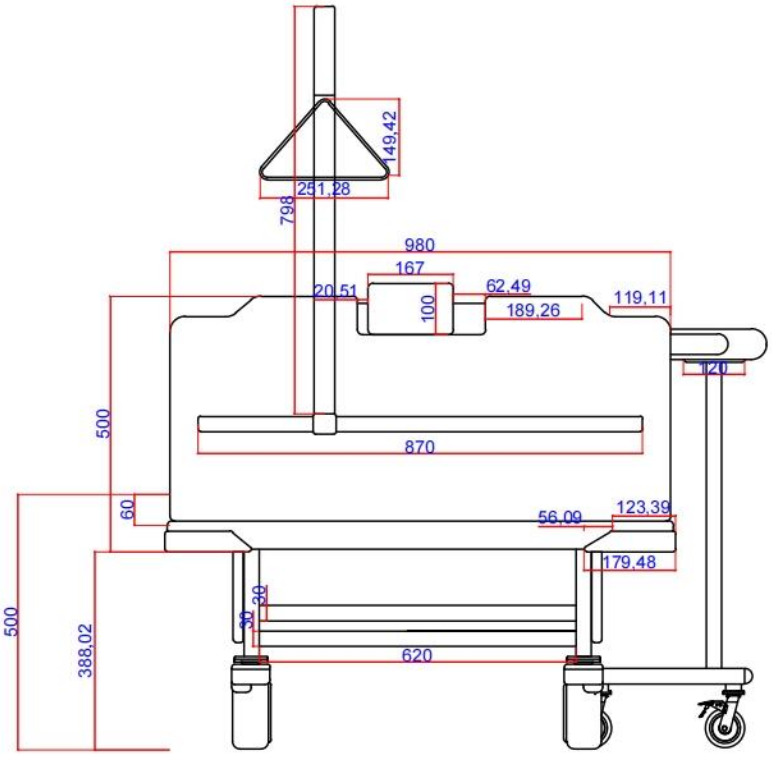


Figure 5.16: Side View of the Bed Design

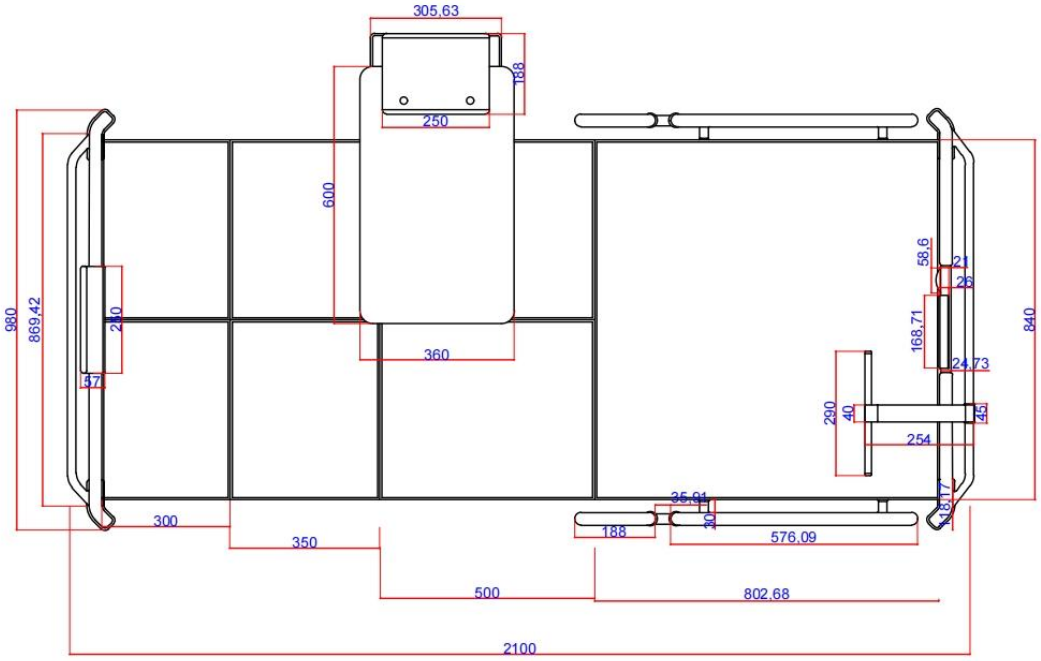


Figure 5.17: Top View of the Bed Design

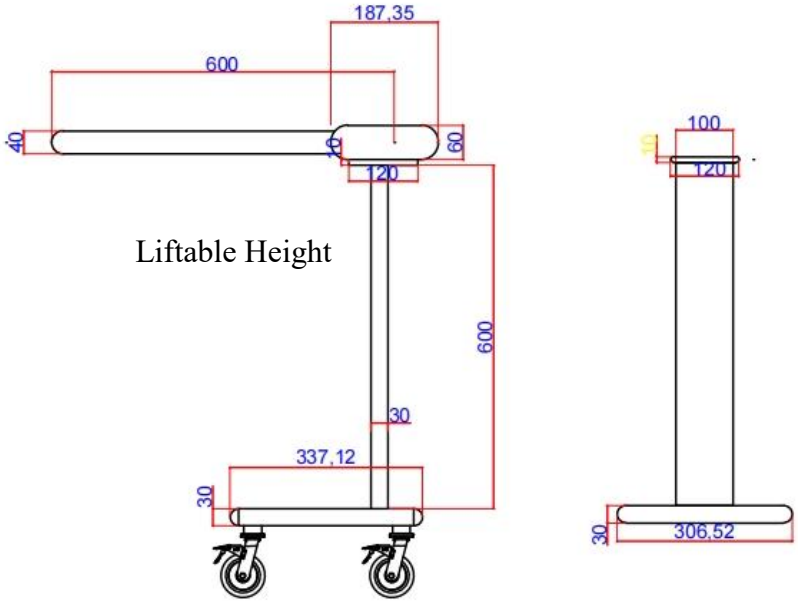


Figure 5.18: Schematic of the Dimensions of a Removable Tabletop

5.6.2 Technical Details and Main Structure of the Multifunctional Bed

Based on the principle of sustainable development, this study employs the modular design concept for the creation of furniture products catering to the elderly in nursing homes. Modular design entails dividing the primary structure of a multifunctional ageing bed into distinct functional modules for design amalgamation. The modular design of the multifunctional ageing bed boasts the characteristic of standardization, wherein the main structure is fragmented into various modular units, subsequently undergoing standardized design. Thereafter, the assembly is combined using a standardized technology node approach.

Perspective views of the Prototype, both disassembled and assembled, along with the components of individual functional modules, are depicted in figures 5.19 - 5.22. While the diagram does not represent a comprehensive technical production diagram, it still enables the identification of specific product's individual functional module units, primary technical structure, specific configurations, modular elements, and the manner in which the individual functional modules are combined.

As a conclusion, the technical nodes and the decomposition diagram of the main functional structure module have the potential to shorten the product design cycle and decrease the production cost of the product. Therefore, it can provide an important reference for designers, researchers, producers, users, and relevant personnel in nursing homes for usage or research purposes, while also facilitating the post-maintenance of furniture products.

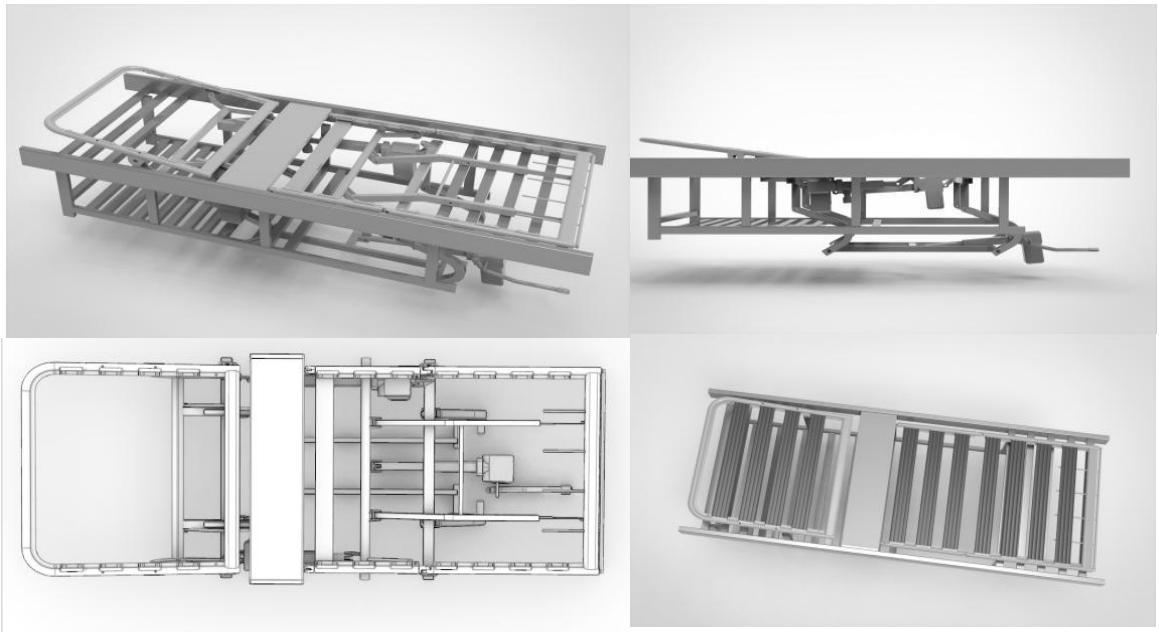


Figure 5.19: Technical Details of the Bed Framer 1

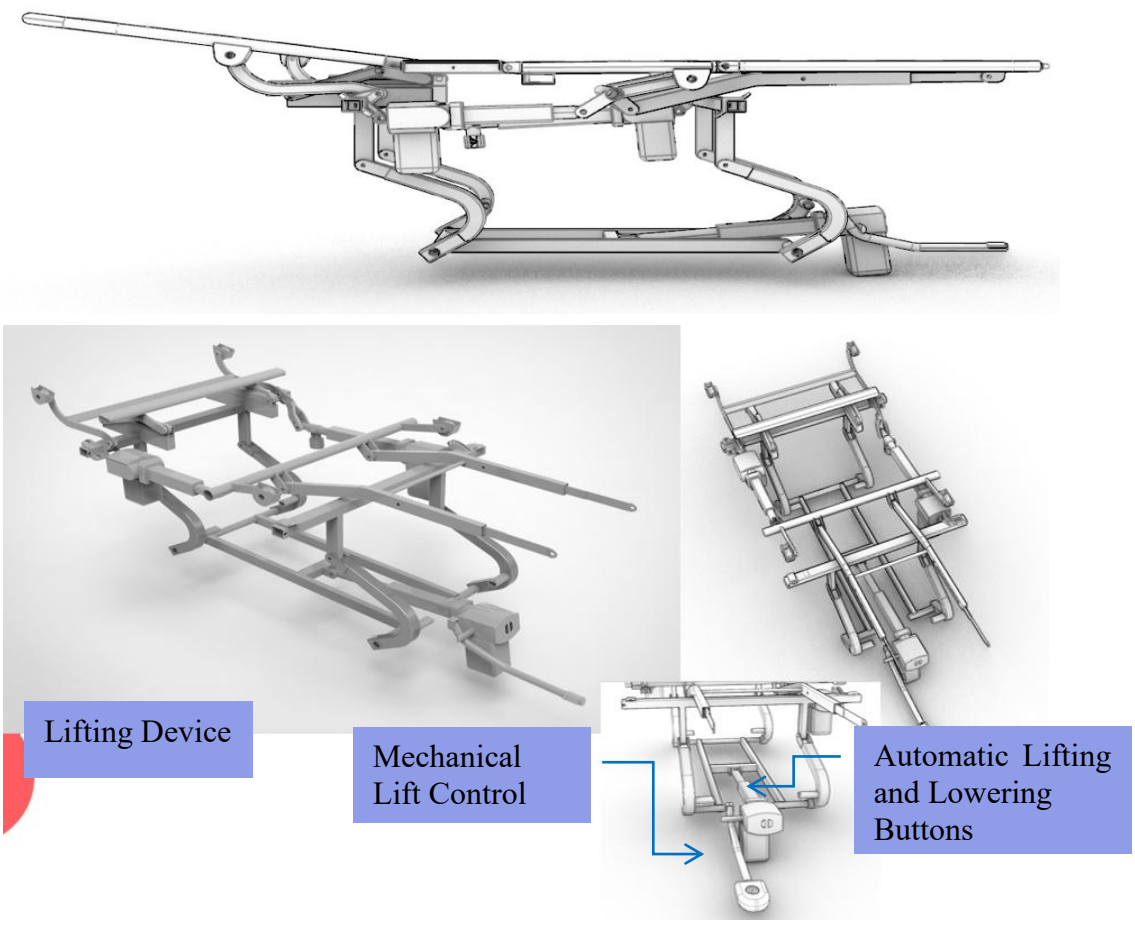


Figure 5.20: Technical Details of the Bed Framer 2

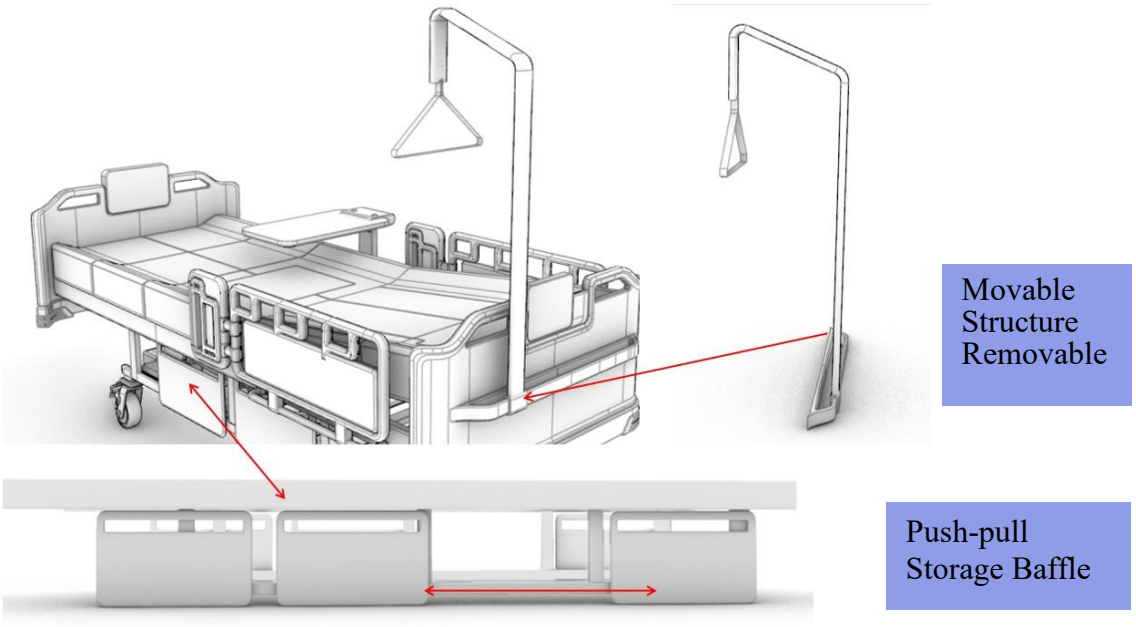


Figure 5.21: Technical Details of the Bed Framer 3



Figure 5.22: Exploded View of the Multi-functional Bed

5.6.3 Recommended Prototyping Specifications and Parameters

Specifications: 2100 x 1000 x 400mm bed height; bed width: 840mm; bed height: 400mm (500)

Function: Back lift adjustment range: 0-80 degrees.

