

Faculty of Applied and Creative Arts

A Research of Design Strategies of Elder-friendly Home Furniture for an Active Aging Society in Shanghai, China

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Doctor of Philosophy
2024

A Research of Design Strategies of Elder-friendly Home Furniture for an Active Aging Society in Shanghai, China

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A thesis submitted

In fulfillment of the requirements for the degree of Doctor of Philosophy

(Design Technology))

Faculty of Applied and Creative Arts
UNIVERSITI MALAYSIA SARAWAK
2024

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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ACKNOWLEDGEMENT

This thesis is the end of my journey in obtaining my Ph.D. This thesis has been successfully completed with the support and encouragement of numerous people including my family and friends. At the end of my thesis, I would like to thank all those people who made this thesis possible and an unforgettable experience for me.

At this moment of accomplishment, I am extremely indebted to my supervisor, Professor Dr. Musdi bin Hj Shanat. This work would not have been possible without his guidance, support, and encouragement. Under his guidance, I successfully overcame many difficulties and learned a lot. Despite his deanship responsibilities, he used to review my thesis progress, give his valuable suggestions, and made corrections. His unflinching encouragement and conviction will always inspire me.

My sincere gratitude to the Centre for Graduate Studies, for the advice and support given during my period of study in Universiti Malaysia Sarawak.

Finally, I would like to thank the management of the Universiti Malaysia Sarawak for making it possible for me to complete my study here in Sarawak. Thank you all.

ABSTRACT

This research was conducted to respond actively to the social pressure brought by the ageing of China's population, and to respond to the smooth operation of China's "multi-level elderly service system based on the home, supported by the community and supplemented by institutions", to help the elderly with declining physical and mental functions to adapt to the existing living environment, extend independent and safe living, so as to realise ageing in place and respond to the expectation of an Active Ageing Society. Through field investigation, questionnaire survey, interview and observation in three Shanghai representative communities, markets and manufactures in Shanghai, complemented by design-based method, this research proposed the design and development strategies of Elder-friendly Home Furniture (EHF) from the perspective of an Active Ageing Society, includes dimension optimization, cabinet layout optimization, storage space optimization, safety and usability design, design for comfort, emotional design, economical design and standardized design. Finally, the above design approach was validated using the design-based validation method. It suggested establishing the correct social perception of Elder-friendly Home Furniture, activating and promoting the furniture market step by step, to guide the elder-friendly industry's steady growth. It hopes that this research could provide a reference and basis for future studies.

Keywords: Elder, furniture, elder-friendly home furniture (EHF), ageing, design

Pembangunan Reka Bentuk Perabot Rumah Mesra Warga Tua untuk Masyarakat Penuaan Aktif

ABSTRAK

Penyelidikan ini dijalankan bagi tujuan bertindak balas secara aktif kepada tekanan sosial fenomenan penuaan penduduk China, dan untuk bertindak balas terhadap operasi lancar "sistem perkhidmatan warga tua pelbagai peringkat berdasarkan rumah, disokong oleh masyarakat dan ditambah oleh institusi", bagi membantu warga tua dengan kemerosotan fungsi fizikal dan mental untuk menyesuaikan diri dengan persekitaran hidup sedia ada, memanjangkan masa hidup berdikari dan selamat, untuk merealisasikan penuaan di tempat dan bertindak balas terhadap jangkaan Masyarakat Penuaan Aktif. Melalui gabungan metodologi penyelidikan kualitatif dan kuantitatif, dilengkapi dengan kaedah berasaskan reka bentuk, penyelidikan ini mencadangkan strategi reka bentuk dan pembangunan Perabot Rumah Mesra Warga Tua（EHF) dari perspektif Masyarakat Penuaan Aktif, berdasarkan ciri-ciri penuaan dan situasi semasa perabot untuk warga tua dalam komuniti perwakilan Shanghai A,B dan C, termasuk pengoptimuman dimensi, pengoptimuman susun atur kabinet, pengoptimuman ruang penyimpanan, reka bentuk keselamatan dan kebolehgunaan, reka bentuk untuk keselesaan, reka bentuk emosi, reka bentuk ekonomi dan reka bentuk Standard. Akhir sekali, pendekatan reka bentuk di atas telah disahkan menggunakan kaedah pengesahan berasaskan reka bentuk. Ia mencadangkan mewujudkan persepsi sosial yang betul tentang perabot rumah mesra warga emas, mengaktifkan dan mempromosikan pasaran perabot langkah demi langkah, untuk membimbing pertumbuhan stabil industri mesra warga emas. Diharapkan kajian ini dapat menjadi rujukan dan asas untuk kajian akan datang.

Kata kunci: *Warga tua, perabot, perabot rumah mesra warga tua (EHF), penuaan, reka bentuk*

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LIST OF ABBREVIATIONS

CGS	Centre for Graduate Studies
UNIMAS	Universiti Malaysia Sarawa
EHF	Elder-friendly Home Furniture

CHAPTER 1

INTRODUCTION

1.1 Research Background

Between the years 2000 to 2050, it was reported that the ageing demographic in the world would be increasing, with China's population ageing on a larger scale rapidly (Guo, 2017). According to the latest data from the China Office for the Ageing， China's elderly population is expected to grow from 241 million at the end of 2017 to 487 million by the year 2050, accounting for a quarter of the world's elderly population. In 2050, China's ageing level would have reached 35.1%, one out of every four elderly people in the world is said to be in China, thus making it the world's highest ageing country in the world.

Ageing in Chinese society is characterized by advanced ageing, empty nesting, and smaller family structures, requiring rapid responses from aspects of design, policy and market etc.

"Active Ageing" is a term that could be defined as referring to the elderly who are taking active efforts in improving their quality of life in various aspects such as personal health, social participation, and public safety (WHO, 2002). These may also include those who are frail, disabled and in need of care (Sixsmith & Gutman, 2013; WHO, 2002). The word "Active" refers to continuing participation in social, economic, cultural, spiritual, and civic affairs, and not only their physical abilities in the labour force (Sixsmith & Gutman, 2013; WHO, 2002). "Elder" (also known as senior citizens) refers to those aged 60 years old and above（Building Design Code for Elderly,1999）

Active Ageing is a strategic policy proposed by the World Health Organization (WHO) in 2002 to deal with the ageing society. Its core aim is to pay attention to the dominant position of the elderly in the ageing system and advocate active coping strategies of lifelong security for the elderly in different social strata and identities. In the context of Active Ageing, furniture design for the elderly needs to match the design ethics of reverence for life and active exploration of the value of life. It should also consider practical issues such as how to actively construct an age-friendly design environment, how to help the elderly live a dignified life, and how to reflect the fairness and justice of design itself.

The elderly are experiencing a range of challenges that may constrain their active lifestyle which includes physical and mental changes, as well as chronic diseases. Therefore, furniture, as an important part of the family physical environment, needs to be able to have positive effects on the lifestyle of the elderly and stimulate their psychology positively. Furniture designers need to understand the physiological, psychological, and behavioural characteristics of the elderly, fully consider the relationship between the elderly and furniture, as well as design furniture suitable for the elderly through functional, interactive, emotional, and other factors. This is to help improve the self-efficacy and happiness of the elderly, and at the same time, slow down the psychological effects of ageing.

Despite the fact that Elder-friendly Home Furniture (hereafter referred to as EHF) consists of and emphasises on important living environment, there are different challenges which arises from this issue itself. The following section discusses these challenges in details.

1.1.1 Challenges from the Elderly and Society

The Pension Plan in China presents the “9073” model, which means 90% of the elderly stays at home, 7% enjoys community care services and 3% are located at elder

institutions (Zhang et al., 2020). In China, approximately 80% of the elderly are willing to live separately from their children due to the improvement of living conditions and the upgrading of living thoughts (Luo, 2016). In addition, chronic diseases caused by ageing bring inconvenience and physical pain to the elderly. Besides that, the elderly have strong psychological dependence and need auxiliary facilities to provide life care and spiritual comfort. Therefore, it is imperative to improve the self-care ability of the elderly as much as possible.

Family structures are becoming smaller in China. Research data showed that with the rapid increase of ageing in China, the trend of empty nest in families is becoming increasingly obvious, and the proportion of elderly living independently has increased significantly. This has resulted in significantly decreased number of elderly living with their children (Hu & Peng, 2014). In addition, China's large-scale urban and rural population mobility since the Reform and Opening up has objectively led to an increasing number of empty nesting in rural areas and small towns. The Chinese family structure presents the “421” mode which means that a couple has 4 parents and is raising 1 child. This increasingly small family size has created more pressure on a couple to support their elderly. This situation is more obvious in big cities and in the young-elderly groups. With societal development, the elderly with a higher sense of modernisation are less and less likely to live with their children. This inter-generational relationship has brought about great changes, which further weakens the function of family support function, and brings greater pressure to the social elder-care system. The issue of how to effectively solve the demands of the elderly, especially those in big cities, to look after themself would be a challenge that the Chinese society has to face and solve.

Another issue related to the ageing society is the empty nesting trend of elderly families. According to statistics of the 7th Population Census of Shanghai in 2020, nearly five out of every ten elderly families in Shanghai are "empty nesting" families. There are three reasons for the emergence of "empty nesting" families. Firstly, with social development, the living conditions of Chinese families have improved, thus, the elderly enjoy the freedom of living alone. Secondly, China's Family Planning Policy has made family structure smaller with fewer family members, and negative population growth in big cities. Last but not least, many young people tend to go out for work, business, and other daily life activities, leaving the elderly alone, which increases the number of “empty nesting" elderly.

Small family structure and empty nesting without doubt requires the elderly to look after themselves via an elderly-friendly environment. However, it is difficult to find elderly-friendly furniture in the market which are genuine. Through market investigation, it is found that firstly, the mainstream products in the furniture market are mostly for middle-aged, young people and children, while furniture for the elderly are rare. Secondly, the only few products which are labelled as elderly-friendly furniture are mainly expensive because they are produced from solid wood such as mahogany. Besides that, the understanding of EHF still remains at the level of appearance and colours related to ageing features but are lacking in the types of products that are truly developed on the foundation of the elderly’s physiological and psychological needs. This shows that the concept of EHF has not yet been properly understood. Therefore, it is difficult for the elderly to buy authentic elder-friendly furniture in the market.

1.1.2 Challenges from Manufacturers

The furniture market in China is still lacking professional manufacturers for EHF. There are only a few professional manufacturers, whose research and product capabilities are not strong, with single product range and a small number of products, which do not meet the needs of the elderly. Due to lack of technological support and high costing, this has resulted in what is known as the "large market, fewer products" situation. In other words, the development of EHF is still low. Furthermore, approximately 89% of the elders were not satisfied with the current furniture (Luo, 2014). This shows that accurate market investigation and thorough understanding of the requirement of the elderly is urgent needed.

Secondly, at present, there is no national standards and norms for the design and production of EHF in China, which restricts the healthy development of EHF. This has resulted in factories not having clear production standards, consumers not knowing qualified product standards, and market supervising agency lacking scientific measurement standards. To ensure the healthy development of elderly-friendly furniture industry, design standards should be introduced from the perspectives of ergonomics, mechanical properties, and safety of materials. It should also correspond with production standards, so that there would be guidelines which government agencies could supervise, and furniture enterprises could follow, and at the same time, which the elderly could take legal action if there are any mishaps. Overall, this could be regarded as a guide to the positive development of the industry.

1.1.3 Challenges from Research

Internet investigation has found that from the mid to the late of the 20th century, Europe, the United States and Japan took the lead in ageing societies and started research on

the elderly population, whereby their elderly-related research mainly focused on elderly residents rather than furniture (Wang, Wu & Gui,2014). The emphasis was on ergonomic size and simplicity forms for furniture design. China's research on this matter began in 2010 and were mainly theoretical literature. These studies lack in terms of sample research and design practice. For instance, they focused mainly on general studies of elderly furniture but lack consideration of home-based situation. Others were studies focusing on one product and lack in terms of systematic furniture research, while there were also those which focused on furniture development from one perspective but lack in terms of comprehensive research. Looking at these studies, one could conclude that studies which are comprehensive and systematic that could guide the design and production of furniture manufacturers are still lacking in numbers.