Embedded Central Control Unit： The Embedded central control all-in-one machine offers a range of options, including three anti-reinforced tablet PCs, industrial-grade capacitive touch screens, and the Windows 10 system information management platform. It also features voice-assisted functions and utilizes man-machine ergonomics assessment software for intelligent adjustment, monitoring, prompting, assistance, early warning, rescue, and other information feedback, processing, and service functions.

Headboard: New material or solid wood head and tailboard.

Rocker: The parts of the machine are made of pure ABS engineering plastics and undergo injection molding. They are built with a steel core and enclosed in a stainless steel casing. The rocker switch is made of professional POM wear-resistant materials to ensure durability and resistance to wear and breakage. The machine has an operating radius of 180mm and an aluminum guardrail with a length of 1480mm and a height of 380mm. The user's strength and body balance are determined by built-in pressure sensors.

Casters: four mute surface casters, intelligent remote control device control, can control the casters automatically lock.

Bed board: The bed board is made of 1.2mm cold rolled steel plate and undergoes one-time molding. It is reinforced with steel tubes at the back to provide balanced force,

strong anti-pressure capabilities, and resistance to deformation. The bed board also features breathable holes and an anti-slip function. The sheet metal production technology ensures overall molding and smooth reinforcement structures at the four corners to enhance pressure. The metal surface treatment also adopts double coating technology, which involves oil removal, rust removal, phosphating, electrostatic powder spraying, and baking paint treatment.

The main frame: cross tube adopts 30*40 thickness 1.2mm, longitudinal beam tube adopts 60*40* thickness 1.2mm, reinforcement tube adopts 40*40* thickness 1.5mm. the bottom of the mattress, the bed frame is a metal automated instrument device, with the mattress to complete a variety of body position changes.

Intelligent mattress: Dimensions of the size are 1.95m x 0.85m x 0.70mm, comprising of an inner cushion made of sponge and brown material. The thickness is measured at 70mm, with a 20mm brown cushion and a 50mm sponge cushion. The thickness ratio can be adjusted according to the specific requirements of the demand side. To prevent the occurrence of bedsores, the mattress is equipped with breathable holes on both sides. The sponge has a density of 21 and a hardness of 35. The outer layer is constructed from medical-grade waterproof oxford fabric, which can be easily disassembled for clinical care and hygienic cleaning. Additionally, the mattress is embedded with sensor devices that monitor various aspects of the elderly's physical condition, including sleep status, blood pressure, and heart rate.

Configuration: with aluminium alloy guardrail, drainage hook, lifting device, intelligent mattress, pull-out storage platform, etc.

Multi-functional table board: can be used for dining, entertaining, receiving objects, etc., 910mm x 300mm x 25mm. can be moved, can be fixed, when in use can be fixed on the guardrail, not in use can be fixed on the end of the bed board or moved to the corner of the room.

5.6.4 Modelling Mock-ups

With the ongoing advancement of the commodity economy, the process of product modelling has become increasingly crucial and integral to the progress of industries and product development. During the planning phase of new product development, models resembling the physical entity are fashioned, and the principles of display, evaluation, and concentration are applied to gain continuous comprehension of the form and design intention of the new product from the model. This aids in understanding the product's movement and subsequently enables a decision to be made regarding the trial production of the new product. Once such a new product is manufactured, it will face minimal risk in the market competition and enhance the competitive prowess of the product.

The effectiveness of a good model is not achieved in one production attempt. Particularly for intricate structural effects, numerous trials, repeated modifications, and adjustments are necessary to ultimately attain the desired outcome. Given the multifunctional characteristics of the product model, this process demands patience and meticulousness. It must be admitted that slow and careful work yields fine results, and the idea must not only be sound but also feasible.

Taking into account the features of prototyping, it has been determined that a model of an age-friendly multifunctional bed will be created through functional modules. In essence, this entails comprehending how the ageing multifunctional bed is actually

constructed, how it can be accomplished, what the effect of its creation will be, and finally considering areas that can be improved. Since each example prototype represents an independent functional module, it is imperative to have a clear understanding of the methodology before initiating the creation of the prototype model. This involves selecting the appropriate components to construct the framework.

Prototyping is an important part of designing and developing multifunctional bed for nursing homes. In this study, a model is created to resemble the physical entity, utilizing a 1:2 scale for production purposes. Through the production of the model, a comprehensive and intuitive exploration of the overall layout, linear style, spatial volume, man-machine size ratio, surface treatment, functional modules, and other design-related aspects of the multifunctional bed can be achieved(Figure 5.23). The model aids in better understanding the shape and design intention of the multifunctional bed, thus enabling a more precise grasp of the direction for the development of elderly furniture products. Simultaneously, it facilitates a deeper understanding and comprehension of the materials, structure, manufacturing process, costing, market prospects, and provides a thorough feasibility analysis and research, laying a solid foundation for sample production and subsequent trial production.



Figure 5.23: Final Mock-ups of the Bed

5.6.5 Prototype Performance Testing

After the completion of the prototype design for the multifunctional bed aimed at the elderly, the project team must further comprehend the actual usability of the interface solution through prototype testing. This will allow them to validate the effectiveness and applicability of the design methodology and identify potential areas of improvement by comparing the design solution with the user tasks of existing products. To ensure that this design practice aligns with the requirements of the elderly population for age-appropriate furniture, the author employed a scoring methodology.

Feedback was gathered regarding the evaluation of the age-friendly seat design. The ratings were divided into two groups. The first group consisted of a pre-selected set of ten elderly users, while the second group comprised designers and practitioners associated

with nursing homes. In order to prevent any subjective bias resulting from later evaluations of existing products and prototype solutions, the pre-design and development focus groups did not include any participants.

Prior to commencing the test, the primary test explained to the subjects the purpose and precautions of the experiment. Additionally, a brief introduction was provided regarding the task content, methods, and rules. To provide specific insights into the design effectiveness of the multifunctional bed, the author conducted one-on-one interviews and utilized a scoring system (refer to Appendix F for the scoring table). During these interviews, the author explained in detail the design scheme of the chapter, the practical functions, and the intelligent elements. The participants were then asked to provide comparison scores, with a total of ten points available. The average value was subsequently calculated for later comparative assessments.

The evaluation benchmark for this design assessment is based on the functional indicators for age-friendly furniture established in previous phase, and the design positioning was selected accordingly. The weight values of design elements, design principles, functional division, user requirements, intelligence, and other perspectives were ranked, with a focus on verifying the top functional indicators.

The evaluation results are presented in figure 5.24 below. The overall subjective satisfaction derived from the user physiological and behavioural requirement, multifunctional experience, comfortable, and smart of the final age-friendly multifunctional bed for nursing homes was found to be highly significant. Therefore, this confirms the research path for ageing in nursing home furniture design at all stages. Furthermore, the results validate the effectiveness of the design elements, principles, and

methods proposed for age-friendly furniture in Chapter 4, as well as their applicability in the design practice of multifunctional beds for ageing in this chapter.

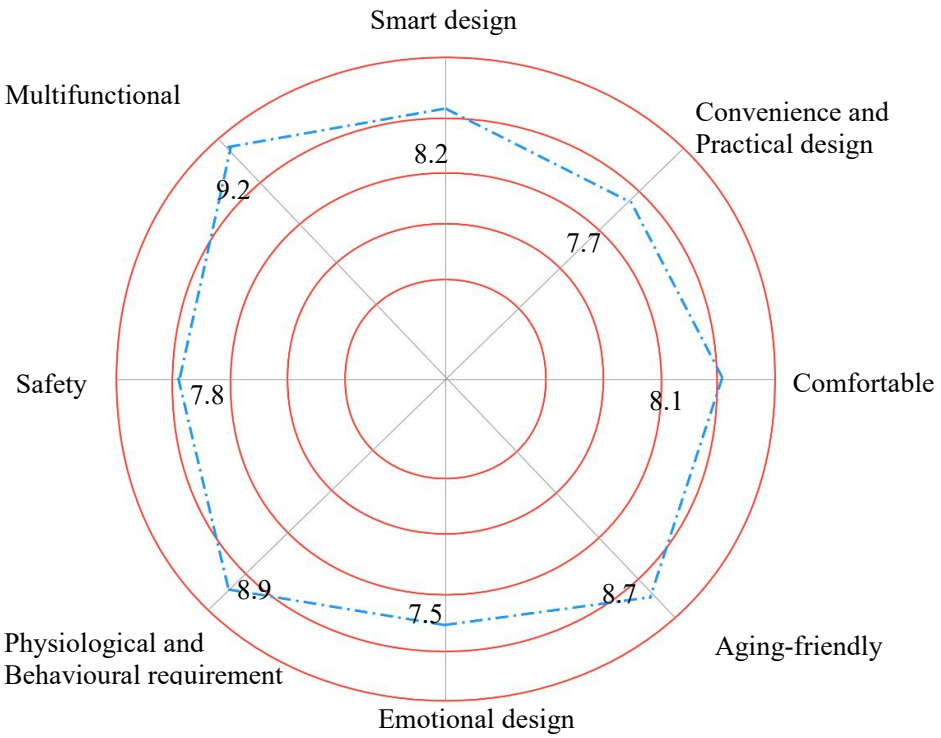


Figure 5.24: Radar Chart of Overall Product Evaluation Results

5.7 Service Design Blueprint and Customer Journey

a) Service Design Blueprint

A service design Blueprint for age-friendly furniture design involves mapping out the entire service ecosystem to ensure that the furniture design not only meets the physiology, psychological, and behavior needs of the elderly but also integrates all stakeholders, technologies, and processes seamlessly(Figure 5.25).

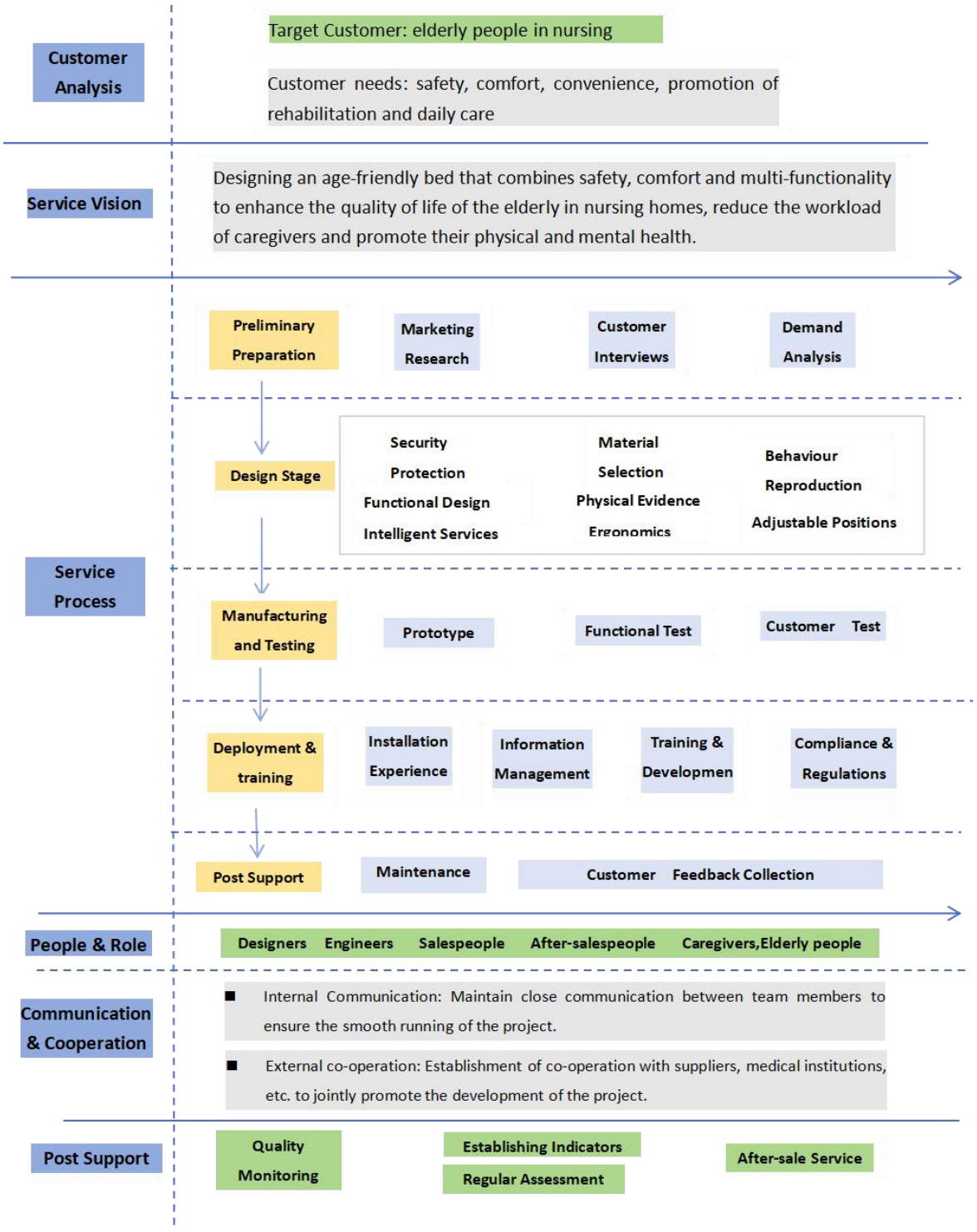


Figure 5.25: Service Design Blueprint

In the context of ageing populations and increasing demand for high-quality nursing care, the design of age-friendly multifunctional beds in nursing homes is crucial. This service design blueprint aims to create a comprehensive framework for designing and implementing beds that enhance elderly resident comfort, safety, and overall quality of life. The objectives include: Improving resident satisfaction and comfort through age-friendly design, Ensuring safety and reducing the risk of accidents, Facilitating easy caregiver access and operations, Enhancing the efficiency and effectiveness of care delivery.

b) Customer Journey

The customer journey map shows the daily experiences of an elderly resident interacting with the multifunctional bed, highlighting key moments and emotional experiences during the day, such as waking up, using the bed's features, and seeking assistance (Table 5.2). Key Stages:

i. Morning: Resident uses bed's smart features to rise comfortably.

ii. Daytime: Resident adjusts bed for sitting, resting, or therapy.

iii. Evening: Caregiver assists in preparing the bed for sleep.

iv. Nighttime: Bed monitors sleep patterns, ensures comfort and health.

Table 5.2: Customer Journey

Stage	Resident Action	Pain Points	Touchpoints / Motivation	Solutions	Emotion
Wake-up	Uses smart control to raise bed and sit up	Initial difficulty in finding control	Bed control panel adjustable position	Easy-access control panel with large buttons	Comfortable

Table 5.2 continued

Morning routine	Caregiver assists with getting out of bed	Slight instability when standing	Armrests adjustable height	Adjustable bed height for safer transitions	Secure
Afternoon rest	Resident adjusts bed to recline for a nap	Difficulty with positioning	Smart adjustments, backrest armrests	Bed memory settings for personalized positions	Relaxed
Evening preparation	Caregiver adjusts bed for night use	Lack of independence at night	Position settings lighting controls	Self-adjusting bed for independent use	Safe
Sleep	Bed monitors Sleep patterns and health	Unawareness of sleep quality	Sensors, smart alerts, health data collection	Health reports and alerts for caregivers	Comfortable
Emergency support	Resident calls for assistance via smart bed	Delayed response time	Control button caregiver alert system	Instant caregiver alerts, Quick response system	Reassured

5.8 Chapter Summary

The content of this chapter is grounded on the analyses and findings of the aforementioned four chapters pertaining to design validation, which were specifically chosen for implementation in survey research. The most frequently utilized nursing home beds were employed as a practical example. An investigation was conducted on the design

practice of multifunctional beds for elderly users in nursing homes, with a particular focus on the design practice of ageing multifunctional beds.