Based on the current situation of social pressure brought about by the ageing China population, there is an urgent need to respond to this issue of lack in elderly-furniture. There is a need to respond to the smooth operation of China's "multi-level elderly service system based on home, supported by community and supplemented by institutions" (Zhang et al., 2020). This is also to help the elderly with declining physical and mental functions to adapt to existing living environment, as well as to extend the time of independent and safe living. Besides that, there is also a need to help manufacturers to understand and produce genuine EHF as a means to overcome this issue.

This research proposed design development approach of EHF, based on the characteristics of the elderly and current using situation of furniture in Shanghai (the city with the highest degree of ageing in China) communities, including basic furniture design methods and ideas of emotional, economical, and standardized development. This study

hoped to give positive impacts on the development of EHF market, where more aesthetic and genuine EHF could be designed and manufactured.

1.2 Research Objectives

The main aim of this research was to propose design approach for EHF based on furniture market and demands of the elderly. The specific objectives of the research were as follows:

i. To investigate current situations and challenges of EHF.
ii. To analyse the core elements of EHF design according to the above investigation based on questionnaire for the elderly.
iii. To recommend developing design approach for EHF.
iv. To evaluate consumers' perceptions towards the proposed design approach

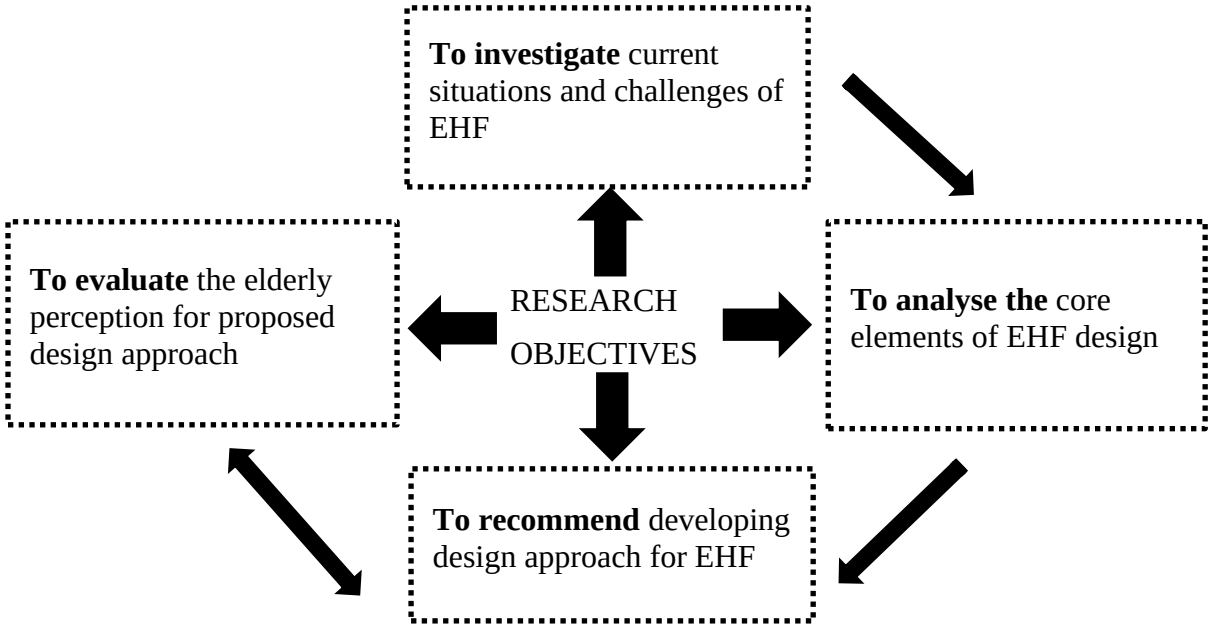


Figure 1.1: Research Objectives of the Study

The first objective of this study was to collect the current situations and challenges of EHF in China, especially in Shanghai. The researcher surveyed mainstream furniture companies of elderly-friendly furniture and major furniture malls to obtain their product information, research, and development status, as well as analysed development challenges faced by EHF.

The second objective of this study was to analyse the core elements of EHF design. This analysis was based on the above market investigation, as well as the questionnaire which was distributed to 246 elderly in Shanghai communities. This was done to gain the perspectives from both the market and the customers in order to refine core elements that

needed to be focused on in the designing of EHF. Physiological, psychological, and behavioural characteristics of the elderly were also collected. The questionnaire survey showed the current situation of furniture used among the elderly in Shanghai, the elderly's using habits, difficulties, and demands on the furniture.

The third objective of this study was to propose a design approach on EHF. These design approaches were put forward from the perspective of kitchen cabinetry which is the common and most frequently used furniture in the home life, and with multiple functions of furniture such as operation, display, storage and so forth.

The fourth objective of this study was to assess consumers' perceptions of the proposed design approach as a means to validate the design's feasibility. This was done through the distribution of a second questionnaire to the same participants who participated in the first questionnaire, which would focus on the participants' perceptions on the sample design of the kitchen cabinetry, their level of satisfaction and their opinion.

1.3 Research Questions

Since this is practical research, it was essential to study the research contents step-by-step according to the research topic and then formulate the final research questions. Table 1.1 illustrates the process of creating research questions from initiating a broad subject to a more focused topic and finally creating specific research questions.

Table 1.1: Broad Topics to Create Focused Research Questions

Broad topic	Narrow Topic	Focused Topic	Research Question
Development	EHF design development	Restrictive factors on EHF design development	What are the constraints of EHF design development in Shanghai, China?
Design elements	Core design elements	Core design elements for EHF design	What are the core elements for EHF design?
Design approach	Design approach on EHF	Design approach on EHF suitable for an Active Ageing Society	What design approach on EHF is suitable for an Active Ageing Society?
Perceptions	Consumer perceptions	To design a perceptible EHF	Does the proposed design approach help improve the consumers' perceptions?

Based on the final research questions, this research attempted to answer the following questions related to the above research objectives:

RQ1: What are the constraints of EFH design development in Shanghai, China?

RQ2: What are the core elements for EHF design?

RQ3: What design approach on EHF is suitable for an Active Ageing Society?

RQ4: Does the proposed design approach help improve the consumers' perceptions?

The relationship between the research objectives and research questions is shown in Figure 1.2:

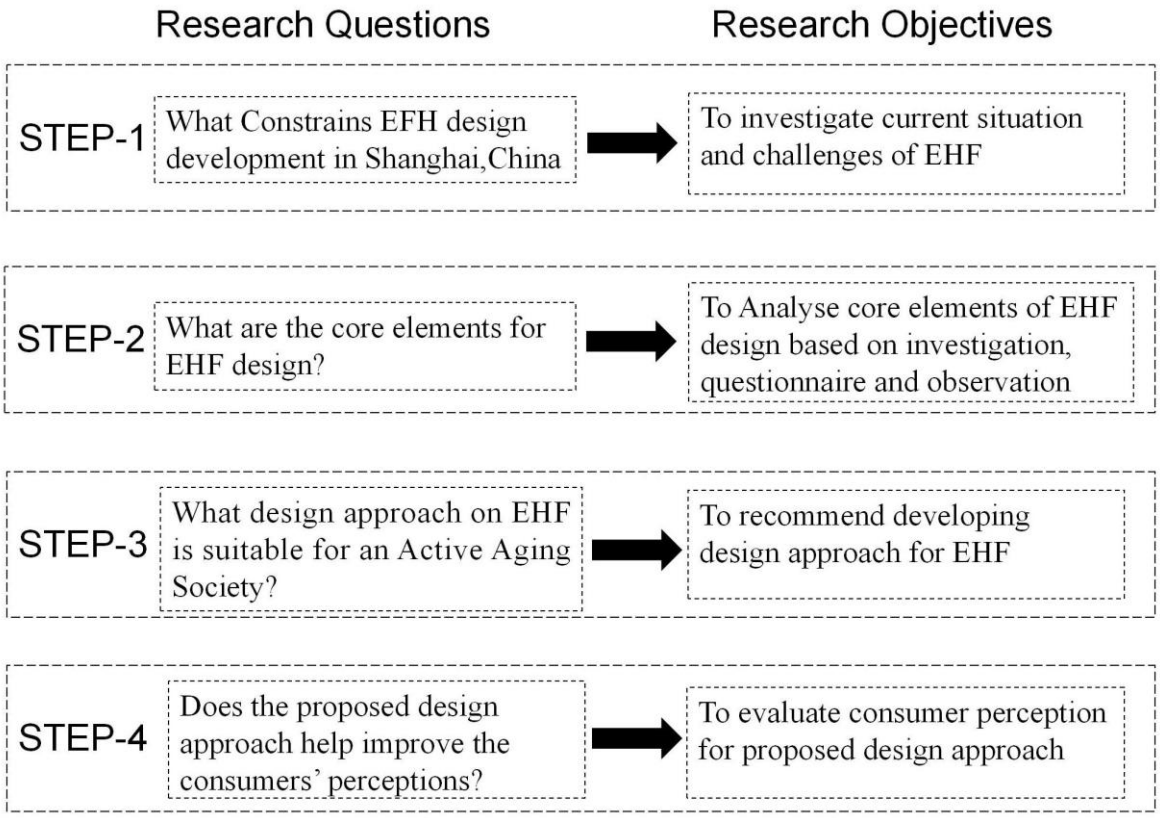


Figure 1.2: Relationship between Research Objectives and Research Questions

1.4 Scope of Research

Based on the research objectives, the scope of this research focused on the followings:

Research geographic sites: This study focused on the elderly in Shanghai, China. This is because it has the biggest population of elderly and the highest degree of ageing in China, it is facing the most urgent challenges of ageing, in addition it represents the trend of aging in China, so this research is worth to do.

Research participants: The research participants for this study are focused on the elderly, aged 60 and above, residing in Shanghai.

According to the Building Design Code for the Elderly (Harbin University of Architecture,1999), the elderly could be divided into three categories:

A: Self-helping Aged People, who could take care of themselves, which accounts for 87.47% of the elderly according to data from the National Health Commission (NHC).

B: Device-helping Aged People, who relied on assisting devices to look after themselves, which accounts for 9.95% of the elderly according to data from NHC.

C: Under-Nursing Aged People, who are completely incapable of self-care, thus, furniture is less used, which accounts for 2.58% of the elderly according to data from NHC.

The first two groups are the largest groups among the elderly and have high demands for furniture. This study focused on the mainstream group of elderly, that is the first group, the Self-helping Aged People and the second group, the Device-helping Aged People, thus this met the needs of the majority of those in the elderly group.