First and foremost, considering the national context of China, the intrinsic function of the bed itself, the physiological and behavioral conditions of the elderly, as well as the physical and mental well-being of the elderly and other rational factors, it was determined that the design of ageing beds in nursing homes would serve as a case study. Subsequently, multiple product features were identified and selected by conducting research around the diverse needs of users. Particular emphasis was placed on the transformation of user behavior and experience, intelligent design methodology, and the concept of modular design. Furthermore, a thorough analysis of the genuine needs of elderly users in nursing homes was undertaken, with the aim of identifying the “pain points” and exploring potential design opportunities.

Taking into account the strategic significance of addressing China's ageing society, the researchers embarked on a series of sketches to formulate a design scheme encompassing both the appearance and functional aspects of the multifunctional bed. Subsequently, more detailed drawings and models of the proposed design scheme were generated using computer-aided design tools, prior to the development of further functional structures. The sketched solutions underwent iterative thinking, refinement, and discussion, culminating in the optimization and finalization of the ultimate solution. A Rhino model was constructed to obtain the final drawing.

Through prototype design, the overall structure and content of the product weredetermined. This process enhanced the understanding of the design intention behind the multifunctional bed, including the choice of modeling materials, structural approaches,

manufacturing processes, costing considerations, and market prospects for an age-friendly multifunctional bed. Finally, performance testing of the prototype and an overall evaluation of user satisfaction were conducted. The test and evaluation results comprehensively validate the effectiveness and applicability of the design principles, methods, and mock-ups proposed in the preceding section.

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Introduction

In this chapter, the researcher presents the research query and provides an overview of the prevailing state of furniture design that caters to the needs of the elderly in nursing homes. The study also delineates the four research objectives that were applied to this investigation. Consequently, a detailed discussion on the four research questions that support the aforementioned research objectives is presented, followed by the validation of the research findings through design practice.

Through the theoretical examination of the physiological and behavioral characteristics of the elderly residing in nursing homes, as well as an exploration of the daily activities of older individuals, coupled with a case study on the design of furniture for the elderly, the locations of discomfort are determined. On this basis, an analysis of age-friendly furniture products is conducted with respect to existing issues, attributes, and user requirements.

Furthermore, by integrating the research findings with the analysis of design demands, the design components of age-friendly furniture are summarized in terms of color, material, shape, decoration, style, and form. Additionally, design principles such as convenience and practicality, accessibility, safety, emotional appeal, assistance, human-machine dimensions, and operability are proposed. These design elements and principles are then combined to suggest specific design approaches that align with the physiological and behavioral characteristics of the elderly in nursing homes.

Lastly, by assimilating the theoretical knowledge of nursing home bed design practice, a multifunctional ageing bed is conceived, which serves as a new design reference and catalyst for contemplating the future of age-friendly furniture design in Chinese nursing homes.

6.2 Physiological and Behavioural Characteristics of Elderly in China Nursing Homes

Research Question 1: What are physiological and behavioural characteristics of the elderly in nursing homes in China?

RQ1 focuses on investigating and researching two primary components. The initial component primarily employs the literature method to analyze and synthesize the pertinent literature from the past decade. Additionally, the CiteSpace software is utilized to visualize and analyse the data. The second component involves conducting questionnaires and interviews to examine and analyse the performance of physiological and behavioral characteristics of older individuals residing in China nursing home.

The primary research objective of this study was to summarise the physiological and behavioural characteristics of elderly people in China nursing home. During the RO1 phase of the study, the primary focus was on organizing research related to the fundamental concepts and contemporary issues of age-friendly furniture in both domestic and international literature concerning the physiological and behavioral characteristics of the elderly. Research methodology used in for this phase involved conducting field surveys and combining them with direct observations of the subjects. This approach enabled an in-depth and systematic examination and analysis of the performance of physiological and behavioral characteristics of the elderly. Through the analysis and synthesis of the gathered data, a foundation was established for the subsequent investigation of RQ3 and RQ4.

6.2.1 Physiological Characteristics of Elderly

a) Physiological Characterisation of Elderly in Nursing Homes

Through interviews and research, it can be ascertained that nursing homes for the elderly should accommodate three distinct groups of individuals: those who have a basic level of health and are capable of self-care, those who are frail and require assistance with daily activities, and those who necessitate continuous medical attention. Over time, all three categories of elderly individuals will inevitably experience varying degrees of physiological decline, deterioration in sensory perception, and the gradual escalation in chronic illnesses and complications. Field observations have demonstrated that regardless of their physical condition, the elderly engage with furniture in the course of their daily behavioural activities. Consequently, the provision of high-quality furniture products specifically tailored to the needs of the elderly will enhance their physical and mental well-being. Thus, the design of furniture intended for use in nursing homes should thoroughly consider the physiological characteristics inherent in the ageing process. The physiological changes that impact the lives of the elderly manifest as they advance in age, and these characteristics can be summarized as follows based on an analysis of survey data.

i. Elderly perceptual ability will be lower and lower, slow reaction, poor concentration, etc. Sensory perception includes visual, auditory, gustatory, olfactory, tactile and so on.
ii. Cognitive decline, as evidenced by neurological deterioration including memory loss, cognitive decline, poor ability to adapt to new environments, and difficulty in recognising new and changing environments.

iii. Reduced physical and motor abilities, as evidenced by a reduction in body size, and deterioration of the locomotor system in terms of reduced limb flexibility, reduced muscle strength and brittle bones.

iv. The decline of mental functions and changes in physiology bring about psychological stress and emotional fluctuations in the elderly, which are manifested in a declining sense of psychological security, weakened adaptive capacity, and a tendency to develop a sense of inferiority, loss, loneliness, impatience and depression.

v. Weakening of immune function and adaptability, especially with the gradual increase in age, the body of the elderly gradually appears to be weakened, physical function decline and chronic diseases aggravated.

b) The Manifestation of the Problems Caused by These Characteristics

Based on the findings of the preliminary questionnaire and interview data, as well as the analysis of the physiological characteristics of the elderly residing in nursing homes, we can delineate the physiological attributes of this demographic. Furthermore, we can outline the specific manifestation of physiological issues experienced by the elderly as a consequence of these aforementioned characteristics, as illustrated in table 6.1. Consequently, we are able to dissect and examine the physiological characteristics of the elderly in nursing homes, thereby paving the way for the development of design strategies pertaining to furniture that caters to the needs of ageing individuals within such facilities.

Table 6.1: Content Analysis of Physiological Characteristics and Problems of Elderly

physiological characteristic		Specific problematic manifestations
Perceptual function	Visually	Sensitivity to the light environment, loss of visual acuity, weakening of colour discrimination and narrowing of the visual field. Elderly people suffer from varying degrees of presbyopia, cataracts, reduced colour discrimination and reduced ability to adapt to light.
	Sense of hearing	Hearing loss, with age, severe hearing loss for high and medium frequency sounds, need to use hearing aids
	Taste,smell, touch pain, temperature perception	Decrease in the perception of taste, smell and touch, with an insignificant initial decline and a pronounced decline in the later stages of the disease Pain and temperature perception deteriorate with age, and inability to adapt well to hot and cold environments leads to illnesses, etc.
Cognitive ability	Ability to remember	Memory loss, ability to receive signals and process information diminishes with advancing age
	Receptivity	Decreased ability to accept new things and adapt to the environment
	Intellectually	Reduced ability to think, express, judge and control, and difficulty in perceiving changing circumstances
	Reaction speed	Reactivity decreases with age, slow reaction time, reduced mobility, and accidents such as falls, fractures, and injuries may occur if one is not careful
	Environmental adaptability	Decreased immune function, greatly reduced tolerance to stimuli such as humidity, temperature, trauma, fatigue, etc., and reduced environmental adaptability
	attention	Lack of concentration and high exposure to external influences
Physical and motor skills	Dimensional changes	Gradual decrease in height due to osteoporosis, curvature of the spine, lower limbs, etc.
	Flesh	Muscle strength will be reduced, muscles will be flaccid, falls will be easy, fatigue will be easy, and control will be diminished
	Skeleton	Reduced elasticity and toughness of the bones, the spine becomes curved and compressed, such as hunchback leading to poor posture, which can cause pain, reduced mobility
	physiology	Degeneration of cartilage and reduced limb flexibility
	Balance	Slightly poor balance, needs assistance with tools
	Mobility	Decreased ability to move on their own, e.g., slower, wobbly walking, need for aids
Mental function	Sense of loss	Changes in the pace and content of life after retirement and a strong sense of loss
	Loneliness	The monotony of life gradually creates a sense of loneliness, easy to be negative and lonely, and the social circle becomes smaller.
	Inferiority complex	Changes in social status and roles make it difficult for the elderly to adapt; psychologically, they begin to feel “old and useless”.
	Sense of responsibility	I hope to be “useful in my old age”, I hope to be self-reliant, and I don't want to bother others.
	Nostalgia	Feelings of nostalgia for the past, and familiar things make older

Table 6.1 continued

		people feel close to them.
	Gloomy	Prone to negative emotions and negativity in the face of difficulties, resulting in depression, boredom, helplessness, etc.
	Paranoid	Prone to insecurity, mistrust and excessive concern for physical health
Immunity	Self-regulation	Sensitivity to environmental change and difficulty in adapting to climate change
	Defensive capability	Reduced resistance to disease and climate change

6.2.2 Behavioural Characteristics of Elderly

Throughout the course of this study, a significant finding emerged: living behaviours were strongly linked to the lifestyles of older individuals in nursing homes. This is evident from the results of a survey on the spatial requirements for behavioural activities and the lives of older individuals in nursing homes, where living behaviours accounted for over 50% of the locations where behavioural accidents were most likely to occur. As a result, the researcher posits a close relationship between the physical functioning of the elderly and their living behaviour and environment. The interviews and questionnaires conducted in this study reveal that the content of living activities and the activity space for elderly individuals in nursing homes should be the primary focus of design attention. This also serves as one of the main rationales for selecting ageing multifunctional beds in nursing homes as a practical case in Chapter 5 of this study.

Through the administration of questionnaires and field investigations, it has been determined that the primary behavioral activities of the elderly in nursing homes encompass sitting quietly, lying quietly, reading, eating (including mealtimes), conversing, engaging in light physical labour (such as tending to plants, hanging laundry, and sweeping), listening to the radio, and participating in exercise. The design of furniture

specifically tailored to the needs of the elderly in nursing homes is closely associated with their daily lives. The characteristics of their behavioral activities can be summarized as follows.

i. Periodicity of activity time is characterised by the fact that older people spend less time sleeping and more time in leisure, and their activities show a certain regularity and periodicity.
ii. Domain-based characteristics, which are manifested in the fact that the domain of activity of older persons is governed by many factors, including their social background, behavioural habits, ethical concepts and the environment in which they live.
iii. Attribute characteristics, combined with the physiological and behavioural needs of the elderly, can be divided into two attributes: individual behavioural activities of the elderly and cluster behavioural activities of the elderly.
iv. Behavioural activity interaction processes of older people in nursing homes can also be divided into dynamic and static behavioural activities by classifying behavioural activity attributes.

Nonetheless, in order to acquire a scientific theoretical foundation and first-hand data for the design of age-friendly furniture in nursing homes, the researcher conducted on-site behavioral research in four different types of nursing homes in six provinces in China. Through interviews, observations, and recordings, the researchers gained insight into the diverse living and lifestyle habits of the elderly residents, and collated and analysed the manifestation of relevant behavioral characteristics exhibited by the elderly individuals in the nursing homes. Specific behavioral issues, characteristics, and manifestations are meticulously outlined in table 6.2.

Table 6.2: Content Analysis of Changes in Behavioral Characteristics and Issues Manifestations in the Elderly

No.	Status of behavioural issues	Specific problematic manifestations
1	Unstable centre of gravity when changing postures unsteady centre of gravity	Mainly in the use of furniture, a sitting position into a standing position of the body's centre of gravity is unstable, such as standing up from the toilet will be physically unsteady, from the chair will be unsteady to stand up; the second for the lying position into a sitting position of the body's centre of gravity is unstable, such as getting up will be unsteady.
	Physical activity while standing unsteady centre of gravity	It is mainly the behavioural activities performed by the elderly in a standing state that produce the condition of unstable body weight, such as standing to put on clothes, standing to take a shower, standing to put on shoes with an unstable body weight.
	Unstable centre of gravity when moving the body	The majority of elderly people are unsteady when they move due to physiological decline, unsteady steps or unaccustomed to the use of mobility aids such as crutches and wheelchairs.
2	Poor physical coordination of behavioural activities	Uncoordinated limb movement and deterioration of balance in the elderly, e.g., elderly people who wobble when walking or standing, and who show uncoordinated and inaccurate characteristics when performing a certain movement.
	Reduced flexibility in behavioural activities	This is mainly due to the deterioration of behavioural activities of the elderly, which leads to a decrease in the degree of flexibility of physical activities, muscle strength and control, such as a slowing down of the speed and amplitude of physical behavioural movements.
	Behavioural capture error, not easy to view small parts	Elderly people's visual, tactile and other abilities deteriorate leading to behavioural activities are prone to make mistakes, such as touch screen interface, press the number of product buttons, area and spacing is small, the elderly are more difficult to click accurately, it is easy to misoperation.
3	Behavioural operations become longer and more difficult	Elderly people do not have enough behavioural ability for products with long and cumbersome operating procedures, feel overwhelmed during operation, and are prone to exclusion and discomfort with complex furniture functions.

Table 6.2 continued

	slow move	Due to ageing and deterioration of body functions, the elderly suffer from inflexibility of the limbs, slow walking due to reduced stride length, and reduction or disappearance of normal swinging of the limbs during walking.
4	poor memory	Memory becomes poor and you tend to forget things, such as forgetting where you put items and not being able to find where they are placed for a short period of time.
	Can't find the right angle.	Mainly when reading and contacting media devices, viewing items without the appropriate angle, resulting in viewing inconvenient convenient situation, such as looking at mobile phones, books, TV, etc., and not being able to find the right angle.
5	sedentary lifestyle	Long time sitting on the chair will make people feel uncomfortable, such as sofa sitting for a long time feel stuffy, in the metal, plastic tables and chairs to do a little longer, the body is too stiff enough to be comfortable.
	Holding items can easily cause Physical fatigue	Uncomfortable sensations in the hands and feet due to holding objects, e.g., sore hands when holding books for a long time, lack of strength when carrying things, etc.
	Reduced strength leads to unsteady handholding	Because of the reduced strength, you may accidentally fall when you hold heavy objects or when you hold objects while moving, causing your body to sway, such as when you hold a kettle and pour water, or when you hold a tray of fruit.
	Loss of limb strength and need for assistance	It is not easy to stand up after sitting for a long time, for example, when designing seating furniture, it is necessary to consider the strength of the limbs of the elderly, and consider how to realise the convenient use of assistive tools for the elderly.
6	Difficulty in falling asleep, poor sleep quality, insomnia and sleepy behaviour	Older people due to the decline of the nervous system, adaptability and adjustment ability to deteriorate, such as: once the night there is sound or other factors of instability, the elderly are easy to wake up or even insomnia; bed length and width of the design of the size of the irrational, hardness, and so on, make the old people sleep is not comfortable.
	Difficulty getting in and out of bed	Elderly people have difficulty bending their knees and some may also use wheelchairs.