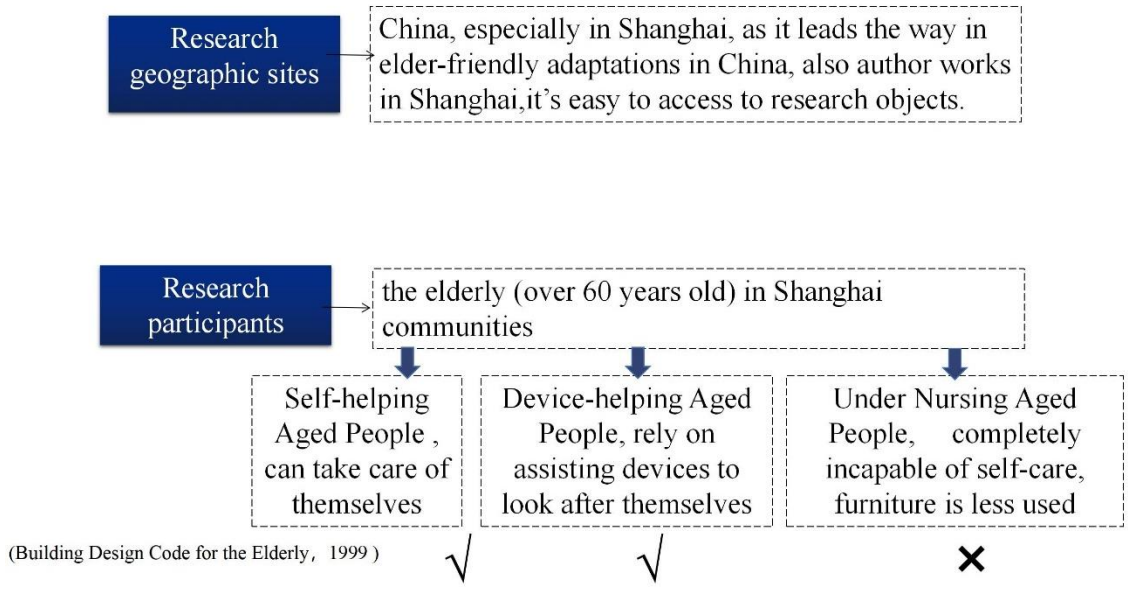


Figure 1.3: Research Geographic Sites and Research Participants

As for the furniture, due to the wide range of categories, this research focused only on EHF of operating furniture, with kitchen cabinet as the research target, which is the basic home furniture that could help the elderly to achieve necessary activities at home. Thus, the concept of EHF was gradually developing on this basis. By combination of theoretical research and design practice, this research would propose counter measures for EHF design development.

1.5 Significance of Research

Ageing in place is the mainstream ageing mode for Chinese people. With the accelerated process of ageing in China, together with the lack of EHF in the market, safe and comfortable EHF has become a necessary facility in China, hence research in this area would certainly benefit the country, society, and the elderly.

For country: China has the highest elderly population in the world, most of them preferring home-based lifestyle, thus EHF shows its potential in the furniture market. Professional EHF are rare and lacking in terms of the standards or quality throughout China's market, which restricts the elderly support strategy proposed by the Chinese government that is home-based, community-supported and institutions to supplement (Yu & Rosenberg, 2017; Zhang et al., 2020). This study included the investigation of EHF market and analysis of elderly's characteristics, subsequently proposing an EHF design approach, so as to promote EHF to develop in large-scale, and extend the smooth operation of home-based elderly support strategy proposed by the Chinese government.

For society: Through improving the self-care abilities of the majority of older people, the limited-service resources could focus on the care for dementia and disability of the elderly with prominent needs, so as to realise the optimal allocation of social resources. It is

not only the needs of the elderly, but also the need for a sustainable social and economic development.

For the elderly: Furniture are needed daily by the elderly, well-designed EHF could help the elderly in self-care and reduce the occurrence of accidental injuries. This could help them with their gradual decline of physiological functions, increase their confidence to reach self-care, and live a life of dignity.

1.6 Research Framework

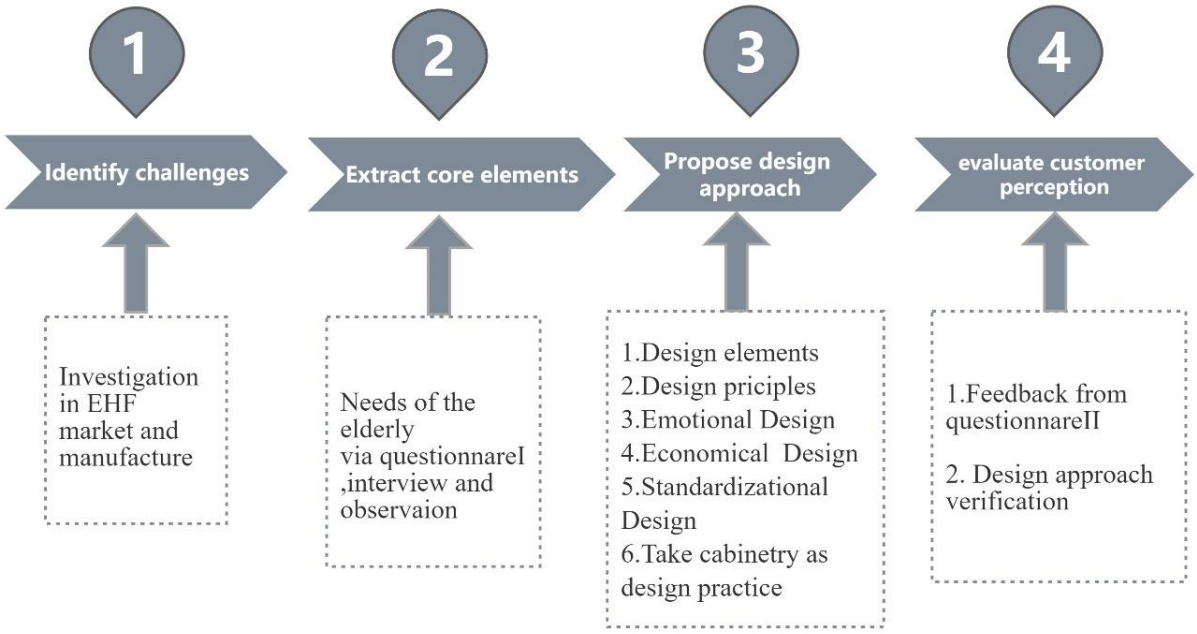


Figure 1.4: Research Framework

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the late part of the 20th century, Europe, America, and Japan took the lead in the global trend of ageing. This shows that studies on the elderly group had already begun in these countries but mainly concentrated on the elderly's residential (Wang, et al., 2014). Most of these studies proposed the use of smaller scale and simple furniture to improve the quality of life for the elderly. The representative books for this area included "Housing for the Elderly (2008)," written by American architect Robert Parkinson, and "Design manual for the Elderly Housing (2011)," written by the Housing Foundation for the Elderly in Japan. There are many types of foreign products designed for the elderly, most of them are barrier-free and has universal designs, however, Japan's products are mostly fine and emotional (Liu, 2017).

Japan is far ahead of many developed countries when it comes to developing products for the elderly. The combination of age-friendly home products with technology has led to the creation of many highly automated devices, and there is a wide range of daily used items such as glasses, special clothing, and wrinkle removers for the elderly.

In the field of architectural related design theory, literatures on topics of ageing have been extensive. In the annual statistics of literature stated that in the recent 10 years, a total of 460 literatures were retrieved, and the number of literatures has been increasing significantly since 2010. These literatures mainly focused on the elderly apartment and

residence, elderly-care model, community service, institutional pension, and other aspects, but research related with furniture design is relatively lower in number.

In view of the above research status, the researcher investigated the literatures from two perspectives, one was on the development of home furniture design for the elderly, and the other was on the active ageing society. From the perspective of active ageing, the researcher developed a design approach of home furniture for the elderly.

The development of home furniture for the elderly could be divided into several steps or processes. The first is the development of design, followed by analysing the market segmentation of furniture for the elderly, then the concept of home furniture for the elderly was introduced, and on the basis of focusing on the establishment of literatures on home furniture for the elderly, the research gap was identified.

In the case of the active ageing society, it was analysed in terms of its definition, role, and expectations, and then a conceptual model of elderly-friendly home furniture in the active ageing society was proposed.

Finally, through the combination of the research gap with a conceptual model of elderly furniture in an active ageing society, the research title “The Design Development of Elder-friendly Home Furniture for an Active Ageing Society” was proposed and discussed in following chapters. Figure 2.1 summarised the Research Flow of the Literature Review.

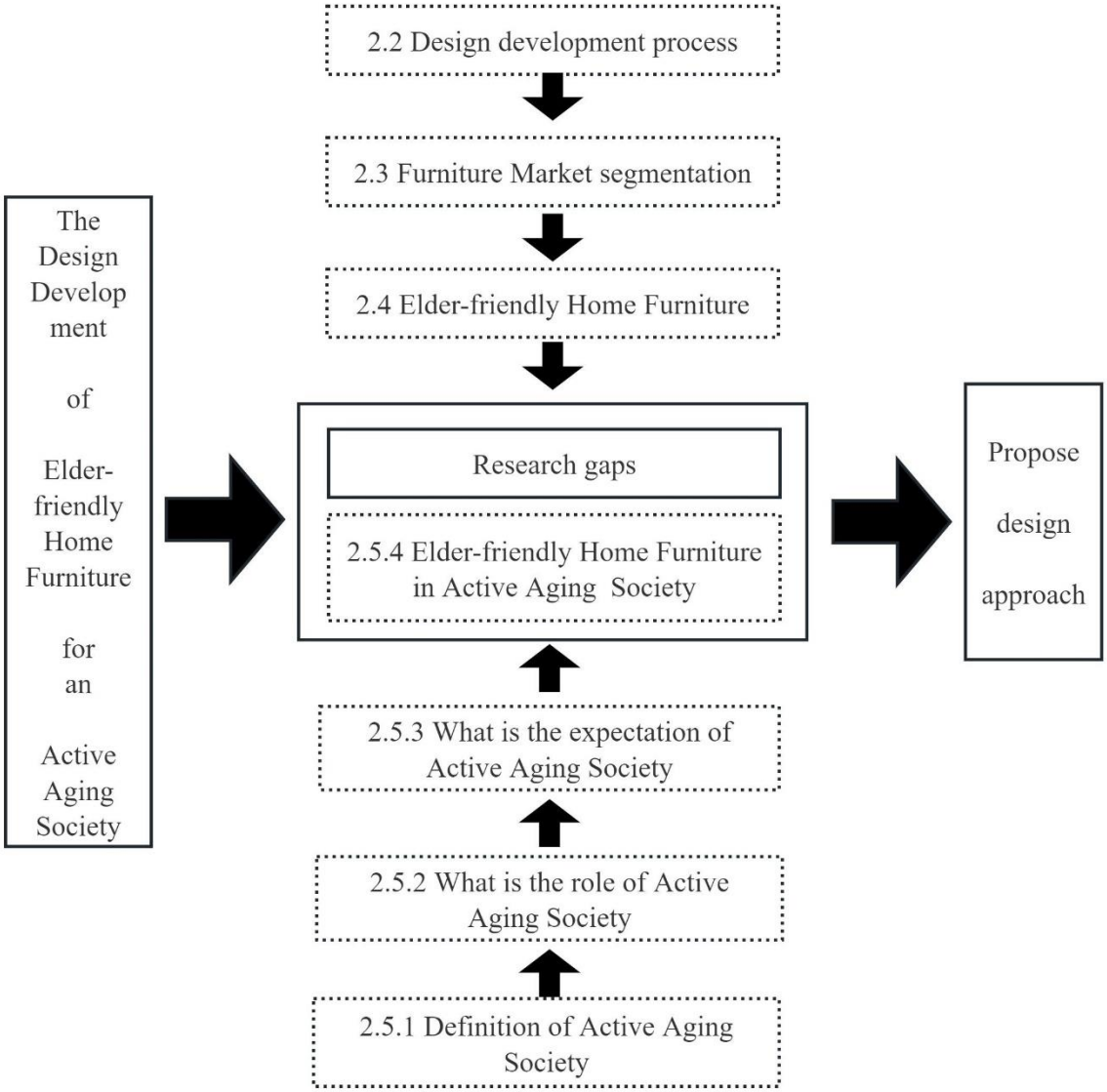


Figure 2.1: Research Flow Chart of Literature Review

2.2 Design Development process

The development of design began with the "Art and Crafts" movement, followed by the "Art Nouveau and Art Deco". With the development of the industry and the generalisation of service objects at the start of the 20th century, " Modernist design" quietly made its debut, and had influenced philosophy, literature, arts, and other fields at that time.

The Bauhaus Institute was established in 1919, and for nearly 20 years, through teaching and developing of design practice, it has formed the theory and ideology of the “Modernist" design. However, in 1933, the German NAZI government shut down the Bauhaus Institute, thus a large number of Bauhaus faculty moved to the United States, and brought their design ideas, which were combined with the U.S. socio-economic environment at the time, resulting in the "internationalist" design style, which influenced the design of countries around the world.

Based on the history of design development, there are two driving forces for design development, which are (1) the innovation and progress of technology and (2) the change of design service target (Wu, 2013).

The development of technology made the design by industrialisation penetration and gradually become the mainstream of design. Industrialisation brought about new technology, new materials and in turn, continued to influence the evolution of design style. To meet the requirements of mass production, the promotion of standardisation in design, reducing cumbersome decorations and cutting production costs became important features of "Modernist" design.

Secondly, the change of design service target. Design is a systematic transformation of objects through human beings, and ultimately serves Human. Therefore, service for human beings is one of the fundamental characteristics of design activities. With the constant development of society, the target of design service gradually shifted from the aristocrats to the civilian. With the maturation and popularisation of industrialised production technology, the emergence of "Modernist" design changed design service targets from the elite to the general public.

With the change of design service target from the superior class of society to the general public, this altered the requirements of design cost, function, and style. As a result, "Modernist" design tended to use concise forms and the design concept of "less is more" to reduce the manufacturing cost. At the same time, technological advances made it possible to reduce costs.

As a whole, technological innovations and development drove the pace of design development, while changes in the design service targets determined the direction of design development. It should be pointed out that the rapid development of industrialisation has also led to environmental related problems such as pollution and ecological deterioration. Green design, economical design, standardised design, and other philosophies to reduce the consumption of resources have become an important theme in design field, which is a reflection and criticism of blind and excessive use of science and technology, as well as a criticism of "Modernity" by "Post-modernism".

2.3 Furniture Market Segmentation

In terms of Furniture Market segmentation, there were two perspectives which were considered, which included the design perspectives and the manufacturers' perspectives.

2.3.1 Furniture Market Segmentation: Design Perspective

Generally, furniture is a living necessity, which needs to be functional while also constituting interior decoration and has aesthetic values. Consequently, from the design perspective, furniture is therefore a combination of function and aesthetics.

Functionality in furniture is achieved via the material, structure, technology, and other elements, while the aesthetic value of furniture is reflected in the colour, shape, texture,

and other elements. From the perspective of furniture design, furniture could be divided into the following categories as shown in Table 2.1 based on the design elements and resulting in the corresponding market segmentation.

Table 2.1: Furniture Segmentation from Design Perspective

	Design Elements	**Furniture Segmentation**
Design function	Material	Solid wood furniture, panel furniture, soft material furniture, rattan furniture, bamboo furniture, metal furniture, steel and wood furniture, glass furniture, stone furniture, fabric furniture, resinous furniture, and combined material furniture, and so on.
	Structure	Frame furniture, panel furniture, soft furniture, etc.
	Technology	Integrated furniture, disassembled furniture, folding furniture, combined furniture, connecting wall furniture, hanging furniture.
	Functional space	Office furniture, outdoor furniture, and home furniture.
Design aesthetics	Shaping effect	Ordinary furniture, art furniture.
	Design style	Modern furniture, Post-modern furniture, European classical furniture, American furniture, Chinese classical furniture, new classical furniture, Korean-style garden furniture, Mediterranean furniture and so on.

One could see based on Table 2.1 that the materials used for making furniture are solid wood furniture, panel furniture, soft material furniture, rattan furniture, bamboo furniture, metal furniture, steel and wood furniture, glass furniture, stone furniture, fabric

furniture, resinous furniture, and combined material furniture, and so on. While the structure typically falls under frame furniture, panel furniture, soft furniture, etc.

In terms of the technology used for furniture development, there are various types including integrated furniture, disassembled furniture, folding furniture, combined furniture, connecting wall furniture, hanging furniture.

The functional space in which furniture is located in could be divided into office furniture, outdoor furniture, and home furniture. Home furniture could then be further divided into living room furniture, bedroom furniture, study furniture, dining room furniture, bathroom furniture, kitchen furniture and auxiliary furniture.

Based on the shaping effect of the furniture, it could be divided into ordinary furniture and art furniture.

The design style of furniture could be divided into Modern furniture, Post-modern furniture, European classical furniture, American furniture, Chinese classical furniture, new classical furniture, Korean-style garden furniture, Mediterranean furniture and so on.

However, it is worth noting that the above classifications may gradually change and enriched one another with the evolution of design.

2.3.2 Furniture Market Segmentation: Manufacture Perspective

Philip Kotler is a famous marketing expert, known as the "Father of Modern Marketing". He put forward many important marketing theories and concepts, which have had a profound impact on the development and practice of marketing. Among them, the Segmenting, Targeting and Positioning Theory of Market (STP) which pointed out that companies should divide the market into different market segments, then choose the target

market and finally, determine the positioning strategy. This theory stressed the need for companies to offer different products and marketing strategies for different market stages and consumer groups (Kotler, 2014). Table 2.2 summarised the steps of STP Theory.

Table 2.2: Steps of STP Theory (Quoted from Kotler,2014)

		Contents
Step-1	Segmenting	Market segmentation based on geographic, demographic, psychological and behavioural factors, includes the following steps: 1. Choose the scope of the product market. 2. List the needs of potential customers. 3. Analyse the different needs of potential customers. 4. develop appropriate marketing strategies.
Step-2	Targeting	Select the target market, generally using the following three strategies: non-differentiated marketing, differentiated marketing, focused marketing.
Step-3	Positioning	Market positioning is to create a distinctive product personality, so as to create a unique market image.

Based on Kotler's (2014) theory, Xu (2002) refined the Chinese furniture market with three levels of segmentation, respectively, mass, personalised and segmented marketing. According to Xu (2002), in the last 20 years of the 20th century, especially in the mass marketing stage, when it was the early stage of Reform and Opening up, the consumers had limited vision, and as long as there was a product, it would be bought in the seller's market, which brought substantial profit to Chinese furniture enterprises.

But with the saturation of the market, product competitiveness declined, and low prices led the enterprise into the micro-profit or even no-profit stage. While personalised marketing could eliminate the dilemma for enterprises, it required specific conditions of maturity.

Segmentation marketing assumed that there are a large number of identifiable groups of people in the market who share the same desires and needs. When a company is unable to provide personalised services, it could isolate segments of the market, which are intermediate groups between mass marketing and personalised marketing. Once the segments are identified, the design is no longer blind, and products which better suit the customer could be created, while distribution channels are easier to choose. If one's competitors also focused on market segments, there would be less competition, and if mass marketing is still used, there is a better chance of winning due to specialisation.

Market segmentation plays a very important role for enterprise marketing, but in order to make it an effective method for management, it is necessary to further find scientific criteria for segmentation.

Western marketing science has put forward different standards and methods in this area. As different countries have different economic cultures, their users also have different needs and purchasing behaviours. At the same time, enterprises have different production and operation characteristics, thus, it is impossible to have uniform standards. Therefore, when countries segment their markets, they should make the segmentation criteria combinational, they should consider the cross-cutting principle between the criteria and make effective combinations. It is only through this way that enterprises could segment their markets scientifically and choose their target markets accurately.

Zheng (2007) proposed to segment the Chinese furniture product market by combining consumer demographic characteristics and geographic regions. According to the characteristics of the consumers' demographic, Chinese furniture market could be segmented into:

i. Group furniture consumer market.
ii. Rural furniture consumption market.
iii. Furniture consumption market of high-income class.
iv. Urban middle-income class furniture consumption market.
v. Furniture consumption market of new married youth.
vi. Children's furniture consumption market.
vii. Furniture consumption market for the elderly.

Here, it is important to clarify the two common classifications of consumer groups in the Chinese consumer market, which are the B-channel and C-channel customers.

B-channel and C-channel refer to different target customer groups in the business field, B referring to business, and C referring to consumers. Therefore, B-channel or Business-to-Business, refers to the business activities between enterprises, that is, enterprises for other enterprises to carry out business activities such as sales, purchasing, supply chain management, cooperation, etc. B-channel customers are mainly enterprises, government agencies, non-profit organisations, and other organisations whose purchasing decisions require multiple consultations and approvals, and the decision-making process is complex.

C-channel or Business-to-Consumer refers to consumer-oriented business activities, i.e., the business activities of companies selling products and services to consumers. C-

channel customers are ordinary consumers, whose purchasing decisions are usually simpler and the purchasing process more direct.

As a result, the B-channel, and the C-channel customers, as two concepts in Chinese market, was used in the following discussion.

Secondly, the market could be segmented by geographic regions into the following seven markets in China as shown in Figure 2.2:



Figure 2.2: Chinese Furniture Market Segmented by Geographic Region

i. The Southwest market, centred on Sichuan and Chongqing. This market mainly includes four provinces, namely Sichuan, Yunnan, Guizhou, Tibet, and Chongqing,

with a population of more than 200 million, accounting for 1/6 of China's total population. The potential market of this region is large. It is highly populated, geographically extensive, and rich in resources. These areas were also included in the construction of the "Third Line" in the past, whereby, construction concentrated on building a lot of big industries, and light industry was weak, furniture production capacity was low, the contradiction between supply and demand was very prominent.

ii. The East China market, centred on Shanghai. With a current population of nearly 170 million, Shanghai, Jiangsu, Zhejiang, and Fujian provinces are historically wealthy places in China and one of the economically fast-growing regions in modern China, especially Shanghai. After decades of development of “Reform and Opening up”, Shanghai has become an international cosmopolitan city, as well as China's largest commodity sales market and distribution centre, which is the largest, most complete, and matured commercial network in China. The East China market is the barometer of China's furniture consumption. The domestic and foreign furniture all take the selling volume in Shanghai market as the standard of their success or failure. The surrounding areas of Jiangsu and Zhejiang follow closely behind.

iii. The Middle Plains market, centred on Wuhan and Zhengzhou. This region comprises of five provinces, Hubei, Henan, Hunan, Anhui, and Jiangxi, with a total population of 330 million and an income level which is between the coastal and inland regions. Zhengzhou and Wuhan are both important transport hubs in China and have traditionally been the most sought-after locations for businesses. Both are located in China's "heart" zone. However, because there are more laid-off workers, and the secondary and tertiary industries are not well-developed, the level of consumption is relatively low while the demands for medium and low-grade furniture are very large.

Hunan and Jiangxi are close to China's furniture manufacturing base in Guangdong, with the function of the furniture secondary wholesale market, medium and low-grade furniture market is particularly prosperous.

iv. Northeast market centred on Harbin. Heilongjiang, Jilin, and Liaoning provinces have a total population of more than 100 million and has an average per capita income of the urban population of the middle level. As this region is China's main heavy industrial base, light industrial production capacity of household products is weak relatively, and this affects the furniture industry. The Northeast people are more straightforward, pay particular attention on home furnishings, advocate brand-name, and provide a broad market for the furniture of the South to the North.

v. North China market centred on Beijing. It includes Beijing, Hebei, Shandong, Shanxi, Inner Mongolia, and Tianjin, four provinces and two cities. North China has a dense population. With a population of about 240 million, the region has a wide geographic scope, a wide income gap between residents, as well as a wide range of high, medium, and low levels of consumption. Beijing's income and expenditure levels are higher than those of other coastal cities. As Beijing is the political and cultural centre of China, it has great and strong influence. There is a huge market for both high-grade home and office furniture, but the surrounding areas are dominated by medium and low-grade furniture.

vi. Northwest China market centred on Xi'an. Located in the northwest of China, the Shanxi, Gansu, Qinghai, Xinjiang, and Ningxia provinces have a total population of about 100 million. This region, despite the economic backwardness, has resources and basic industries which are relatively developed. They also have shortage of light

industrial consumer goods, and although they have low-grade product requirements, they are, however, high in quantity demand.

vii. The South China market centred on Guangzhou. The Guangdong, Guangxi and Hainan provinces in South China have a total population of 135 million. Guangdong is one of the wealthiest regions in China as a frontier of the Reform and Opening-up process. Over the years, this region has led the trend of development and progress of China's furniture industry, accounting for half of China's furniture industry. Guangdong furniture market has experienced three stages of development, maturity, and prosperity, and has gradually moved from the beginning of the disorganised state to an organised one. Shunde, Panyu and other cities in the Pearl River Delta region, were springing up tens of thousands of furniture shops. Shops were gathered in the main road, called the "Furniture City", along the highway stretching along both sides of more than 10 kilometres, is very magnificent. Dongguan and Shenzhen have also become the largest production and sales and export bases of furniture in China in recent years, especially the "Famous Furniture Fair" in Dongguan, which, after several years of development and refinement, can be regarded as China's largest furniture exhibition, both in terms of area and scale of exhibitors.