Table 6.2 continued

	Poor nocturnal mobility in the elderly	When you get up in the middle of the night to use the toilet, you need to go through the act of getting up - putting on your shoes - (switching on the light) - walking to the toilet. In a darkened room, it is difficult to find where the shoes were placed before going to bed, making it inconvenient to walk, etc.
	People and objects are too Too far away for mobility	Conditions where items are not easily accessible because they are too far away, or placed too high or too low, such as far away bedside storage, or cabinets that are too high or too low causing mobility problems.
7	Inconvenient space movement	As a result of restricted movement space and irrational division of space, problems such as inconvenient living activities and low space utilisation arise, seriously affecting their quality of life.
8	Sudden behavioural accidents	The decline of physiological functions in the elderly may easily lead to sudden behavioural accidents, such as emotional instability resulting in a sudden fall due to increased blood pressure.

6.3 Existing Problems, Attributes and Requirements of Age-friendly Furniture Design in Nursing Homes

Research Question 2: What are the existing problems and user requirements of the elderly?

The second objective of this study is to explore the main problems in the utilization of furniture within China nursing homes within a focus on uncovering the design requirements and needs of elderly users. To achieve this, questionnaire 3 was employed, and in-depth interviews were conducted with the elderly to gather data on the issues related to elderly furniture and the needs of the elderly in nursing homes. The questionnaires and interviews were utilized to analyse the respondents' familiarity, attitude, intention, usage, and perception of elderly furniture in nursing homes. Furthermore, the study aimed to summarize the design attributes and user needs associated with this furniture.

6.3.1 Problem Identification

Through the feedback survey on the furniture used by the elderly in nursing homes, the study aimed to investigate the challenges encountered by the elderly during the utilization process. Additionally, the study aimed to explore the crucial factors that influence the satisfaction of the elderly with institutional-type elderly furniture, as well as their feedback and usage patterns. This analysis served as the basis for identifying the design attributes and needs related to elderly furniture in nursing homes.

Initially, the satisfaction evaluation of age-friendly furniture in nursing homes was analyzed using a matrix scale through a questionnaire. The results of the analysis indicated that the elderly were dissatisfied with the existing furniture. Approximately 27.55% of the respondents were essentially dissatisfied, while 7.87% were very dissatisfied. Furthermore, the survey on the interest, reasons, awareness, and concerns of the elderly regarding age-friendly furniture indicated that most of them had a limited understanding of this type of furniture. The analysis revealed that the main reasons for the elderly's interest in furniture for the elderly were the material, style, and safety, accounting for 23.62%, 20.21%, and 19.05% respectively. Comfort is also the focus of people's attention, accounting for 33.82%. These findings demonstrate that most elderly individuals share similar concerns regarding furniture for the elderly.

Moreover, in-depth interviews were conducted with elderly individuals in six nursing homes of varying sizes and levels in different provinces of China, including Jiangsu, Zhejiang, Guangxi, and Guangzhou. Based on the results of these interviews, it was identified that there are numerous significant issues with the current elderly furniture in Chinese nursing homes. Furthermore, there exists a strong desire for improvement and a

high demand for design among the elderly. By combining the findings from the questionnaires and interviews, the researcher has identified the main problems and reasons for the existence of elderly furniture products in Chinese nursing homes.

i. The existing furniture in nursing homes is designed based on the size, shape, and physical abilities of the elderly. This can be observed in two main aspects: the ergonomic design for the comfort of the elderly and the dimensional relationship between different components of the furniture products.

ii. Currently, there are limited options available for furniture suitable for the elderly in terms of form, colour, shape, and material. Additionally, there is not a clear distinction between furniture designed for the elderly and regular furniture. The consideration of physiological and psychological needs, such as colour and shape, lacks the emotional and humanistic care required for the elderly. Furthermore, the selection and matching of materials have not been focused on meeting the preferences of the new generation of elderly individuals.

iii. The elderly population face challenges using tables, chairs, and cabinets. One major issue is the controversy surrounding the height of these furniture pieces. Another issue is the inconvenience encountered when using existing furniture, which does not provide the necessary safety and security for the elderly.

iv. More than 70% of older individuals who use bed furniture have reported various problems such as uncomfortable sleeping positions, difficulty in getting up, and the lack of proper support. This highlights the urgent need for design solutions to address these serious issues.

v. Many elderly institutions have fragmented procurement processes for furniture, resulting in the purchase of low-quality and inexpensive furniture that does not

meet functional requirements and poses hidden safety hazards. This has led to the emergence of numerous problems in these institutions.

vi. There is currently a limited selection of furniture products in the market specifically designed to accommodate the physiological decline and behavioral characteristics of older users. Furthermore, there is no dedicated professional market or brand for age-friendly furniture. However, the demand for furniture catering to the needs of the elderly in China is particularly high.

6.3.2 Design Attributes

On the grounds of preliminary theoretical knowledge on sorting and analysis, a series of interviews were conducted with experts. Considering the outcomes of the expert interviews, the composition structure of elderly furniture for nursing homes is established, and subsequently categorized into attributes. The design attributes are primarily classified into six categories: sensory attributes, intelligent attributes, material attributes, emotional attributes, operational attributes, and social attributes. The findings of the study demonstrate that the six attributes of the design composition structure of age-friendly furniture serve as the foundations for the thoughts and ideas in the design practice of age-friendly furniture in Chinese nursing homes. In order to obtain the composition structure of the design attributes, the researcher initially facilitated the sharing of specific design cases and research on the design of age-friendly furniture among relevant experts and designers.

Building upon this foundation, the data results are discussed through the extraction of keywords from the expert interviews. Subsequently, the researcher synthesized the design attributes of age-friendly furniture in nursing homes based on the results of the comprehensive interviews. Simultaneously, the influential factors of the relevant design attributes are analyzed and summarized, and an evaluation and analysis of the current state

of product design and user feedback of existing elderly furniture in nursing homes is conducted.

In this phase, the interview method is employed to examine the behavioral characteristics of the elderly residing in nursing homes. The aim of this analysis is to identify the difficulties and issues they encounter when using furniture products, with the intention of addressing these pain points. Given that the elderly in nursing homes constitute a distinct group, the researcher places particular emphasis on observing subtle changes in their demeanour and language during the interview process. Through a thorough analysis of the in-depth interview results, the design considerations for this type of elderly furniture can be initially summarized.

6.3.3 User Requirements and Analyses

This study makes a distinctive contribution by expanding on previous research to discern the specific characteristics of the needs of elderly individuals residing in nursing homes. The findings of the study demonstrate that the needs of older adults in nursing homes encompass various dimensions and are of utmost importance in the design and development of furniture that promotes age-friendly environments.

Initially, the physical and mental characteristics of the elderly were thoroughly examined in relation to their physiological and behavioral needs. The results of the survey reveal that addressing the physiological and behavioral needs of the elderly is crucial for enhancing their physical and mental well-being, as well as facilitating their daily activities with maximum convenience. Likewise, the psychological needs of elderly individuals in nursing homes are influenced by their own physiological decline and the external social environment. Specifically, the elderly are prone to feelings of loss, low self-esteem,

loneliness, and emptiness. Surveys indicate that the psychological needs of older adults play a significant role in shaping their social roles and also impact their actual behavioral patterns in daily life, including their sensitivity to environmental insecurity.

In addition to the physical, behavioral, psychological, and safety needs of the elderly, designers must also consider the spiritual, cultural, and emotional needs of elderly individuals in nursing homes. Research findings demonstrate that the spiritual needs of elderly individuals in nursing homes primarily revolve around public activities and interpersonal communication. Therefore, when designing furniture for the elderly in nursing homes, the entertainment function of the furniture should be fully taken into account. Additionally, research analysis indicates that elderly furniture serves as a pivotal means for the elderly to connect emotionally with the outside world. It also facilitates emotional transmission among the elderly and between the elderly and others. Consequently, the design of age-friendly furniture should have an understanding of the emotional needs of the elderly, creating emotional resonance for them.

In summary, a key determinant for the triumph of the design of furniture that caters to the ageing population lies in its ability to address the requirements of elderly users. Primarily, it is imperative to acquire a comprehensive understanding of the authentic necessities of the elderly residing in nursing homes by means of meticulous research. This research enables the identification and examination of the “pain points” associated with the needs of elderly users. Unquestionably, identifying these “pain points” represents the most arduous aspect of the design endeavour. Subsequently, based on the findings of the investigation into the needs of elderly users, the researcher categorized the needs of elderly

users in nursing homes into three tiers: fundamental needs, advanced needs, and superior-level needs. This categorization was achieved according to the hierarchy of needs theory postulated by Maslow, as illustrated in figure 6.1.

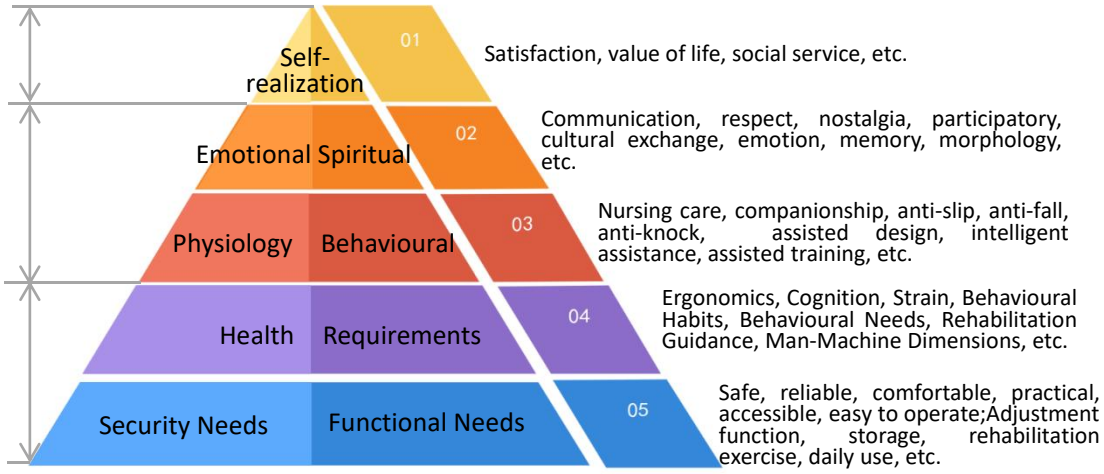


Figure 6.1: Analysis of User Demand for Age-friendly Furniture Products for Elderly in Nursing Homes（Maslow's Hierarchy of Needs,1943）

6.4 Key Points for Designing for the Physiological and Behavioural Characteristics of Elderly

Research Question 3: How the attributes, elements, principles and methods of age-friendly furniture design for the elderly can be proposed?

The third research objective of this study is to propose the attributes, elements, principles and methods of designing age-friendly furniture from the perspective of the physiological and behavioural characteristics of the elderly in China nursing homes. This will be done by considering the physiological and behavioral characteristics of the elderly residing in nursing homes in China. In the initial stage, the design attributes and elements will be examined through a survey that focuses on identifying the existing problems and the needs of users in relation to the design of furniture suitable for the elderly in Chinese

nursing homes. Subsequently, based on this analysis, the design elements, principles, and methods of furniture that promotes age-friendly environments will be proposed, taking into account the physiological and behavioral characteristics of the elderly.

6.4.1 Specificity and Key Points of Design Element

This study also explores strategies to appeal to the elderly population in terms of design elements. The analysis of the survey results revealed that the market would not accept age-friendly furniture if attention is not given to visual elements and the creation of aesthetic effects. As a result, the researcher suggests a comprehensive analysis of design elements such as color, material, shape, decoration, style. This will enhance the overall consideration of furniture design for the elderly.

c) Colour

The colour of a product determines the initial impression it leaves on the user, while the colour of furniture plays a decisive role in shaping the overall ambiance of a space. As a matter of fact, the use of colours in the design of age-friendly furniture is not limited to rigidity and dullness; instead, it can be flexibly and appropriately applied. Therefore, when designing furniture for the elderly, the first step is to investigate the colour properties relevant to the elderly population. This entails examining their visual needs, emotional responses to colour, and the humane elements associated with colour. Subsequently, specific ideas can be developed for the selection and coordination of colours in age-friendly furniture.

The study's findings suggest that when considering colour for furniture in nursing homes that is suitable for ageing individuals, five elements should be broadly taken into

account.

i. The colours chosen should be emotionally appealing and align with the psychological needs and preferences of the elderly.
ii. The colours are emotional and in line with the psychological needs and preferences of the elderly.
iii. Adhering to the principle of age-friendly design in terms of colour, while also emphasizing the importance of designing furniture that caters to the needs of ageing individuals.
iv. The selection of colours should be appropriate for the target older population.
v. The chosen colour scheme should align with the physiological characteristics of the elderly, while also maintaining a balance between colour differentiation and diversity, as well as coordinating with the surrounding environment.

d) Material

The design and selection of materials for age-friendly furniture are closely intertwined. Different materials can create different textures and effects, and advances in material science have propelled the development of furniture industry. When selecting materials for age-friendly furniture in nursing homes, it is crucial to consider the physiological and behavioral characteristics of the elderly group. By choosing appropriate materials, one can create furniture that offers the desired texture, experience, and comfort.

Based on the analysis and summary of the survey findings, the researcher posits that the selection of furniture materials should fully consider the needs of the elderly.

i. The material have the qualities of being waterproof, resistant to stains and abrasions, as well as easy to clean.

ii. The selection of materials take into account the perceived comfort and emotional requirements of the elderly individuals.

iii. While composites and novel high-performance materials are structurally stable, they must not compromise the sentiments and safety of older individuals.

iv. The texture and style of the material should align with the design theme and adhere to the overall living style.

v. The attributes of the material should correspond to the physiological and behavioral variations of the elderly, with a particular emphasis on hardness, toughness, and practicality.

vi. The material should have well-established processing technology, be reasonably priced, and facilitate the production and processing of enterprises.

e) Modelling

When it comes to furniture usage among older individuals, their perception and experience primarily rely on their visual and tactile senses. Consequently, the overall design of age-friendly furniture assumes paramount importance. Additionally, given the decline in physiological functions experienced by the elderly, they tend to exhibit resistance towards novel elements, with unfamiliar and abstract furniture designs often evoking feelings of insecurity. Therefore, designers should exercise caution when incorporating innovative elements into furniture design while prioritizing usability and intuitiveness. Simultaneously, the design of age-friendly furniture should first and foremost fulfil the basic functional requirements, thereby effectively reflecting the rationality in terms of functionality and aesthetic appeal.

Behind the third research objective, there exist approximately six components of styling that require specific attention in order to render the design of furniture suitable for

the ageing population more scientifically grounded and to fulfil the overall physiological, behavioral, and emotional needs of the elderly.

i. The material should have the attributes of being impermeable, resistant to stains and abrasions, and easily cleanable.
ii. The design of the furniture should be proportionate to the dimensions of the elderly body, and the overall scale should be based on the ergonomic principles specifically suited for the elderly.
iii. The shape and design should cater to the aesthetic and emotional requirements of the elderly, ensuring that the furniture provides them with a pleasing aesthetic experience and emotional satisfaction.
iv. Any sharp or abrupt features of the furniture should be concealed or softened, replacing them with smooth and gentle angular lines, incorporating more curves in order to create a sense of tranquillity and softness.
v. The design should have symbolic qualities, with a clear theme, and the various design elements should be harmonious and cohesive with one another.

f) Style and Decoration

The style of furniture for the elderly determines the aesthetic value and design positioning of the product. The favourite style of the elderly is inevitably related to their life experience and behavioural activities, presenting a representative and unique appearance. According to the results of questionnaires and interviews, it can be seen that the elderly in nursing homes are most favourable to the Chinese style and modern style, and they also love the traditional Chinese decorative elements in the decoration, but they do not want it to be too cumbersome.

The findings derived from the survey indicate that designers must consider both the elements of influence and the specific needs of the elderly when crafting furniture suitable for use in nursing homes. This entails taking into account several key factors.

i. Adapting to the aesthetic requirements of the elderly demographic are met, with particular attention paid to their physical and emotional characteristics.
ii. The furniture design should align with prevailing fashion trends and cater to the demands of the contemporary market.
iii. Essential to take into consideration the shared upbringing and life experiences of the elderly residents of the nursing home, to avoid the creation of overly ornate decorations.
iv. The decor should align with the intended style, design theme, and overall interior aesthetic.
v. Decoration should harmonize with the style of the furniture, refraining from excessive embellishment, and ultimately enhancing the value of the furniture products targeted towards the elderly.

6.4.2 Specificity and Key Points of Design Principle

The design of age-friendly furniture for nursing homes should be based on the perspective of the group of elderly people, through in-depth research to understand the needs of elderly people in nursing homes. Then, design furniture that is suitable for the physiological and behavioural activity needs of the elderly in nursing homes. Data analysis shows that the design of age-friendly furniture for nursing homes should adhere to the design principles of convenience, practicality, accessibility, safety, emotionality, assistance, human-machine dimensions, and operability.

To begin with, the principles of convenience and practical design are of paramount importance. The study's findings demonstrate the criticality of whether age-friendly furniture can provide convenience to the elderly in terms of physical or behavioral activities. The researcher meticulously analyses the convenience and practicality attributes of the furniture, primarily focusing on five aspects: simplicity, convenience, detailing, rehabilitation guidance, and utilization. Additionally, the study identifies a growing emphasis among designers on accessibility design principles, leading to various experimental endeavours. This phase primarily revolves around the behavioral traits of the elderly and utilizes the barrier-free design theory to influence the design of age-friendly furniture for nursing homes.

In fact, as the physiological functions and behavioral capabilities of the elderly decline, safety design becomes an essential prerequisite for the development of age-friendly furniture products. Survey results underscore the pivotal role of safety in the actual behavioral activities of older individuals. Special attention must be given to the safety of materials, shapes, colours, and structures, while not neglecting psychological safety. The study's findings indicate that behavioral assistive design and intelligent monitoring can effectively reduce the occurrence of safety hazards for older people. Consequently, the principle of assistive design is to reinforce and deepen the safety and sturdiness of furniture. Similarly, the foundational requirement of furniture design for the elderly is to enhance the assistive function of furniture to prevent unnecessary safety incidents.

Based on the findings from surveys and extensive interviews, emotions serve as a means for the elderly to comprehend and contemplate life based on their own personal experiences. Consequently, it is crucial to thoroughly analyse the psychological traits and

emotional requirements of the elderly when devising furniture specifically for them. In this regard, the emotional design principles governing furniture intended for the elderly in nursing homes must effectively integrate both their physiological and psychological characteristics as well as their emotional needs. As a result, it is imperative to expound upon the emotional design principles from the detailed elements such as its shape, colour, material, functionality, and design components, and how these elements impact the emotional design. This approach will enhance the comprehensive deliberation of furniture design that caters to the needs of the ageing population. Moreover, it is essential to conduct an in-depth analysis of the emotional design principles underlying the manifestations of emotional design in elderly furniture, and explicitly define the design criteria and objectives to be accomplished at all levels of design.

Finally, from a market operational standpoint, the researcher meticulously examines the current demand for furniture products in the Chinese nursing home market. In light of China's regional economic development level, the design process for nursing home furniture must adhere to targeted, economic, and sustainable design principles, which will stimulate the creation of an increasing number of exceptional furniture products for the elderly. This will provide essential theoretical support and practical guidance to foster the continuous development and promotion of the emerging market for elderly furniture.

6.4.3 Specificity and Key Points of Design Method

a) Design Methods of Age-friendly Furniture based on Physiological Characteristics of Elderly

The researcher initially examined and assessed the physiological characteristics of the elderly in five key areas: perception, cognitive ability, physical and motor ability,

psychological function, and immune function. Subsequently, in conjunction with design elements and design principles, a set of methods for designing age-friendly furniture for elderly users in nursing homes based on their physiological characteristics is proposed (Table 6.3).

Firstly, an analysis of perceptual ability reveals that older individuals experience significant physiological, psychological, cognitive, and behavioral changes as their age. These changes have a profound impact on their ability to perceive external information and stimuli. Notably, the elderly differ from the general population in terms of vision, hearing, touch, taste, smell, and perception. Consequently, a more detailed and considerate design approach is necessitated. Thus, in the design of furniture products, it is imperative to control and minimize the impact on the declining physiological functions of the elderly, enhance the user-friendliness of furniture products, and effectively utilize the strengths in the perception of elderly users.

Secondly, with respect to cognitive ability, the memory, receptivity, reaction speed, and attention of the elderly gradually diminish. Consequently, it becomes necessary to enhance the cognitive ability of the elderly through simplified furniture appearance designs, ergonomic considerations, intelligent voice assistance, and other design applications. Additionally, the cognitive ability of the elderly can also be enhanced through the incorporation of traditional appearance elements and styles, the extraction of aesthetic elements from the living environment, and the selection of appropriate colours and materials. Concurrently, research findings indicate that the decline in physical fitness and athletic ability of the elderly is primarily manifested body shape changes, weakened muscle strength, deterioration of bones and joints, and decerased limb flexibility. Thus,

based on ergonomics, the design of suitable furniture for the elderly must prioritize their needs in terms of physical and motor ability. In terms of modelling design, the design should aim to provide the elderly with an intuitive sense of security, such as by rounding the corners of the furniture or covering the edges.

At the same time, research findings reveal that the physical and motor capabilities of elderly individuals decline primarily in terms of changes in body size, diminished muscle strength, deterioration of bones and joints, and reduced limb flexibility. As a result, when considering ergonomics, the design of furniture tailored for the elderly should prioritize their physical and motor abilities. In terms of the design features, furniture should be selected to give seniors a sense of security, such as rounded corners or wrapped edges. Additionally, the functionality of the furniture should prioritize the safety of the elderly, aiming to reduce operational difficulties by creating barrier-free, easy-to-use, and stable furniture.

This study also delves into the design of age-friendly furniture from the perspective of the immune function of elderly individuals residing in nursing homes, a novel approach in this field. The focus lies on designing furniture that enhances both the self-regulation and defence capabilities of the elderly. Interviews conducted indicate that the elderly are particularly concerned about health and well-being, readily accepting health-related products and features even without incurring additional costs or effort. Consequently, the elderly express a desire for furniture that integrates intelligent design, offering functions such as physical health monitoring, information communication, emergency warnings, and assistance. Simultaneously, there should be an emphasis on incorporating recreational and

physical support features within everyday furniture to facilitate exercise and promote the health of the elderly.

Table 6.3: Design Methods for Physiological Characteristics and Issues of Elderly in Nursing Homes

Physiological characteristic		Design methodology or recommendations
Perceptual function	Visually	• Colour selection should follow the principle of coordination of low purity, low brightness and low luminance, and the tone should be chosen to be steady, light and flat, which visually can bring the elderly a sense of affinity, temperature and security. • Interface design should make more use of attention-grabbing and recognizable colours to provide visual reminders of key content and areas to guide older persons to perform targeted operations, for example, by using attention-grabbing colours for reminders of suggestive headings. • Taking into account the weakened perceptual function of the elderly, sensor-assisted lighting is added to the furniture design, such as adding LED sensor light strips to wardrobes and beds to help improve the visual sensitivity of the elderly.
	Sense of hearing	• To consider the elderly in the nursing home can hear clearly, better delivery of information, the spatial environment should reduce echo, noise, and sometimes need soundproofing treatment. • For situations where the local area cannot meet the hearing needs of the elderly, smart furniture facilities need to be intervened to provide auxiliary prompt.
	Taste, smell, touch	• Smart sensors such as automatic smoke alarm switches and electronic noses can be introduced into smart furniture design to ensure the safety of the living space for the elderly. • The tactile button design should be easy to locate and identify by touch, and the buttons for touch should be raised and also sturdy.
	Pain, temperature perception	• Intelligent sensing and control systems should be added to some of the furniture in life, and environmental changes such as temperature, humidity, light and electrical appliances should be intelligently adjusted according to the physiological needs of the elderly. • Create a more comfortable and personalised perceptual experience through information interaction.
Cognitive ability	Ability remember	• Furniture with motorised functions should be equipped with eye-catching button prompts or voice reminders for easy identification and use by the elderly. • Setting up an intelligent voice assistant, the control user

Table 6.3 continued

		interface is able to provide the elderly user with a reservation function, and by waking up the voice assistant, it can give reminders to the elderly daily life activities, avoiding the elderly user from having a weakened memory.
	Receptivity intellectually	• Furniture should be simple in shape and operation should be easy to discover, understand and master to maximise accessibility and use for the elderly. • Shapes, materials and colours should be relatively soft, avoiding exaggeration, and conforming to the inner perception of the elderly and their aesthetics.
	Reaction speed	• Based on visual comfort, contrasting colours are used on key functional components to increase the intensity of instructions for easy identification by older people.
	Environmental adaptability	• A distinctive signage system with memory cues creates a familiar home environment.
	Attention	• Adding fun design provides older people's engagement and facilitates focusing older people's attention. • Add puzzle features to the design, such as adding fun games to the furniture's.
Physical and Motor skill	Dimensional changes	• The use of functions should be based on the ergonomic point of view of the elderly, through reasonable human-machine dimensions and scientific interactive operation design, to reduce the possibility of danger when the elderly use furniture. • The design of structural dimensions should be in line with the physiological characteristics and body proportions of elderly users, and the overall design should be based on contraction and smoothness. • The height above the head should be avoided as much as possible, 200mm above the neck to the top of the head is suitable for storing infrequently used items, the waist to the head is suitable for storing commonly used clothing, and the waist to the knee is suitable for storing miscellaneous household items.
	Flesh skeleton joint (physiology)	• For the muscles, bones, joints have recession of the elderly, to give the elderly a certain degree of support through the surface of the furniture to reduce the pressure on the legs, to consider the degree of softness and hardness of the mattress in order to ensure that the elderly do not cause harm to the waist and forehead. • Give the elderly a certain degree of leg support to reduce the pressure on the legs and avoid excessive pressure on the bottom of the thighs because the seating surface is too high • The lifting function, storage function and adjustable function can simultaneously meet the multiple needs of the elderly for lifting, storage and adjustment of sitting posture. • Use of hand support, such as seats equipped with armrests as a

Table 6.3 continued

		borrowing point for the elderly to get up, etc.
	Balance	• Furniture should be equipped with handrails or hidden handrail positions at all places to effectively help the elderly to stand up, or as a temporary resting point to lean on, and can be used as a support point when the position needs to be moved. • Furniture with wide edges can be designed with hidden support points, such as grooves along the edges of the furniture to make it easier for the elderly to find a point of strength.
	Mobility	• Most of them adopt no sharp corners and smooth modelling, in order to reduce the occurrence of bumps, bruises and other accidental injuries of the elderly in the process of moving because of accidents or the elderly's own health reasons. • Elderly people use walking aids such as crutches frequently, and furniture design needs to allow for crutch storage.
Mental Function	Sense of loss loneliness feeling of nostalgia	• Increase the use of traditional elements to give Chinese furniture a rich cultural connotation. • Colour selection of warm tones, should try to increase the brightness of the furniture, while ensuring that the overall harmony of the furniture effect, echo each other, is conducive to stabilising the mood of the elderly. • Nostalgic psychology, avoid too large a span, cause the old man's sense of strangeness, modelling also consider the good times style, give the old man a peace of mind familiar with the furniture.
	Low self-esteem gloomy paranoid	• Close to the natural form and soft lines more healing emotions, so that the elderly more love life, enjoy life, such as flower's petals, butterflies as the prototype of the design of the petal table, butterfly-shaped table and so on. • Choose more natural and soft materials as cooking dishes, furniture should choose bamboo, wood, rattan and other materials, its natural good natural properties are conducive to the physical and mental health of the elderly. • The design should be stretchy and soft, with super-tasteful shapes that add interest, so that the furniture conveys a sense of humour and imagination, and allows the elderly to have a more relaxed state of mind and a broader outlook. • In the choice of furniture colours should be avoided too bright, saturated, jumping colour scheme design, more calm, subdued colours, to avoid excessive excitement and excitement.
Immunity	self-regulation defensive capability	• Intelligent design is applied to provide body condition monitoring information, instant communication with the healthcare service system network, active and passive help alarms in emergency situations, and other types of product capabilities. • Health assistance design, appropriate increase of physical rehabilitation exercise facilities for the elderly in daily life furniture.

b) Design Methods of Age-friendly Furniture based on Behavioural Characteristics of Elderly

This study, for the first time, discovered that the behavior of elderly individuals residing in nursing facilities differs depending on the spatial environment and individual physiological conditions. The utilization of questionnaires and interviews in the material investigation revealed that the behavior of the elderly in nursing homes can generally be classified into four types: independent, assisted, cared-for, and reclining. As a result, the primary focus of the design approach for age-friendly furniture lies in understanding the behavioral disparities among these four types of elderly individuals. Then, a series of age-friendly furniture design methods for the behavioural characteristics of elderly users in nursing homes are proposed by combining design elements and design principles (Table 6.4).

The researcher initially establishes the direction for the proposed design approach by concentrating on the aforementioned four aspects of behavioral characteristics in conjunction with user requirements, design components, and design principles. In view of the design approach for age-friendly furniture that accounts for the behavioral characteristics of elderly users, this study primarily examines the roduct stability, safety, convenience, assistance, and behavioral habits.

Firstly, particular attention is given to the design of stability and safety. Furniture must be designed in a manner that ensures stability in order to prevent safety risks that tend to arise when older individuals utilize furniture, such as scratches, impacts, and falls.

In addition, research findings indicate that elderly individuals often reject and experience discomfort with complex furniture functionalities. Consequently, while

enhancing the functionality of furniture, it is also imperative to minimize the complexity of operating said furniture, ensuring that the use of furniture is as straightforward and convenient as possible, facilitating easy learning and remembrance.

Subsequently, the focus shifts to the design approach for assisting the design of elderly furniture. For instance, handrails or concealed handrails should be incorporated into all sections of the furniture intended for the elderly, providing them with support and a focal point to maintain bodily balance, thus averting instability in their centre of gravity during actions such as standing up or sitting down. If necessary, intelligent systems can be employed to aid the elderly in their interactions with the furniture.

Additionally, during in-depth interviews, the researcher discovered that the daily lives of elderly individuals residing in nursing homes primarily revolve around activities related to daily living and recreation. Therefore, the design of age-friendly furniture should be based on the living behaviors of the elderly during their later years. Consequently, the design of adapted furniture should consider how to facilitate the elderly in conveniently and comfortably engaging in activities such as eating, writing, conversing, rehabilitating, exercising, and resting.

Finally, observations are made on the implementation of intelligent design. Surveys indicate that a majority of elderly individuals are starting to derive satisfaction from the ease and experience brought forth by technology. To illustrate, intelligent furniture design can be incorporated with intelligent sensors to guarantee the safety of the living environment for the elderly, thus achieving a form of interaction between humans and computers. By means of the intelligent adjustment feature encompassing aspects such as contact surface temperature and spatial position, among others, automatic adjustments can

be made to enhance the safety, comfort, and convenience of utilizing furniture for the elderly. Moreover, the intelligent design can also enable various functions such as sleep data collection, emergency assistance calling, intelligent lighting, health monitoring, and aided rehabilitation.