Figure 2.3: "Furniture City" in Shunde Guangdong Province

This research focused on Shanghai as the research site and the elderly in Shanghai communities as the research target, which were both typical in terms of the geographical area and the target population, thus, giving this research value for market.

2.4 Elder-friendly Home Furniture

2.4.1 Definition of Elder-friendly Home Furniture (EHF)

Elder-friendly Home Furniture or EHF consists of two key words, elderly, and home. "Elderly" refers to a specific group of people, and "home" refers to the specific scenario in which the behaviour of the ageing activity and behaviours take place, namely, the place where the furniture is being used.

Internationally, there are two criteria for defining the elderly, one of which is that those aged above 65, as recommended by the United Nations in 1956, and the other is those aged above 60, as recommended by the World Conference on Ageing in 1982 (Gu, 2000). The former is used mostly in developed countries and the latter is used mostly in developing countries, however both definitions are universal.

In China, the first Association of Gerontology and Geriatrics stipulated those 60 years old is the age said to be entering old age. Norms related to design for the elderly, Building Design Code for the Elderly (Harbin University of Architecture,1999) defined people over 60 years old as the elderly, and could be divided into three categories based on their physical conditions, (1) Self-helping Aged People, (2) Device-helping Aged People and (3) Under-Nursing Aged People.

Self-helping Aged People with physical abilities could take care of themselves, while Device-helping Aged People and Under-Nursing Aged People would need to be assisted as they get older. Thus, each category would have different demands on furniture. Self-helping elderly individuals would prefer visually pleasing and comfortable furniture, while Device-helping Aged People and Under-Nursing Aged People start to require auxiliary functions, and at the same time, Under-Nursing Aged People would prefer auxiliary furniture due to their reduced self-care abilities (Luo, 2016). This study addressed two categories of the elderly in China, which were the Self-helping Aged People and Device-helping Aged People, as they constituted the majority of elderly individuals in China.

Luo Shan (2016) pointed out that elderly furniture refers to furniture dedicated to the elderly, which functionally and stylistically meets the psycho-physiological needs of the elderly in terms of use and aesthetic needs.

As mentioned above, in China, there are three types of ageing in place: home-based ageing, community-based ageing and institutional ageing. Home-based ageing refers to the elderly who are living in their own homes and relying on their own abilities or on their children to spend their senior life.

Community care refers to the mode in which the elderly still live at home and the communities provide them with on-site support services, which still takes place at home.

Institutional ageing, on the other hand, is a model in which the elderly live in nursing homes or special care institutions, provided with services by elderly service professionals, and it takes place in the context of institutions.

Luo Shan (2016) proposed that home, community, and institutional care, although they all need to use furniture, the different modes of care also determine the different requirements for furniture design. Firstly, characteristics of the space are different, the elderly institutions provide group living for the elderly, which is public space, while the family is a private space with personal living. Secondly, the lifestyle and activities of the elderly in these two different environments are different. Such variations determine the design of elderly furniture could not be generalised and should be separately designed in order to adapt to the different modes of old-age care.

In summary, EHF proposed in this research referred to the furniture designed for Self-helping Aged People, and Device-helping Aged People over 60 years old, who adopted home-based ageing and community-based ageing, which were suitable for the home scenario. As for the Under-Nursing Aged People, they are those who could not take care of themselves completely and would need to move to nursing homes or be looked after by caregivers, so

their demands for furniture would be different from the elderly of the first two groups and should be studied separately.

Home environment has different functional spaces, accordingly, there are different types of EHF, which usually could be divided into living room furniture, bedroom furniture, kitchen furniture, bathroom furniture, study furniture, dining room furniture, balcony furniture, storage furniture and so on.

Table 2.3: Classification of Elder-friendly Home Furniture (EHF)

Categories	Item
Living room furniture	Sofa, Tea table, TV cabinet, Decorative shelves, etc.
Bedroom furniture	Beds, Bedside tables, Dressing tables, Wardrobes etc.
Kitchen furniture	Kitchen Cabinet, Islands Cabinet, Storage Shelves, etc.
Bathroom furniture	Washroom Cabinet, Storage Cabinet, Bath Towel Rack, etc.
Study room furniture	Study Table, Bookcases, Newspaper racks, Computer desks and Chairs, Recliner chairs, side tables, etc.
Dining room furniture	Dining table and chairs, Wine cabinet, Bar cabinet, Bar stools, Tableware cabinet, etc.
Balcony furniture	Leisure Chair, Coffee Table, Flower Stand, etc.
Entrance hall furniture	Shoe Cabinet, Cloak Cabinet, Clothes Rack, Display Case, Footstool, etc.

In the 1990s, the integral cabinet began to enter the Chinese market. By the year 2000, with the widespread adoption of supporting technology, China's kitchen cabinet market entered an era of adoption, in line with the development of the world’s market.

The kitchen's integral cabinet comprises of bottom and suspended cabinets, countertops, sinks, and associated hardware and fittings. These units serve to store cooking utensils, food, and spices, providing an organised and efficient container for all kitchen items (Li, 2010). Wu (2019) asserted that unlike most kitchen cabinets in the present market, which is based on European and American designs, elderly kitchen cabinet in China are kitchen cabinets designed to be used comfortably and pleasantly by the elderly of different ages and physical stages. The design of elderly kitchen cabinet should be improved according to the special conditions of the elderly.

Elderly-friendly kitchen cabinet in this research are defined as integral cabinet designed for Self-helping Aged People and Device-helping Aged People in home scenarios to achieve the goal of an active ageing society by enhancing the ease and comfort of use for the elderly. The reasons why Elderly-friendly kitchen cabinet were chosen for the study are as below.

For the elderly, the kitchen cabinet is a type of furniture which is frequently used on a daily basis. It combines operation, storage, and display. Therefore, it was chosen as the research object for this study.

For the furniture market, the researcher discovered after investigation that single products such as elderly sofa, bed and wardrobe have already appeared in furniture manufacturers' studies. However, the number of studies on kitchen cabinet is still rare (see Chapter 4 Data Collection and Analysis). Therefore, choosing it as the object of research could fill the gap of elderly furniture in the market.

For elderly, the kitchen cabinet integrates multiple functions, including storage, display, and functionality. Selecting it as the research subject enabled a comprehensive

reflection of the ageing renovation and the upgrading process of various furniture types, such as functional, storage, and display furniture. It also facilitated the extension of the research methodology to other categories of furniture.

2.4.2 Research on Elder-friendly Furniture

Domestic and foreign literatures were collected through different leading academic platforms such as CNKI, Cqvip, Wanfang database and Baidu Scholar for the domestic academic platforms, and Web of Science, Google Scholar for the foreign academic platforms. This was done by typing in keywords such as "elder-friendly home furniture" and its synonyms including "elderly furniture, ageing furniture, age-friendly furniture, elderly furniture design" into the above platforms, and the literature searched were then arranged according to the relevant themes:

i. Literatures on furniture design for nursing home

In WOS database, there were 34 pieces of foreign literature directly related to elderly-friendly furniture, 25 of which were Korean scholar's literature. Among them, some literatures focused on Furniture design for nursing home rather than home situation. Yang (2016) proposed furniture design for the elderly day-care centres from the perspective of function, structure, materials, and shape elements. Yeoum & Cho (2016) explored the development of a safer and more comfortable table which the elders in the nursing homes used to have their meals while sitting on the floor. They were designed for the elderly with muscle rigidity and curved legs which had difficulties in stretching and bending. Jung-in （2017）investigated and analysed cases for developing furniture design appropriately for elderly group homes in Korea and provided ways for differentiated planning. He found that characteristics of furniture design in overseas care facilities were those that applied design

respecting each individual's personality instead of standardising or unifying furniture so that each of the aged in the group homes could feel as though they were in their own former houses.

ii. Theoretical studies of elderly furniture

Cho & Yeoum (2016) jointly conducted a study on elderly furniture development by the Department of Nursing Science and furniture design to determine the critical factors. The furniture design guideline for the elderly was presented from the perspective of multiple functions, ergonomically dimension in terms of structure, bright and vivid colour as well as material which contributed to prevention of fracture. Moon & Hyun (2021) investigated the biological changes and characteristics of the elderly, studied the concept definition, scope and limitations of system households. In addition, by grasping the changes in the home appliance market and trends in the home appliance market, the design direction of system furniture required by the elderly was presented.

There were also a substantial number of literatures related to the general study of elderly furniture. Saputri, Kurniawan and Suryono (2021) found that nursing home needed special attention to satisfy the physical and psychological of the elderly. One of the attempts was by adding entertainment space with good ergonomic and aesthetic design. The form of dynamic furniture used was also to help the elderly who were more eager in their activities. Dawal et al. (2015) suggested that an anthropometric database for Malaysian elderly population needed to be developed. Earlier anthropometric database of Malaysian elderly population was developed, and this database could be used as a guideline in designing household facilities for the Malaysian elderly and elderly of other

countries. Therefore, the design of the household facilities should be influenced by sound ergonomics dimensions in order to create a safe and healthy environment for the elderly.

Chinese research started in 2010, with mainly qualitative research articles, and a small number of master's theses. Previous research on elderly-friendly furniture in China showed some weakness.

There were general studies of elderly furniture, but these lacks in terms of focus on home-based situation. Liu (2017) suggested that designs of elderly-friendly furniture should be considered in terms of ergonomics, optimising storage space and mobility assistance. Zhong and Shen (2018) proposed that the designs of elderly-friendly furniture should be based on the physiological and psychological characteristics of the elderly, with multiple considerations in terms of structure, technology, colour, and shape. Zhong and Shen (2018) also proposed that the designs of elderly-friendly furniture should be combined with assistive functions and safety assurance.

iii. Theoretical studies for specific elderly furniture

Certain types of elderly furniture such as kitchen furniture, sitting furniture, did not include the whole or basic products line. Mihyun (2020) showed that the approachability of kitchen furniture and space should be considered, followed by the legibility as a factor so that the elderly could recognise them easily, while convenience should ultimately be considered so that the physical elements could be easily used. Hee, Kim and Lee (2017) developed a safe and convenient multifunctional sofa by removing complex combinations and decomposing processes of the multifunctional transformable furniture. This was found to be appropriate for the use by elderly living alone based on the observations which were carried out via a 24-hour scheduling, interviews, and actual measurement.

Literatures related to specific type of elderly furniture were also discovered. Hrovatin, Jevšnik, Oblak and Berginc (2012) pointed out that the common shortcomings of kitchen furniture included insufficient lighting (32%), inappropriate sequential composition of work surfaces (56%), ease of hygiene maintenance (68%), inappropriately - shaped furniture (72 %), and tasks that become troublesome because of declining memory (75 %). Hrovatin et al (2015) stated that it was possible to significantly ease kitchen chores with properly sized and appropriately arranged cupboards. In designing kitchen furniture, the optimal depth, and the height of storage capacities, as well as the accessibility for the elderly should be taken into consideration. They proposed a model with a deeper worktop and wall cabinets which were lowered onto the worktop.

Google Scholar is another search engine for foreign literature, in which keywords such as “Elder-friendly Home Furniture” were entered. The search results showed that almost all literatures on elderly-friendly hospitals and community, and a small number about furniture. While with the keywords “ageing-friendly furniture”, the literatures showed results which mainly focused on Urban Environments, housing, and indoor space. Among them, Beata et al (2021) identified seniors' preferences in relation to characteristics of sitting furniture among people in Poland, Germany, Denmark, Finland, Latvia, and Lithuania. It was found that the preference was having an armchair with a high backrest reaching above the head, a chair with armrests and an upholstered backrest and seat. Furthermore, respondents paid attention to the durability of furniture, stain resistance of upholstery, and adaptation of the furniture to the user's dimensions.

There were a number of research focusing on one product, especially for sitting furniture, but lacking on systematic research on elderly furniture. Cheng and Li (2019)

presented an elderly-friendly design approach for beds and bedside tables, wardrobes, and shelves in terms of functions and shapes. Xu and Yang (2016) proposed that seating comfort included two categories: physiological comfort and psychological comfort, both of which influenced each other. Tao, Chen and Chen (2020) optimised wardrobe for the elderly from the perspective of storage space expansion, size adjustment and optimisation of functional components. Jiang, Niu, and Zhou (2017) focused on furniture used by the ageing population and discussed the furniture' influence on the quality of sleep and proposed the design direction for these kinds of furniture. Wang, Lin, and Huang (2022) explored the relationship between the efficiency of daily activities and the spatial layout of home kitchens in the elderly population by assessing the moderating role of cognitive function. The results showed a significant association between home kitchen space layout of homebound older adults and their kitchen activity efficiency. Wen, Dong, and Li (2019) proposed emotional reading furniture suitable for the elderly by means of empathy, implication, and reasonable form from size, colour, structure, and cultural requirements.

iv. Literatures on smart design of furniture

In WOS database, except for 25 Korean scholars' literature, 9 were directly relevant international literature focusing on smart elderly-furniture, general study, and certain types of furniture.

Literatures related to Smart elderly furniture were also found, Zhou, Huang, Luo, Jake and Fu (2022) discovered that users with "pain points focused on low seat surfaces caused by the difficulty in getting up, a Kinect-based experimental device was used, an intelligent age-friendly sofa with three forms was designed and prototyped". Zhou, Xin, Ting and Tao (2020) discussed the functional matching of smart adaptable furniture terminal

modules based on wireless sensor networks. They focused on the smart system for nursing homes as their research subject. The system used ZigBee technology to complete the indoor wireless sensor network (WSN) layout and conducted fall test experiments. Frischer et al (2020) presented a review of the state-of-the-art literature in smart solutions for the elderly based on publications under ICT smart solutions for the elderly, along with smart furniture options and manufacturer activities in terms of fixing market prices for these furniture materials. In addition, patenting rights on some existing smart furniture designs for the elderly, given the current trends in worldwide acceptance, were also examined.

Merilampi et al (2020) developed several modular smart furniture prototypes to customise solutions according to the end user's capabilities and needs. Their results highlighted that smart furniture should be aesthetically pleasing whilst still serving its primary purpose (i.e., as an item of furniture).

Chen (2022) proposed four types of smart home contexts for elderly users, including user, task, time, and environmental context. They proposed a specific smart home product voice user interface design strategy. Luo (2022) expressed the foundational idea that furniture for the elderly should be made secure, convenient, intelligent, and cost-effective based on the use of the internet of things technology (IoT).

v. Literatures on Furniture from specific perspective

Many studies done on elderly-friendly furniture were developed from one perspective, either safety, humanisation, or emotional design, but were lacking in terms of comprehensive research. Mu (2021) pointed out that the humanisation design for elder-friendly furniture is reflected in colour, form, material, and function. Shen and Wang (2020)

suggested that elderly furniture safety should include functional and psychological safety. Safety design could start with size, colour, and materials. Liu and Yin（2018）proposed that the emotional characteristics of the elderly are fear of loneliness and the desire to be respected, thus emotional design could be achieved from the safety, comfort, convenience, and individuality of furniture. Chen (2021) investigated and analysed the preference of relevant personnel for the design of furniture suitable for the elderly under the home care model via the Q method. It was concluded that design focusing on the life behaviour, physiological and psychological characteristics of the elderly was the most biased design element of the designer. Wang and Yang (2012) analysed the national standards of furniture size, and the market furniture size, and discovered thigh that high scale furniture was a major problem for the elderly furniture designs. Table 2.4 summarised the literatures related.

Table 2.4: Literature Review Matrix

Research topics	List of literature	Remark
EF (Nursing Home)	1.Yang, Woo Chang (2016) 2.Yeoum, SoonGyo & Cho, sook-kyung (2020) 3.Jung-in Moon（2017）	Proposed design concepts in terms of function, material, structure, and personalisation. But it's not suitable for EHF totally as different scenario.
EHF (Theoretical Studies)	1. Cho Sook-kyung & Yeoum SoonGyo (2016) 2. Moon Hyungjoon &Hyun Kim Sung (2021) 3. F N Saputri, B K Kurniawan & D I Suryono (2021) 4. Dawal SZM，et al (2015) 5. Liu Junlan (2017) 6. Zhong Zhenya & Shen Liming (2018)	Provide theoretical entry points for EHF from perspective of functions, ergonomics, Aesthetics, and market trends.

Table 2.4 continued

EHF (Specific types)	1. Mihyun Oh (2020) 2. Hee Kim Myung, Kim Hwikyung & Lee Jonghee (2017) 3. Jasna Hrovatin, Kaja Širok Simona Jevšnik, Leon Oblak & Jordan Berginc (2012) 4. Hrovatin Jasna, et al (2015) 5. Fabisiak Beata, et al (2021) 6. Cheng Yuanhua & Li Panpan (2019) 7. Xu Baiming & Yang Guangrong (2016) 8. Tao Tao, Chen Yi-lian & Chen Yun (2020) 9. Jiang B, Niu H, & Zhou D (2017) 10. Wang Y, Lin D, & Huang Z. (2022) 11. Wen Z, Dong W, & Li J. (2019)	Concept of age-friendly design for individual furniture is proposed, providing research foundation for developing comprehensive design solution.
EHF (Smart Design)	1. Zhou Chengmin, Huang Ting, Luo Xin, Kaner Jake &Fu, Xiaoman (2022) 2. Chengmin Zhou, Xin Luo, Ting Huang &Tao Zhou (2020) 3. Frischer R, et al (2020) 4. Merilampi S, et al (2020) 5. Chen Wei (2022) 6. Luo Deyu (2022)	Combined with the Internet of Things (LoI), Artificial Intelligence (AI) technology, explored the direction and possibility of the development of EHF.
EHF (Humanization)	1.Mu Ren (2021)	Providing ideas for the development of EHF design.
EHF (Safety)	1.Shen Di & Wang Jie (2020)	Providing ideas for the development of EHF design.
EHF (Emotional Design)	1.Liu Shulao & Yin Ling（2018）	Providing ideas for the development of EHF design.
EHF (Research Method Preference)	1.Chen W. (2021)	Pointing out that research methodology based on the psychology, physiology and behaviour of the elderly is a designer's preference, this provides methodological guidance for research.
EHF (Dimension)	Wang Q & Yang A (2012)	Providing ideas for the development of EHF design.

vi. Analyse of Literature Review

Through the above literature, it could be concluded that in the context of global ageing, both foreign and Chinese researchers have begun to pay attention to the field of elderly furniture. Both Western and Chinese literature, most of which appeared in the last 10 years, indicated that scholars all over the world have started to study the EHF as a sub-field. It also showed that this research has both theoretical significance and practical value.

Among them, East Asian scholars, especially Korean and Chinese scholars, pay more attention to elderly furniture, which may be because of the increasingly serious ageing situation in these two countries and this situation has inspired the enthusiasm of researchers. Their research included general studies of EHF, but lack in terms of the consideration on home-based situation. Most studies have focused on one product but lacks in terms of systematic research, while studies developed from one perspective, lack comprehensive research. As a result, there were few comprehensive and practical design solutions for EHF, which became the research gap.

Western scholars showed preference for the research of intelligent furniture for the elderly. This could be due to the development of AI and the Internet of Things technology in the West, providing a better platform for the research of intelligent furniture for the elderly.

In general, current research on elderly furniture partly focused on nursing home furniture, while research for elderly-friendly home furniture could be divided into three aspects, theoretical research, a certain type of furniture and a certain type of properties of furniture. Most of the research are theoretical in terms of results and suggestions. They lack in-depth observation, interview, and design practice, and were still in the stages of experimentation and exploration. For manufacturers and designers who are interested in the

development of EHF, there is an urgent need to carry out a series of systematic work to understand the real living status of the elderly, observe and analyse the problems existing in the process of furniture using for the elderly, and solve the existing problems through design practice.

Research gaps found. Firstly, EHF is a systematic solution due to its large volume and various categories, but the literatures reveal that there were few comprehensive solutions that could satisfy consumers and manufacturers at the same time. Therefore, it is difficult to replicate the research on a single piece of furniture or a single characteristic to other types of furniture, in addition, research related to home context was less. Secondly, there were very few studies that combined the concept of active ageing with furniture design. Therefore, based on the background of active ageing society, this study proposed to put forward the concept of a universal design approach of EHF. Thirdly, theoretical research could provide guidance for the market, but the practicality was poor, although manufacturers know that the elderly furniture market is "a blue ocean", but there was no point to start with, therefore, this study proposed to adopt the design practice method, the theory would be materialised and shaped, and verify research results through questionnaires, to ensure that the study's visibility and feasibility.

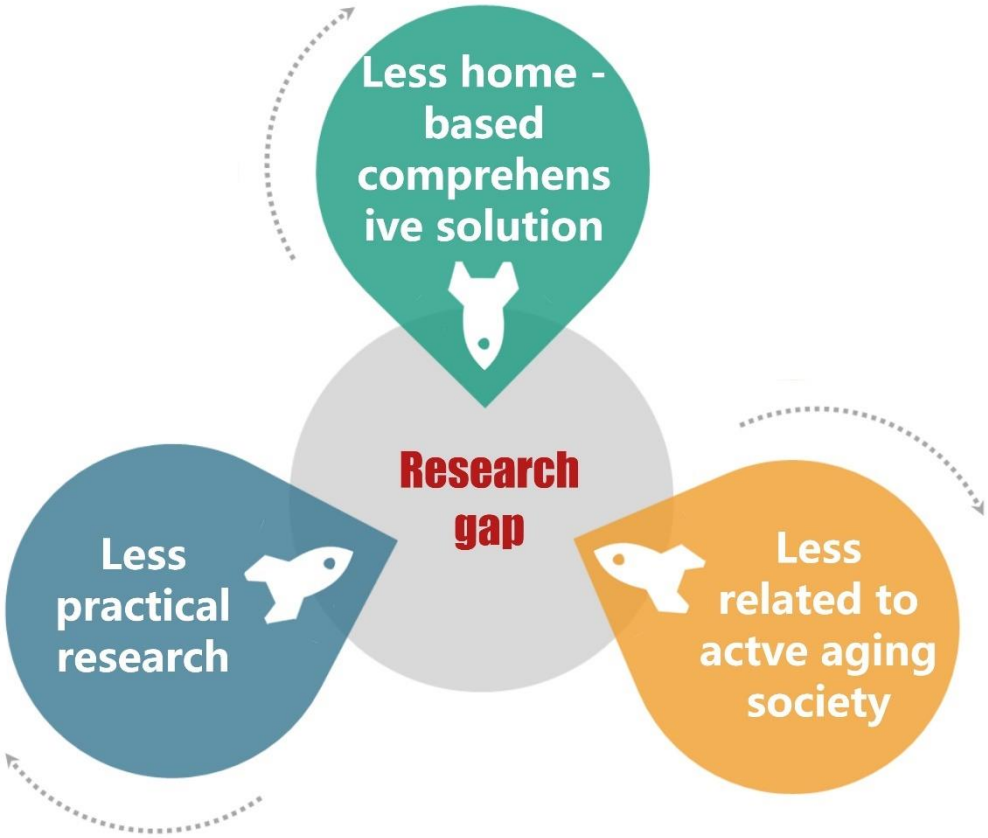


Figure 2.4: Research Gaps Found

2.5 Active Ageing Society

2.5.1 Definition of Active Ageing Society

The concept and strategy of "Active Ageing" was first proposed by the World Health Organization (WHO) in 2002. It advocates that the elderly should devote themselves to life with a positive attitude, paying more attention to their physical and mental health, to their human dignity, and self-fulfilment. Their policy entitled “Active Ageing: A Policy Framework” defines Active Ageing as enhancing the quality of life of older people by optimising their opportunities for health, participation and security (WHO, 2002).