Table 6.4: Design Methods for Behavioural Characteristics and Issues of Elderly in China Nursing Homes

No.	Status of behavioural issues	Design methodology or recommendations
1	Unstable centre of gravity when changing postures unsteady centre of gravity	✓ Auxiliary function, through the furniture design to give the elderly support points and points of force to maintain body balance, to avoid the body centre of gravity is not stable and lead to fall, bump and other unnecessary bodily injury. ✓ Consider the stability and safety of the furniture itself. Furniture that is too light may cause the elderly to topple over when using it, too tall or too short may make it difficult for the elderly to sit up, etc.
	Physical activity while standing unsteady centre of gravity	✓ The bottom of the furniture is designed to shrink to avoid the legs being too long and to prevent seniors from tripping. ✓ Elderly dining table, desk and other edges at the location of digging a curved small groove as a safety handrail, can help the elderly body support, grip role, to maintain the balance and stability of the body. ✓ Adding a shoe-changing seat function to the original shoe cabinet structure allows the elderly to change and retrieve shoes comfortably and effortlessly.
	Unstable centre of gravity when moving the body	✓ The corners of the old furniture should be rounded, smooth and curved to avoid the appearance of sharp corners, to prevent the elderly from falling when moving, accidental bumps and scratches. ✓ The modelling promotes the use of relatively soft curves and larger surfaces to increase the size of the impact surface.
2	Poor coordination of behavioural activities	✓ Enhance the ease of use and intuitive operation of furniture for the elderly. ✓ (c) Designing safe, accessible and easy-to-use furniture to improve the safety, comfort and convenience of using age-friendly furniture .
	Reduced flexibility in behavioural activities	✓ Intelligent aids are added for intelligent adjustment to improve the flexibility of the furniture itself through automatic adjustment of functional dimensions, internal environment, contact surface temperature and spatial location.

Table 6.4 continued

	Behavioural capture error, not easy to view small parts	• Adjust the furniture logo size, colours, icons and patterns, and try not to produce strong reflections in the background. • Increase the contrast of colours to enhance strong visual contrasts, and try to be as concise and graphic as possible. • Reduced visual sensitivity, especially the ability to distinguish between similar colours, so if there are functional cues in the area should be highlighted with more obvious colours or patterns. • The touch screen interface reduces the number of buttons and increases the area and spacing of buttons, allowing older people to click more accurately and reducing the error rate.
3	Behavioural operations become longer and more difficult, the slow move	• Designed with relatively tactilely different materials in key areas as a way to help the elderly find their position in time and accurately. • Functional performance should be simple and straightforward, reduce complex and redundant design, add appropriate guiding functions, easy to operate for the elderly, and the use method should be as simple and convenient as possible, easy to learn and remember. • When designing products, try to simplify the length of time and difficulty of behavioural operations, to avoid the operation of complex furniture to produce rejection and discomfort.
4	poor memory	• Cabinets and other furniture with storage functions are as open and flat as possible to make it easy for older people to find what they need in a short time. • Requires the use of stronger contrasting colours in key areas of the furniture in a design that compensates with the senses. • The use of transparent or translucent materials allows stored items to be seen at a glance, saving searching time and reducing the memory burden. • The use of colours to differentiate between functional modules, with different colours representing different types of storage, and the use of multiple colours for comparison, can be assisted by the use of intelligent speech.
	Can't find the right angle.	• The intelligent design of furniture such as seats and sofas is mainly reflected in the convenience of the elderly in adjusting and changing their sitting positions. • With the automatic adjustment function of armrest height, headrest angle, sitting height, etc., it improves the safety and convenience of the elderly in the process of using.
5	sedentary lifestyle	• Cushions and backrests should be appropriately tilted to relieve the elderly from slipping out of their seats due to the material of their clothes and cushions as well as to relieve the elderly from lumbar spine discomfort. • The padding of some soft cushions should have a certain degree of support and resilience to avoid back pain when the elderly sit or lie down for a long time.

Table 6.4 continued

	Holding items can easily cause Physical fatigue	✓ Furniture design should take into account the body size of the elderly, too high or too low is not suitable for the elderly to use. ✓ Provide more auxiliary functions, if necessary, you can use automatic lifting system to assist the elderly operation, such as hanging cabinets to join the lifting device to reduce the difficulty of access to the items.
	Reduced strength leads to unsteady handholding	✓ Aiming at the physiological characteristics of delayed sensation and weakened reflexes, the design of the retaining edge is added, and the retaining edge that prevents objects from falling is made with rounded corners.
	Loss of limb strength and need for assistance	✓ When designing seating furniture, it is important to consider the strength of the limbs of the elderly and how to achieve easy access to aids for the elderly. ✓ Intelligent armrests can be used in the design of seating and bathroom seats to make it easier for the elderly to use their upper body strength to assist them in getting up. ✓ Smart handrails can be fitted with pressure sensors to determine whether the user's strength and balance have improved or deteriorated through the relationship between the changes in pressure values used by older people when using them.
6	Difficulty in falling asleep, poor sleep quality, insomnia and sleepy behaviour	✓ Consider lifting, turning, folding, moving and other medical aids in age-friendly furniture such as beds and recliners. ✓ Use a smart mattress design for seniors for health monitoring and physiotherapy for sleep quality.
	Difficulty getting in and out of bed	✓ The mattress can be selected according to the customer's individual needs with a remote-controlled motorised mattress, which meets the different tilting angles required by the elderly when lying down and reclining, and also assists in getting up. ✓ The arm-style design on the side of the bed provides support to help the body sit up and assist in lying down.
	Poor nocturnal mobility in the elderly	✓ Furniture lighting design to set up LED induction strip, can identify the light intensity automatically open to meet the elderly night lighting, such as the design of intelligent LED strip under the bed. ✓ Mainly for the storage function of the main furniture, such as the depth of the cabinet may not be visible due to the insufficient light, and so sensor light can be installed in the wardrobe.
	People and objects are too Too far away for mobility	✓ Mobility area furniture can be moved, such as nursing beds, removable bedside tables, wheelchairs, etc. ✓ Designed with the function of placing objects, the elderly can place cups of water, medication and other commonly used small objects that need to be carried with them in case of emergencies.

Table 6.4 continued

		✓ Wardrobes are separated into as many areas as possible, with lower hanging heights and fewer hanging areas to stack.
7	Inconvenient space movement	✓ Furniture furnishing design based on the physiological and functional characteristics of the elderly, in terms of spatial function ratio, overall spatial organisation, and infrastructure equipment. ✓ Elderly people are very prone to knocking over objects around them, which may lead to safety hazards, and should make full use of furniture placement to optimise the space floor plan design. ✓ Activity area furniture can be transformed into a variety of combinations according to care needs and entertainment needs. ✓ Design furniture that can be moved flexibly, e.g. nursing beds can be moved for use, etc.
8	Sudden behavioural accidents	✓ Well-equipped with emergency communication devices, emergency call equipment, and direct connection to the community or medical-related institutions. ✓ Provide objective monitoring information on physical conditions, instant communication with the healthcare delivery system network, and active and passive help alarms in case of emergency.

6.5 Design Verification and Recommendation of Multifunctional Age-friendly Bed

Research Question 4: How the feasibility and effectiveness of the proposed research questions and objectives can be established through design practice?

The fourth objective of this study is to verify the practical feasibility of the design of multi-functional age-friendly beds with actual problem solving, and to provide basic samples for the extension of the design of age-friendly furniture for nursing homes in the future through the complete design thinking and process.

6.5.1 Validation of Design Practices

During this phase, the proposed design constituents, principles, and methodologies are employed to conduct pragmatic research on the design of age-friendly furniture

products for elderly users in nursing homes, utilizing beds as an exemplification. The results of research inquiries 1-3 are validated through design practice, further exploring and implementing the realization of age-friendly furniture design, and providing innovative design references and contemplation for future nursing home furniture design.

In reality, the rationale behind selecting the design of ageing beds in nursing homes as a Case Study mainly arises from China's national circumstances, the intrinsic function of beds, the investigation on the physiological and behavioral conditions of the elderly, and the physical and mental well-being of the elderly, among other logical factors. Survey reveals that bed are one of the most commonly used pieces of furniture for the elderly. According to statistics, the elderly spend 8 to 14 hours per day in bed in their bedrooms, and the comfort and utility of the bed directly impact the quality of life and health status of the elderly. Hence, a comfortable multifunctional bed is exceedingly crucial to the physical and mental well-being of the elderly in nursing homes.

The design practice case of this investigation focuses on optimizing the design of nursing home beds, commencing from research on the physiological conditions and bedside behaviors of the elderly, and adhering to the notion of user needs as the core of the design principles and methodologies. The design requirements for multifunctional beds in nursing homes are divided into six major aspects, primarily encompassing physiological and behavioral, psychological, safety, living environment, mental and emotional needs, from which we can scrutinize and excavate the needs of the elderly users for the “pain points”, while seeking design opportunities.

Building upon the research findings regarding the physiological and behavioral attributes of the elderly in nursing homes, this design solution amalgamates the functions

of the bed with the physical and mental characteristics of the elderly, considering them in design concepts and thinking, and proceeding with the modeling of the multifunctional bed and the testing of the prototype design. The results demonstrate that the overall subjective satisfaction of this design scheme on the prototype is higher than that of existing products, thereby substantiating the rationality of the design constituents, principles, and methodologies of this research.

The empirical findings demonstrate that the configuration of age-friendly versatile beds has the potential to augment the ease of living for senior citizens residing in assisted living facilities, ameliorate the behavioral circumstances of the elderly, alleviate the responsibilities of caregivers, and diminish the expenses associated with social services. Therefore, it also comprehensively corroborates the applicability and validity of the investigation into designing for the needs of ageing individuals in nursing homes based on their physiological and behavioral attributes.

6.5.2 Design Recommendation of Age-friendly for China Nursing Homes

According to the research and analysis, the results of the study indicate that the design of furniture suitable for older adults in nursing homes differs from that of regular furniture for the elderly. It is necessary to consider the specific circumstances of the elderly in nursing homes. The design should not only cater to the daily needs of the elderly but also facilitate the staff in providing daily care. As a result, nursing homes tend to prefer multifunctional nursing beds in their design. Subsequently, the researcher conducts a comprehensive examination and analysis of the challenges faced by elderly users in Chinese nursing homes. The researcher posits that the Design Recommendation of Bed

Ageing for Nursing Home primarily encompasses the following aspects.

i. The design should fully integrate with the physiological and psychological needs of the user, emphasizing auxiliary functions and user experience design. The form should be simple and cozy, with a focus on care functions.

ii. The bed's functionality should be considered in conjunction with the physical and mental characteristics of the elderly, aiming to enhance their physiological and.

iii. Intelligent design should contemplate providing the elderly with service functions such as intelligent assistance, voice systems, health monitoring, and emergency assistance. This should be combined with internet and intelligent technology, as well as easily adjustable bed settings.

iv. To address the diverse functional needs of users, the design should fully account for the physical functions and mobility characteristics of the elderly. It should also address the psychological, safety, environmental, emotional, and behavioral needs of the elderly in nursing homes.

v. The adoption of a modular design concept is recommended, where the bed is divided into four parts: bed frame, bed base, intelligent mattress, and information service platform system.

vi. Design elements should be envisaged at four levels: physical sensory, behavioral interaction, emotional linkage, and intelligent assistance. Design practices and applications should be implemented at each level.

vii. By breaking down the behaviors of elderly individuals in nursing homes, particular emphasis should be placed on transforming user behaviors and experiences in areas such as sleeping, getting in and out of bed, nursing care, dining, health monitoring, reading, recreation, and rehabilitation training.

viii. The design should satisfy the elderly’s needs in terms of function, form, colour,

material, intelligence, and humanization. It should provide convenient, safe, comfortable, and intelligent design services for the elderly.

ix. Enhancements should be made to the fundamental functional design related to mobility, lighting, backboard adjustment, turning, and rehabilitation exercises. These improvements should align with the safety, ease of operation, and physiological requirements of the elderly, in accordance with ergonomic dimensions.

6.6 Conclusion

This study is focused on the elderly population residing in nursing homes. The research object of this study is age-friendly furniture. The study collects and organizes relevant research on age-friendly furniture, the physiological and behavioral characteristics of elderly individuals in nursing homes, and the design of products for the elderly both domestically and internationally. A varierty of research methods such as literature research, questionnaires, interviews, and brainstorming were utilized to identify the existing issues in the design of age-friendly furniture in nursing homes, as well as the characteristics and needs of the elderly population. Subsequently, the attributes and essential aspects of suitable furniture design for the elderly are summarized and analyzed. Based on this analysis, the design elements of appropriate furniture for nursing homes are proposed.

A questionnaire survey was also conducted to investigate the usage and perception of suitable furniture among elderly individuals residing in nursing homes. The impact of existing furniture designs on the physiological and behavioral intentions of users is analysed, leading to the proposal of a set of design principles for furniture intended for the elderly in nursing homes. Additionally, a range of design methods that take into account the physiological and behavioral characteristics of the elderly are explored and analysed.

Finally, this paper validates the proposed research by implementing the design of a multifunctional age-friendly bed, thereby achieving the research objectives.

The issues pertaining to uncomfortable living conditions and inappropriate furniture for the elderly in Chinese nursing homes are more pronounced. Simultaneously, there is a substantial and urgent demand in the market for furniture that caters to the needs of an ageing population. However, the implementation of age-friendly design in nursing homes is still in its infancy. The number of professional design institutions specializing in this area is quite limited, with most of them adhering to traditional furniture design methods and lacking targeted practices and approaches for age-friendly design. Consequently, the furniture in nursing homes fails to adequately address the specific needs of the elderly and falls short of achieving the desired design goals.

The design of age-friendly furniture for nursing homes differs significantly from that of regular home furniture, as it has a profound impact on the daily routines and care-giving outcomes for the elderly. Nonetheless, current research lacks a comprehensive analysis of the existing practices in age-friendly furniture design for nursing homes, and there is an insufficient understanding of how to effectively carry out such design practices in these settings. These challenges result in furniture products that struggle to provide scientific and effective support for the care services offered by elderly care institutions in China, thus hindering the realization of the ideal vision of "a happy and healthy life for the elderly."

This study presents a novel approach and framework for the design of age-friendly furniture in Chinese nursing homes. Based on the study objectives, the research on age-friendly furniture design for nursing homes can be categorized into four distinct parts, each

corresponding to one of the four research objectives. Through the analysis and synthesis of the gathered data and design practices, this study aims to address the research questions and achieve the desired research objectives.

a) Re-conceptualising the Design of Age-friendly Furniture in China Nursing Homes

The design of furniture that is conducive to the ageing population in nursing homes differs from the design of similar furniture products, necessitating a more thorough comprehension and clarification. In essence, the distinct features of the design of age-friendly furniture in Chinese nursing homes are mainly reflected in the physiological and behavioral characteristics of the elderly in nursing homes, the unique attributes of prevailing issues and their underlying causes, the distinctive characteristics of design attributes and their corresponding design focal points, as well as the distinct characteristics of design objects and their accompanying needs, when compared to conventional elderly home furniture.