It emphasises the connection between activity and health, as well as the importance of healthy ageing, in which "active" refers to continuous participation in the affairs of society, and includes optimizing behaviours related to employment, politics, education, arts and religion, as well as improving the contribution of the elderly to society.

At the policy level, Active Ageing encourages the provision of health-enhancing activities and the creation of healthy environments to enrich the life of the elderly and improve their quality of life. This is done by increasing their autonomy and independence, reducing medical expenditures, and reducing the cost of care. In other words, if the support for services that encourage the social participation of older individuals is not provided, it would increase the risk of dependency and exclusion of older individuals, and then the Active Ageing policies would also be weakened (Deeming, 2009). In the context of this research, it was obvious that the optimisation of home furnishings to create a healthy home environment for the elderly, and to improve their self-care ability, as well as their self-reliance and confidence in life, was a positive response to the Active Ageing Policy.

In view of the number of research done in recent years, research in this area has shown a general upward trend. Yang (2019) stated that Active Ageing is based on the principles of independence, participation, care and self-fulfilment. This focuses on government and social forces to create a mechanism platform that facilitates the continued participation of the elderly in the society through conceptual innovations in policy and organisational aspects. The European Union or EU is the regional international organisation that has used and researched the concept of Active Ageing the most and the earliest. It has also been the most proactive in promoting the practice of Active Ageing policies. Mendizabal (2018) argued that in the context of Active Ageing, people seek health as well

as social goals such as independence and mobility in the widest sense, in order to promote the possibility of developing work programmes and to connect with each individual's previous life. Antonio (2020) stated that the concept of Active Ageing demonstrated the importance of policies and programmes to improve the quality of life of the elderly in an ageing society.

The hot spots of China's Active Ageing research mainly focus on the combination of medicine and nursing, mutual care, education, and social participation of the elderly. Its future research hot spots tend to be the construction of evaluation standards for Active Ageing, Artificial Intelligence-enabled Healthy Elderly Industry, and Internet plus Elderly Social Activity Participation (Gong et al., 2022). Few research has been conducted on the connection between Active Ageing and elderly furniture. There is still less concrete implementation and related research in practice concerning this issue. This research, therefore, tried to explore the significance of creating an Active Ageing society from the perspective of elderly-friendly furniture.

The content of Active Ageing research mainly includes four aspects (Tong, 2017) (1) denying the traditional negative view of ageing, (2) establishing a theoretical and policy framework for Active Ageing, (3) promoting Active Ageing policies and practice, and (4) condensing the core value elements of Active Ageing.

Active Ageing challenges negative theories of ageing that see the elderly as passive dependents (Walker & Zhu, 2023). China's 14th Five-Year Plan has explicitly promoted "Active Ageing" as a national strategy, which is a higher-level policy implementation of the concept of "Active Ageing".

2.5.2 The Role of Active Ageing Society

Changing social cognition. One of the roles of an Active Ageing Society is to change the public mindset of the society. First, there should be a better and more clear understanding of ageing. Population ageing is an objective trend of social development and is neither a problem nor a crisis. The emergence of ageing is consistent with the post-industrial and the information society, which means that human development has entered a new historical stage. Issues that emerged as a result of the demographic transition and development as well as economic and social restructuring, such as low birth rate, increasing labour prices, and the problems of elderly support, are not the problems of ageing themselves. Secondly, it is necessary to see the elderly in an accurate manner whereby there is a need to change the misconceptions concerning the elderly. The elderly are not a burden to society, but rather a participant in social construction, and most of them are energetic old people rather than the stereotype of old, weak, sick and disabled and socially disadvantaged groups or vulnerable groups.

Eliminating institutional barriers. The second role of an Active Ageing society is to remove institutional barriers. This refers not only to the Government and society who are actively providing materials and service securities for the elderly, but also emphasises on the empowerment of the elderly, provides institutional and policy support for their participation, enhances their ability to participate in society, and provides opportunities for them to participate in society. More obvious evidence is shown in age discrimination in job markets, which reduces the labour participation of the elderly, and to some extent constitutes access restrictions and infringement of their rights. Secondly, in reality, the intelligence gap caused by the lack of digital skills prevents older individuals from exercising their legitimate rights and is not conducive to enhancing the abilities of the elderly to participate in society.

Active Ageing could help build platforms and create opportunities for elderly with working abilities, especially in industries where the proportion of elderly employed is high, and actively develop new modes and channels for their re-employment. On the basis of voluntary participation by the elderly, and on the condition that their health permits it, the participation of retired elderly in social services should be encouraged, thus combining a sense of fulfilment with a sense of well-being in their old age.

Enhancing health management capacities. The third role of Active Ageing Society is to improve health management ability, and one of the concepts of Active Ageing is to utilise in, use up, and to break through the mindset that feeding up and nursing up are to respect the elderly. "Respect for the elderly" refers to the act of encouraging their social participation. Old age is only a natural transition period from middle age to old age. Active Ageing aims to develop education for the elderly through communities, individuals, families, and groups. It focuses on home life, transport and travelling, medical care, consumption and payment, and other high-frequency daily life scenarios, and to strengthen information technology skills training, so as to eliminate the "digital gap for the elderly". It is also necessary to promote healthy living and fitness for the elderly, and to carry out a wide range of activities for cultural and sports exchanges among the elderly, so as to promote voluntary health.

2.5.3 What is the Expectation of Active Ageing Society

Active Ageing Strategy, as defined by the World Health Organisation (2002), is a strategy aimed at improving quality of life for the elderly, with the aim of implementing policies in the three main areas of health, participation, and security. This leads to a policy framework for Active Ageing which consists of three main support systems.

A. Health. Health refers to the perspective of the entire life span and emphasises the recognition of citizen' rights by society to receive full and equal opportunities and treatment in all aspects. It also refers to the maintenance, to the greatest extent possible, of the individual's independence, well-being, and dignity. Governments should provide a comprehensive range of health services, including health promotion, health care, health education and health care services. Individuals are expected to adopt healthy lifestyles and take care of themselves in order to minimise illnesses associated with ageing, thereby building a quality health service system that meets the basic needs and fundamental rights of individuals.

One of the most fundamental conditions for participation is the good health of the elderly.

B. Participation. This refers to the context of society reducing and eliminating discrimination against older citizens by safeguarding their basic rights and legitimate interests. This is done by engaging in education on ageing, providing appropriate and equal work opportunities. At the same time, the whole society acknowledges the unpaid contributions made by elderly citizens at home and supports their responsible participation in political, and voluntary activities, as well as other related activities. Therefore, the elderly are regarded as active participants in society, and efforts are made to create a social climate of respect, love, and honour for the elderly and "Active Ageing". At the same time, the elderly could continue to contribute to their families, communities, and societies besides achieving self-esteem by making use of their accumulated knowledge, skills, and experience in accordance with their abilities, needs and preferences.

Participation is an internal motivation and an important way to promote Active Ageing. Human beings are social creatures, and their social nature determines that they should not be solitary but should take the initiative to participate in various social activities.

C. Security. This refers to the provision of social, economic, and physical security needs and basic rights of the citizens in the process of ageing. Governments guarantee that the protection, dignity, and care of the residents in situations where they are unable to maintain and protect themselves, through the provision of basic social security and services, crisis relief, consumer protection and social justice. In addition, society and families provide the elderly with a series of indirect safeguards, including income support, family support and medical care, safety, and rights, through creating an environment of social equality and intergenerational solidarity, so as to enable older people to live a life of dignity.

Security is the goal of Active Ageing. A secure and healthy life would enable individuals to participate more effectively in social activities. Meanwhile, the understanding of security should be broadened beyond traditional material security to include medical and even psychological security.

From the contents above, it could be understood that Active Ageing seeks to maintain the physical and psychological health of the elderly and emphasises on the establishment of a sound social security system to improve the level of government public services, so as to create an excellent environment for the elderly to participate in public affairs. At the same time, it also emphasises that the expertise and experience accumulated by the elderly should be regarded as valuable social resources, so that the image of the elderly could be transformed from passive recipients to valuable resource in society. In other words, in contrast to traditional ageing, the concept of Active Ageing combines social protection with

social participation. It reinterprets the meaning of ageing by giving older individuals the rights to participate in public affairs and social development. Active Ageing also raises the understanding of the welfare of older members from social protection to the need for social participation, self-development, and self-fulfilment, so as to achieve a healthy and sustainable development of ageing.

In terms of the relationship between the three components, "health" is the foundation for achieving Active Ageing. "Participation" is a prerequisite for Active Ageing, because even if the elderly have a lot of knowledge and valuable experience, they would not be able to participate in the development of society and realise their value if they are unable to do so. "Protection" is the fundamental guarantee for active ageing. Since older people are still a vulnerable group in society, their basic social rights should be guaranteed in the process of their participation in society, so as to eliminate their concerns.

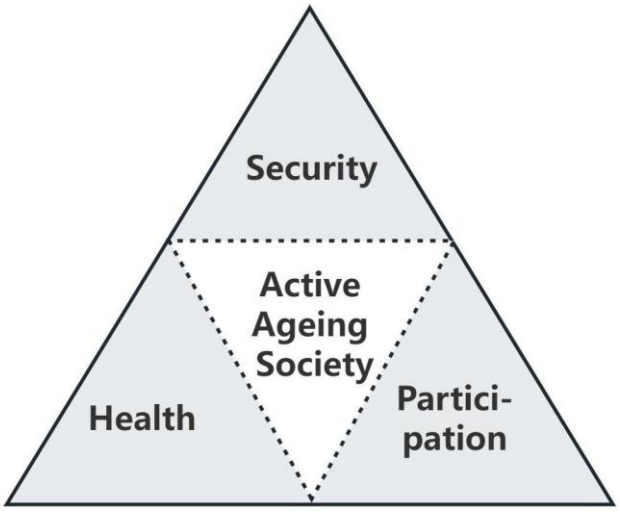


Figure 2.5: Relationship between the "Three-pillar" of Active Ageing Society

In short, the main expectations of Active Ageing are a comprehensive elderly citizen's security system based on "health", "participation" and "protection", focusing on the realisation of elderly's rights, and the construction of a security system for the elderly. Thus, the contribution of the elderly to economic and social development is emphasised. This target is the best way for the elderly to be truly healthy, participate in social activities and obtain old-age security, thus constituting a "three-pillar" system of ageing as shown in Figure 2.5.

2.5.4 Elder-friendly Home Furniture for Active Ageing Society

The World Health Organisation (2002) has also proposed six components of Active Ageing based on the three support systems for Active Ageing, namely health and social service, individual behavioural, individual physical and mental, physical environment, social environment, and economic factors.