The researcher believes that prioritizing the requirements of elderly residents in nursing homes serves as a crucial starting point for designing furniture that accommodates the ageing process. Understanding user needs significantly determines the relevance and success of furniture design that caters to the elderly. Throughout the study, the researcher discovered that designers must not only investigate the design of furniture products for the elderly but also conduct a comprehensive evaluation and analysis of the needs of elderly residents in nursing homes. This entails focusing on the physiological and behavioral characteristics of the elderly in these settings, comprehending their life attitudes, aesthetic preferences, living habits, emotional requirements, as well as their physiological and behavioral traits.

b) Entry Points for Designing Age-friendly Furniture for China Nursing Homes

Through research methods such as interviews and brainstorming, and the incorporation of research materials derived from a variety of sources, this study examines and explores the remarkable depiction, causal analysis, and suggestions for enhancing the prevailing issues pertaining to furniture that caters to the needs of the elderly within nursing homes. This analysis is conducted from an analytical standpoint, focusing on design attributes, design objects, and priority concerns, respectively. Additionally, the study comprehensively outlines the characteristics of the current state of development and the existing problems associated with furniture suitable for the ageing population. On this basis, the study selects design elements, design principles, and design methodologies and applications as the entry point and focal area for subsequent research, using the perspectives of elderly institutions as a basis. Notably, the study underscores the importance of design practice and the pursuit of systematic design thinking.

The findings of the research indicate that the success of the design of furniture that is suitable for older adults is often dependent on the rationality of the chosen elements. Consequently, if the design of furniture for the elderly neglects the visual elements and the creation of aesthetic effects, its products will not be embraced by the market. In fact, the selection of furniture design elements suitable for older adults in Chinese nursing homes is highly exploratory nature and covers the common life experiences, social culture, and historical context of the elderly. First and foremost, the researcher has reached the conclusion that the ability of nursing home furniture to provide the elderly with ease of movement and psychological comfort is of utmost importance. This conclusion is based on an analysis of the activity ability of the elderly in the individual behavioural field. It is evident that the design principles of convenience and practicality can greatly assist the

elderly in carrying out their daily activities and alleviate the challenges they may face. Thus, this study presents a novel perspective to address this issue by considering the needs of elderly users. The researcher proposes to focus on five aspects: the simplicity of furniture, convenient operation, attention to details and local treatment, rehabilitation guidance, and intelligent assistance.

c) Recommend Series of Innovative Design Methods and Practices

The design approach employed in the creation of the product series for nursing home furniture for the elderly is a comprehensive synthesis of innovative principles, design thinking, and practical design methods that are applied in specific contexts. Extensive research confirms the pivotal role that innovative design techniques play in the development of serialised products. In the process of designing furniture products for the elderly should consider the physiological and behavioral characteristics of the elderly, as well as humanistic care, the selection of elements, diverse functional requirements, the transformation of behavior and experience, the application of intelligence, modular design, and other approaches.

In conclusion, the refined design elements, design principles, and design methods have been effectively applied to the design practice of the age-friendly multifunctional bed, catering to the needs of elderly individuals in nursing homes. The design case is thoroughly verified and evaluated. Practical results demonstrate that the multifunctional bed design can enhance the convenience and self-care abilities of elderly individuals in nursing homes, while reducing the burden on caregivers and social service costs. Hence, the effectiveness and rationality of the design method proposed in this study are fully substantiated.

6.7 Future Work and Recommendations

The emergence of age-friendly furniture design for nursing homes is a recent development in China. Consequently, the entire elderly furniture industry is currently undergoing market transformation and industrial structure upgrading. However, due to the intricate nature of the physiological and behavioral characteristics of the elderly, certain aspects of the study have not been adequately explored and comprehensively addressed. Moving forward, as design practice expands extensively, further research can be conducted in the following areas.

a) Integration of Smart Technologies

Investigate the use of Internet of Things , sensors, and artificial intelligence to make furniture "smarter." For example, smart beds that monitor health metrics like heart rate, movement, and sleep quality, or chairs that adjust posture based on user movements. Leverage Internet of Things technology to connect furniture with other smart devices in the nursing home (e.g., lighting, HVAC, security systems). Explore the use of voice-activated controls and wearable devices that allow elderly users to interact with furniture in a more intuitive and less physically demanding way. This could also be paired with home automation for seamless integration into the wider living environment.

b) Artificial Intelligence (AI) and Machine Learning.

Develop AI-powered furniture that can learn residents' habits and preferences over time. For instance, AI algorithms could adjust seating positions, lighting levels, or temperature settings based on individuals' past behaviors and current health status. In addition, augmented reality and virtual reality applications. Explore the use of AR and VR in furniture design and selection processes. AR can be used to visualize furniture in the

actual nursing home environment before purchase, while VR can provide immersive experiences that help residents test and evaluate furniture designs.

c) Safety and Accessibility Enhancements

Future studies should delve into how to improve the safety features of age-friendly furniture, particularly focusing on preventing falls and supporting mobility. Specific focus should be placed on slip-resistant materials, anti-collision systems, and improved ergonomic designs that enhance ease of use. Research can explore sensor-based fall detection integrated into furniture, which could alert caregivers or emergency services when necessary. Motion-sensing technologies could also help track movements and provide assistance if residents struggle to rise or move.

As the ageing of the population intensifies, it is foreseeable that the market share of elderly users in the elderly furniture market will continue to rise in the near future. In order to make the later lives of the elderly more convenient, healthy, and joyful, while also reducing the workload of caregivers and alleviating the burden on social pensions, it is vital to consider the intention, physiological, and behavioral characteristics of the elderly group in the design of age-friendly furniture.

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APPENDICES

Appendix A: Journal Publications

1. **Zhang, Y.** (2023). Research on design strategies for age-friendly furniture based on physiological and behavioural surveys of Chinese elderly people. *Journal of Materials, Processing and Design, 7*(4), 42 – 51.
2. **Zhang, Y.**, Shanat, M. B. H., & Ya, L. (2023). Information fusion model of age-appropriate home environment design in pervasive computing environment. *Wireless Personal Communications*, 1-24.
3. **Zhang, Y.**, Shanat, M. B. H. (2021). Tourism revitalising path and innovative development strategies of traditional craft cultural heritage. *Nveo-natural volatiles & essential oils,* 9051-9065.

Appendix B: Questionnaire 1

Questionnaire

Faculty Applied and Creative Arts

Universiti Malaysia Sarawak (UNIMAS)

Questionnaire 1: Basic Situation of the Elderly in China Nursing Homes

1.What is your gender?

□ Male □Female

2.How old are you?

□ 60-69 years old □ 70-74 years old

□75-79 years old □Over the age of 80

3.What is your height(cm)?

□ 145~155 □ 156~165 □ 166~175 □176~180 □Above 181

4.What is your level of education?

□Illiterate □Primary school □Middle school

□High school □ University □ Postgraduates

5.Where does your family live?

□ Rural □ Urban

6.What was your occupation before 60 years old?

□Civil servant □Public institutions

□Public Corporation □Private enterprises

□Self-employed □Farmer

□Others

7. What is your major source of income?

□Pension □Saving

□Support Payments from Children

□Salary □Social Security Payment □Others

8. What is your approximate monthly income Level?

☐ ¥1000 and below

☐ ¥1000- ¥2000

☐ ¥2000-3000

☐ ¥3000-5000

☐ Above ¥5,000

9. What was your living situation before you moved into the nursing home?

☐ Living alone

☐ Couples living together (without children)

☐ Living with children(Children are not married)

☐ Living with children and grandchildren

☐ Living with live-in Caregivers

☐ Nursing homes

Questionnaire

Faculty Applied and Creative Arts

Universiti Malaysia Sarawak (UNIMAS)

Questionnaire 2: Physiological and Behavioural Characteristics of the Elderly in China Nursing Homes

1.How do you feel about your living situation?

☐Completely Self-care

☐Self-care with the aid of crutches, armrests, etc.

☐ Occasional need for care by others

☐ Often needing care from others

☐Completely dependent on others for care

2.What part of your body do you think has poor physical function?

□Hands or arms □ Legs or feet

□Ears □Eyes

□Mouth □Internal organs

□Others

3.Do you have any of the following problems with your body?

□Unable to see clearly .

□Hearing problems

□Hands or arms disease

□Legs or feet disease

□Back pain

□Cervical spondylosis

□Poor memory

□No symptoms

□Others

4.How is your physical behavior?

□ Healthy Behavioural Capacity □Independent Capacity

□ Vulnerable Capacity □ Auxiliary Care □ Others

5.What are the major activities of your daily behavior?

□ Housework □ Watching TV

□ Playing with mobile phones

□ Reading newspapers & books

□ Musical instruments □ Physical fitness

□ Chatting □ Singing and Dancing

□ Chess and Mahjong

□Walking □ Practising Taijiquan

□ Others

6.Where have you had an accident in your daily life?

□ Kitchen □ Bathroom □ Bedroom

□ Living room □ Staricase □ Balcony

□ Porch □ Others □ I've had no accidents.

7.What do you think of your physical health condition?
□Very healthy
□Healthy
□ Sub-healthy
□ Unhealthy
□Very unhealthy
8.Do you chronically suffer from any of the following psychological states?
□ Loneliness □ Depression
□ Disappointment □ Decreased sense of security
□ Reduced adaptability □ Sleep disorder
□ No symptoms □ Others
9.What aspects of your later life are you most satisfied with?
□ Physical health □ Economic well-being □ Happy family
□ Many friends □ Convenient living
□ Beautiful living environment □ Others
10.How do you plan to live after retirement?
□ Live alone □ Live with children
□ Live in the same city as children □ Live in nursing homes
□ Tourism elderly care □ Others
11 What were your reasons for moving into nursing homes?
□ Being able to make friends of the same age
□ Access to professional care
□ Reducing the burden of children in supporting the elderly
□ Reasonable fees for nursing homes
□ Good for health.
□ Helps to live a regular life
□ Lots of recreational activities
□ Others
12.What interior spaces in nursing homes make you feel private?
□ Bedroom □ The end of the corridor
□ Partial public event space □ Corner of the room
□ Shared living spaces within living units □ Others
13.What spaces would you like to see in nursing homes to accommodate communication in addition to bedrooms?
□ Gymnasium □ Game room □ Reading Room
□ Art Studio □ Living Room □ Lounge □ Others
14.What do you think you need most in nursing homes?
□ Psychological Services □ Medical care □ Leisure activity
□ Life Service □Rehabilitation guidance □ Safety of residence
□ Beautiful environment □ Others

Questionnaire

Faculty Applied and Creative Arts

Universiti Malaysia Sarawak (UNIMAS)

Questionnaire 3: Aging-friendly Furniture in China Nursing Homes

a) Evaluation of elderly people's satisfaction with age-friendly furniture in nursing homes

Categories	Very Satisfied 	Satisfied 	Average 	Dissatisfied 	Very Dissatisfied 
Comfort	☐	☐	☐	☐	☐
Function	☐	☐	☐	☐	☐
Colour	☐	☐	☐	☐	☐
Size	☐	☐	☐	☐	☐
Safety	☐	☐	☐	☐	☐
solid	☐	☐	☐	☐	☐
Auxiliary	☐	☐	☐	☐	☐
Accessibility	☐	☐	☐	☐	☐
Aging-friendly	☐	☐	☐	☐	☐
Intelligence	☐	☐	☐	☐	☐
Affinity	☐	☐	☐	☐	☐
Artistic	☐	☐	☐	☐	☐

b) Respondents' awareness and design demands of aging-friendly furniture

1. Are you interested in aging-friendly furniture products: (Single Choice)

□ Not interested □ Interested □ Very interested

2. How much do you know about aging-friendly furniture products?（Multiple choice）

□ Not at all □Know a little □Know but not understand

□Basic understanding □Strong understanding □ Others

3. What is the major reason you are interested in aging-friendly furniture?

□ Material □ Safety

□ Style □ Price

□ Function □ Appearance

□ durability □Brand □ Others

4. Which aspects of aging-friendly furniture do you pay more attention to?

□ Artistic □ Safety □ Comfortable

□Convenient □ Others

5. What kind of aging-friendly furniture material do you prefer?

□Solid wood □Glass □Leather

□ MDF chipboard □Metals □Fabric

□Plastics □ Stone □ Finish made from rattan

□Finish made from bamboo

6. Which color do you prefer for aging-friendly furniture:

□ Warm colors □ Cool colors □ Black

□White □ Grey

7.What kind of aging-friendly furniture style do you prefer?

□ American style □ Minimalist style □ Fashion style

□ Retro style □ European style □ Chinese style

□ Affordable luxury style □ Natural style □ Others

8.Which functions do you think aging-friendly furniture should have:

□ Massage function □ Intelligent function □ Voice control function

□ Automatic power-off function □ Emergency call function □ others

9.Which aspect of improvement do you think is most needed for aging-friendly furniture:

□ Styling □ Size

□Habits □ Sturdy

□Auxiliary functions □ others

10. What categories of furniture do you think are needed that can be specialized for the elderly?

□ Furniture for dressing room □Furniture for foyer

□ Furniture for exercise area □ Furniture for game room

□ Furniture for chat area □ Furniture for medical care area

□ Furniture for rehabilitation training area □ Others

c) Feedback survey on the current state of use and demand for existing furniture in nursing homes

1. Do you think there is any problem with the existing aging-friendly furniture (Sofa, coffee table, chair, bed, cabinet, etc)?

□ No problem □ Some problems of existing furniture

□ Need or upgrading □ Others

2. Which of the following have you encountered with table furniture:

□ Table top too low □ Table top too high □ Insufficient under-table space

□Unreasonable size of storage space □ Without baffles

□ High risk to get injure □ Lack of emotional design

□ Others

3. Which of the following have you encountered with chair furniture:

□Too high to sit □ Too low to sit

□ Lack of armrests □ High risk to get injure

□ Equipped with armrests, but difficult to support getting up

□ Backrest too short □ Too soft to sit

□ Too heavy to move □ Hard to clean

□ Others

4. Which of the following have you encountered with cabinet furniture:

□ Too high to reach

□ Too low to reach

□ Not follow the standard size

□ Poor lighting

□ High risk to get injure

5. What functions would you like for the design of aging-friendly furniture cabinets in nursing homes?

□ Built-in sensor light □ Automatic rising and lowering

□ Auxiliary push-pull □ Intelligent voice control

□ Intelligent operator interface

□ Others

6. Do you have any problems with your bed in use:

□ No problem □ Lack of auxiliary function

□ Create unpleasant sound □ Mattress too hard

□ Mattress too soft □ Inappropriate size

□ Lack of sensor light □ High risk of falling

7.What functions would you like to have for the design of aging-friendly furniture bed?

□ Foldable bedside armrest □ Automatic sensory light

□ Automatic control □ Bed feet equipped with rollers

□ Intelligent auxiliary function

□ Emergency button □ Others

8.What do you feel are the major problems with your existing bathroom furniture：

☐No problem

☐Difficulty in standing continuously while washing face

☐Hard to take a shower because of feet disease

☐Difficulty standing up after using a toilet

☐Difficulty sitting down when using a toilet

☐Others

Appendix C: Experts, Designers, and Manufacturers Interview Form

Interview

Faculty Applied and Creative Arts

University Malaysia Sarawak (UNIMAS)

a) Basic information of interviewers

Interview number:

Name		Genders		Career	
Workplace					

b) Items of Interview Questions for experts, designers, and manufacturers,etc.

1. What do you think is the most important and the reason for all the influencing factors of nursing home aging-friendly furniture ?

No.	Scope of Question	Sample Question for Open-Ended interview
1	Sensory attributes	Style, form and shape, decoration, color, etc.
2	material property	Craft, structure, function, materials, etc.
3	Operational Properties	Safety tips, post-maintenance, rehabilitation guidance, etc.
4	social property	Eco-friendly, benefit value, product innovation, etc.
5	emotional property	Nostalgia, humanization, accessibility, communication, etc.
6	Intelligent Properties	Voice-assisted, intelligent identification, data collection, health monitoring, etc.

2. What do you think is most important in terms of physiological and behavioral characteristics of the elderly in the design of aging-friendly furniture for nursing homes and why?

3. What perspectives do you think are most important in the use scenarios of aging-friendly furniture in nursing homes and why?

4.What do you think is most important in the day-to-day operation and post-maintenance of aging-friendly furniture in nursing homes and why?

5. What design perspectives of aging-friendly furniture for nursing homes do you think are most important in social systems and why?

6. What do you think is the most important perspective in the design of institutional aging-friendly furniture?(Multiple choice50: 10 items at most)

□Physical, psychological, and behavioral characteristics
□ Emotional memory
□ Perception ability
□ Participatory
□ Form
□ Decorate
□ Theme
□ Colour
□ Aesthetic
□ Vision
□ Craft
□ Production
□ Assembling
□ Structural stability
□ Stackable
□ Easy to clean and store
□ Size
□ Function
□ Ergonomics
□ Personal customization
□ Fully equipped
□ Detachable
□ Ease of use
□ Easy visibility
□Waterproof
□Anti-fouling
□Wear-resistant
□ Comfortable material
□ Cognitive
□ Meet an emergency
□ Regularity
□ Style
□ Modelling
□ Design Themes
□ Cost control
□ Warning sign
□ Cost of errors
□ Safety design
□ Elderly social interaction
□ Medical level
□ Efficient and practical
□ Convenient cleaning
□ Help the elderly develop good living habits
□ Rehabilitation training
□ Accessibility
□ Anti-knock and fall
□ Intelligent and technological elements
□ New materials and processes
□ Novel design concept
□ Intelligent assistance
□ Respect and Care
□ Health and Environmental Protection
□ Strengthen spatial signage

Appendix D: Nursing Home Elderly Interview Form

Interview

Faculty Applied and Creative Arts

University Malaysia Sarawak (UNIMAS)

a) Basic information of interviewers

Interview Number:

Name of the nursing home								
Name of the older person		Gender		Age		Height		Weight	
Current health condition								

b) Items of Interview Questions for Older People in Nursing Homes

1. How do you feel about your health condition? What are the biggest obstacles encountered in physiological functions and behavioural activities? How do you overcome them? Do you need external assistance?

2. What do you think are the main problems encountered in the use of furniture today? What are the causes of these problems? If it can be resolved, how exactly should it be resolved?

3 What parts of the furniture currently in use are recognizable? How effective is it? Which parts are still deficient?

4.What basic functions do you think aging-friendly furniture should have?

5. What are the individual and desired functions that you would like to see in aging-friendly furniture? What are the main reasons?

6. What changes would you like to see in the design of aging-friendly furniture compared to existing furniture? Share your views on the design of aging-friendly furniture and suggestions for improvement?

Appendix E: Information on Participants in Interviews

Table 1: List of Participants

No.	Name	Occupation	Agency	Province
1	Jinying Chen	Designer	Mingjiang Decoration Co., Ltd	Guangzhou
2	Shuang Liang	Designer	Mingjiang Decoration Co., Ltd	Guangzhou
3	Zejing Chen	Designer	Xingyi Decoration Co., Ltd	Guangzhou
4	Yutong Jiang	Designer	Xingyi Decoration Co., Ltd	Guangzhou
5	Yufen Wang	Designer	Longtou Decoration Co., Ltd	Guangxi
6	Meijing Yu	Designer	Musheng Furniture Design and Production Co., Ltd	Jiangsu
7	Sibei Zhu	Designer	Musheng Furniture Design and Production Co., Ltd	Jiangsu
8	Xinyuan Lu	Designer	Kolabi Furniture Co., Ltd	Jiangsu
9	Fei Wang	Designer	Kolabi Furniture Co., Ltd	Jiangsu
10	Tongyang Xu	Designer	Jiangshan Wood Industry Co., Ltd	Zhejiang
11	Ting Zhang	Designer	Nanjing Wood Industry Co., Ltd	Jiangsu
12	Kaiyi Wen	Designer	Nanjing Wood Industry Co., Ltd	Jiangsu
13	Yongming He	Designer	Suzhou Alice Furniture Manufacturing Co., Ltd	Jiangsu
14	Shuhan Xie	Designer	Suzhou Alice Furniture Manufacturing Co., Ltd	Jiangsu
15	Zhilei Deng	Designer	Qidian Furniture Manufacturing Co., Ltd	Zhejiang
16	Shujia Hao	Designer	Qidian Furniture Manufacturing Co., Ltd	Zhejiang
17	Juanhua Hu	Designer	Longtou Decoration Co., Ltd	Guangxi
18	Gan Huang	Manufacturer	Suzhou Muke Furniture Co., Ltd	Jiangsu
19	Zhaoxin Li	Manufacturer	Enxin Furniture Co., Ltd	Jiangsu
20	Jirong Liu	Manufacturer	Suqian Shuanghu Furniture Co., Ltd	Jiangsu
21	Mingbin Pan	Manufacturer	Shuangfujiang Furniture Co., Ltd	Guangzhou
22	Ruoqiong Li	Manufacturer	JinTanglang Furniture Co., Ltd	Jiangsu
23	Haifeng Xu	Academia	Zhejiang Sci-Tech University	Zhejiang
24	Fajie Xie	Academia	Zhejiang Industrial University	Zhejiang

25	Zihao Yan	Academia	Soochow University	Jiangsu
26	Xiaoxue Yu	Academia	Yulin Normal University	Guangxi
27	YangunLin	Academia	Yulin Normal University	Guangxi
28	Wenwen Li	Academia	Jishou university	Hunan
29	Fan Feng	Academia	Soochow University	Jiangsu
30	Jiachun Li	Academia	Guangzhou Software College	Guangzhou

Table 2: List of Participants

No.	Name	Gender	Age	Agency	Province
1	Yuyang Ou	M	76	Suzhou Fuhai Nursing Home	Jangsu
2	Gui Lin	F	77	Suzhou Fuhai Nursing Home	Jangsu
3	Chunyan Lin	M	69	Suzhou Fuhai Nursing Home	Jangsu
4	Wen Xiao	F	70	Suzhou Fuhai Nursing Home	Jangsu
5	Jiangmin Li	M	74	Suqian Ren'ai Nursing Home	Jangsu
6	Wencai Li	F	75	Suqian Ren'ai Nursing Home	Jangsu
7	Weijie Dai	M	68	Suqian Ren'ai Nursing Home	Jangsu
8	Youjia Liao	F	71	Hangzhou Dejia Nursing Home	Zhejiang
9	Suixiu Wang	F	78	Hangzhou Dejia Nursing Home	Zhejiang
10	Jiali Chen	M	69	Hangzhou Dejia Nursing Home	Zhejiang
11	Yinyi Nong	F	66	Hangzhou Dejia Nursing Home	Zhejiang
12	Han Zahng	F	71	Nanning Liugang Xianyuan Nursing Centre	Guangxi
13	Xiaoyan Tang	M	72	Nanning Liugang Xianyuan Nursing Centre	Guangxi
14	Cunlin Ceng	F	80	Nanning Liugang Xianyuan Nursing Centre	Guangxi
15	Xiang Gan	F	78	Changsha Xiehe Nursing Home	Hunan
16	Qiu Yan	M	69	Changsha Xiehe Nursing Home	Hunan
17	Jing Huang	F	76	Changsha Xiehe Nursing Home	Hunan
18	Zhihua Zhou	M	68	Changsha Xiehe Nursing Home	Hunan
19	Ximei Li	F	77	Guangzhou Taining Nursing Home	Guangzhou
20	Kaita Zou	M	81	Guangzhou Taining Nursing Home	Guangzhou
21	Meijun Zhou	F	75	Guangzhou Taining Nursing Home	Guangzhou
22	Bao Zhang	M	72	Guangzhou Taining Nursing Home	Guangzhou

Appendix F: Brainstorming Sessions

Table F.1: Experimental Themes for the Brainstorming Sessions

Frequency of meeting	Topic of discussion	Contents
Session 1	Important Keywords	Identifying important keywords for the design of furniture that is suitable for ageing individuals in nursing homes.
Session 2	Functional hierarchy model	Identifying design keywords and functional hierarchy models for age-friendly multifunctional beds.

Figure F.1: Expert, Designer and Academia Brainstorming Sessions Results Pictures

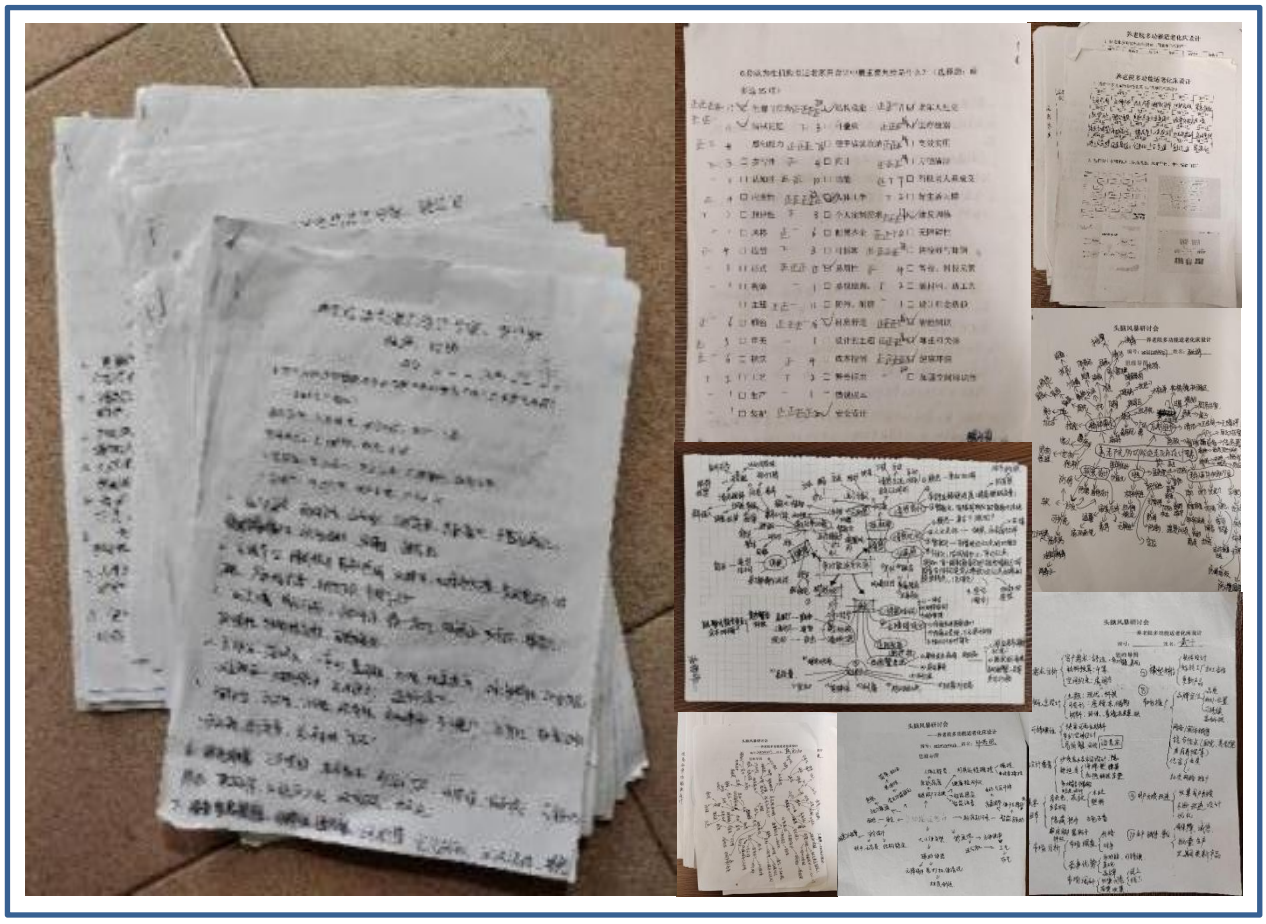


Figure F.2: Focus Group for the Brainstorming Sessions



Appendix G: Works for Design of Prototypes

Table G.1: Demonstration of Mock-ups Process and Effects

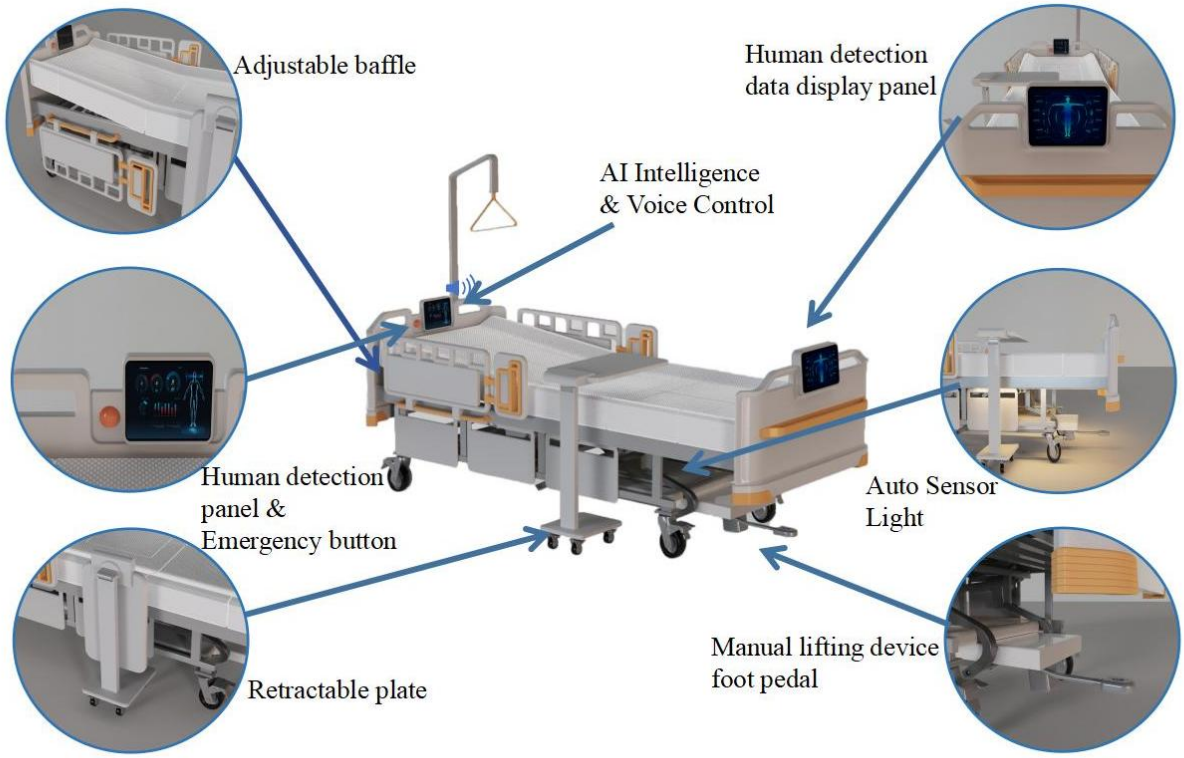
	
Materials and mock-ups making	Details of the bed mock-ups making
	
Different angle of the bed	Prospective view of the bed
	
Prospective view of the bed	Final Mock-ups of the Bed

Appendix H: Evaluation Score Table for the Design Scheme of Multi-functional Beds in Nursing Homes

Marking Scheme

Faculty Applied and Creative Arts

University Malaysia Sarawak (UNIMAS)



Value (of a score) / Topic	1	2	3	4	5	6	7	8	9	10
1. Multifunctional										
2. Safety										
3. Smart design										
4. Convenience and Practical design										
5. Comfortable										
6. Aging-friendly										
7. Emotional design										
8. Physiological & Behavioural										