The physical environment serves as one of the most important influences on Active Ageing. Chrysikou (2016) suggested that environmental factors such as urban planning, architectural design and other environmental factors are closely related to Active Ageing. Hence, improving basic living facilities could help promote active and healthy ageing. He also pointed out that the concept of Active Ageing should be integrated into the education of architecture, design, and other disciplines in order to strive for the creation of an age-friendly living space.

The World Health Organization has also worked with a total of 35 cities from developed and developing countries to produce the Global Age-Friendly Cities Guide and the List of Essential Characteristics of Age-Friendly Cities (2010), which identifies eight characteristics of age-friendly city that provide a reference standard for self-assessment in

building Active Ageing communities. The characteristics are outdoor space and architecture, transport, housing, social participation, respect and social inclusion, civic engagement and employment, communication and information, community support and health services (Plouffe & Kalache,2010).

The EU, as the world's proactive organisation in promoting the practice of Active Ageing policies, in 2012, through the Declaration on the European Year of Active Ageing and Intergenerational Solidarity, proposed policy actions for Active Ageing. This policy covers the three areas of employment, social participation, and independent living. Independent living includes four actions such as (1) health promotion, (2) disease prevention, (3) adapted housing and services, (4) accessible and affordable transport (European Commission, 2020). It also set out the five principles of active ageing policy: independent living, participation, care, self-fulfilment, and dignity.

Both the UN and the EU policies on Active Ageing have included the living environment of the elderly as an important element and have advocated the creation of age-friendly living environments in order to create an Active Ageing society. An age-friendly environment not only provides comfort and convenience, but also promotes social interaction, physical and mental health, and even self-awareness among the elderly.

Furniture for the elderly is an important part of the home environment, accompanying them from day-to-day and playing an important role in creating an Active Ageing society. By designing and providing furniture that are suitable for the elderly, it is possible to create an environment that supports healthy, comfortable, and independent living for them. It is also to tap into the potential of the elderly to ensure dignified ageing and promote the

construction of an Active Ageing society. Therefore, it is necessary to consider the needs of the elderly and design furniture that fits them.

According to Maslow's hierarchy of needs, human needs could be divided into five categories with hierarchical relationships: physiological needs, safety needs, love and belonging needs, esteem needs, and self-actualisation needs (Maslow, 2008). Specifically for furniture, these needs could be met through appropriate design elements. For example, physiological needs could be met by ergonomic designs, furniture structure and material, functional design, etc. Safety needs could be achieved through solid and safe, smooth edge design, while love and belonging, respect and self-actualisation needs could be achieved through interaction design, colour and vision, emotional design, etc.

Under the Active Ageing policy, the concept of old age has also undergone significant changes, and the needs of the elderly are multi-levelled and has diversified characteristics, which includes the basic needs of daily living, lifestyle, medical and health care, skills guidance, information security, as well as the high-level needs of social and emotional, respect and realisation of self-worth. With the Active Ageing policy framework consisting of the three support systems of "health, participation and security" proposed by the World Health Organisation, the furniture needs of older people could be assigned to the appropriate framework and the design approach could be used to address these needs and achieve an active response to population ageing.

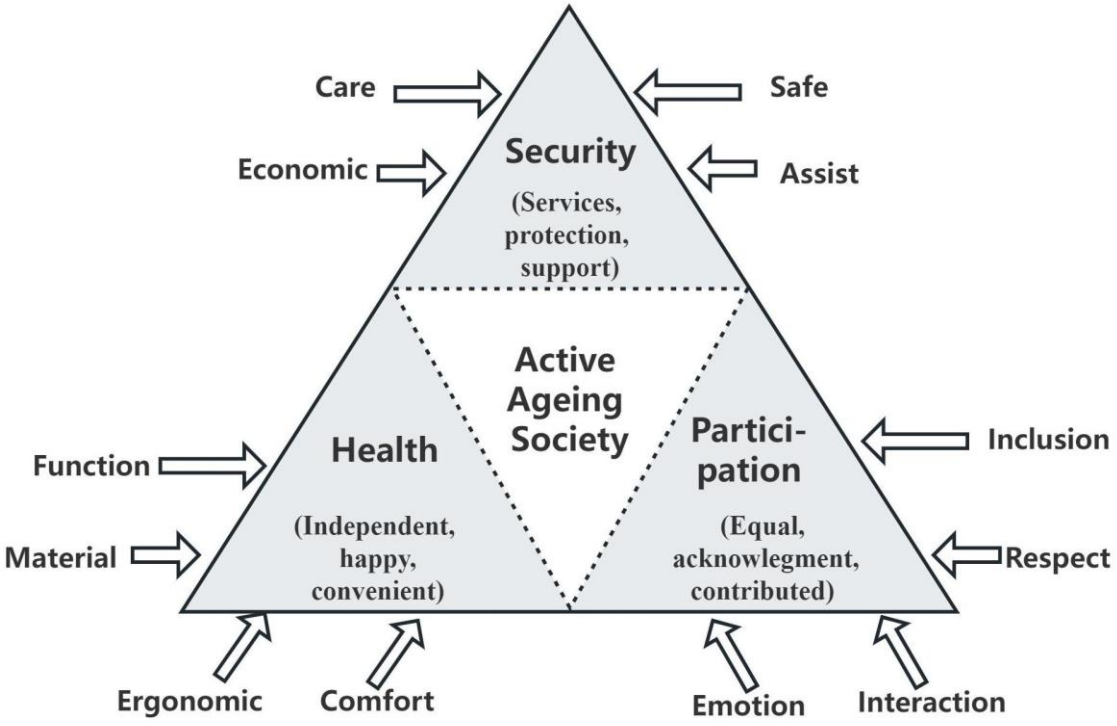


Figure 2.6: Design Approach to Meet Active Ageing Society

2.6 Chapter Summary

This chapter discussed the literatures related to the research and was divided into five main sections.

The first section was the introduction, which presented the idea of the literature study.

The second section, by analysing the history of the development of design in the world, pointed out that the innovation of technology and the change of design service objects were the two main driving forces for the development of design.

In Section Three, the classification of furniture was reviewed from the design and the market perspective respectively. Through Kotler's market segmentation theory, the

segmentation of the Chinese furniture market was further summarised. This study focused on the East China market, represented by Shanghai, which is representative and has market value.

Section Four, which clarified the definition and classification of Elder-friendly Home Furniture and pointed out that in this research, EHF refers to the furniture designed for Self-helping Aged People and Device-helping Aged People over 60 years old, who adopted home-based ageing, community-based ageing, and was suitable for the home scenario. Classify EHF according to home space scenarios.

Through the compilation of research on EHF, it has been identified that the research gaps included fewer comprehensive solutions, less practical research and less research related to Active Ageing.

Section Five presented the definition of an Active Ageing society, the role of Active Ageing in the light of the WHO framework and the policy perspective of the EU. The expectation of Active Ageing Society is Health, Participation and Security. This expectation has been specified in the field of elderly furniture. A conceptual model of EHF was proposed.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The aim of this study was to propose a suitable Elder-friendly Home Furniture (EHF) design approach to meet the demands of the elderly in China and to verify the feasibility of this approach. To achieve this aim, the research objectives of this study were divided into the following four specific research objectives:

i. To investigate current situations and challenges of EHF.
ii. To analyse the core elements of EHF design according to the above investigation based on questionnaire for the elderly.
iii. To recommend a developing design approach for EHF.
iv. To evaluate consumers' perceptions towards the proposed design approach.

The research methods adopted to achieve these research objectives were determined by the characteristics of the research subject itself.

This is problem-oriented research which focused on issues that existed in furniture using by the elderly. This coincided with the Research Objective1, whereby there was a need to identify the current situation and challenges related to elderly furniture. To achieve so, it was necessary to conduct field investigations. This was done through the field investigation on elderly furniture manufactures and retail shops in shanghai. In addition, secondary information was also obtained by analysing previous research on the elderly furniture market and enterprises.

The Research Objective 2 explored the core elements of EHF design. It was necessary to have a clear understanding of the behavioural habits of the elderly in place, including their physiological and psychological characteristics and their demands for furniture. Therefore, questionnaire survey, in-depth interview and observation were adopted to obtain the above information, 246 participants residing in the Shanghai 3 communities were chosen randomly, among them, 9 interviewees and 2 observed people were selected from different communities. At the same time, library and desktop were employed to obtain second hand information about physiological and psychological condition of the elderly, which could be used to support the findings from the questionnaires and interviews.

Based on the data from the first two objectives, the proposed design was created using 3DMAX for visualisation and VR technology simulating the real environment of the kitchen, so as to achieve Research Objective 3.

Last but not least, Research Objective 4 was to evaluate the elderly perceptions towards proposed design approach. This was done through the use of another set of questionnaires which was designed to collect the elderly's acceptance and suggestions. This feedback was an important basis for verifying the feasibility of the design approach and provided direction for subsequent research.

3.2 Design Research Methodology

The detailed research methodology flow chart below is based on this study's research objectives:

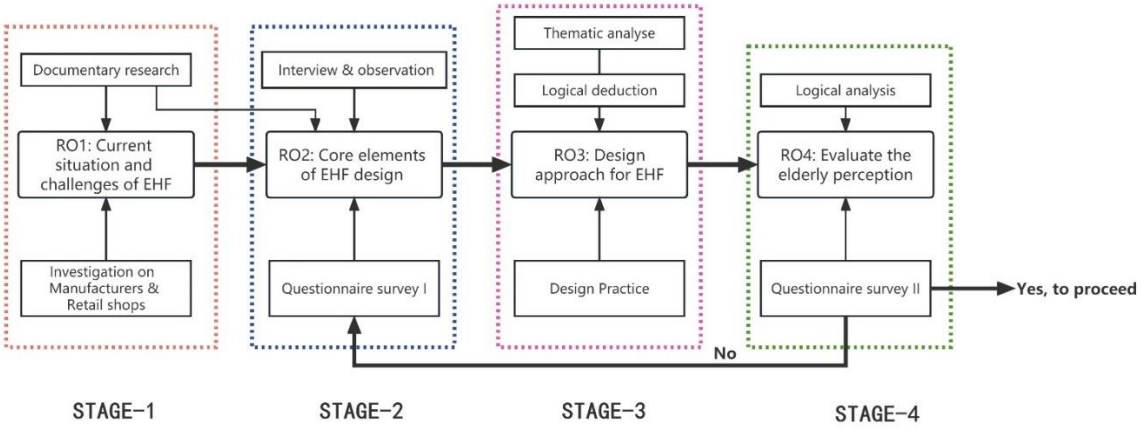


Figure 3.1: Research Methodology Flowchart

With China's ageing population becoming more and more serious, the elderly have become a group that needed attention. Due to the influence of traditional ideas and social environment, elderly people in China were reluctant to change their original living place after retirement. The furniture within their households were basically the ones which that obtained when they were younger, thus the furniture could not meet the needs of their changing physical functions which were gradually deteriorating with age. Therefore, it was necessary to understand their needs and requirement, by analysing the main problems in their daily usage. One of the many reasons for the lagging development of elderly-friendly furniture was that the exclusive needs of the elderly were not clearly defined. Therefore, through questionnaires and interviews, the core elements of the elderly furniture were identified, so as to propose a furniture design approach which was suitable for the elderly.

3.2.1 Research Participants

The elderly in this study referred to people who were aged 60 and above (Law on the Protection of the Rights and Interests of the Elderly, 2018). They were divided into three categories: Self-helping Aged People, Device-helping Aged People and Under Nursing

Aged People (Building Design Code for the Elderly,1999), which also coincided with the three ageing stages of the human body and has different elderly requirements for different furniture.

The Self-helping Aged People were those who could take care of themselves and the main consideration of furniture for them was about appearance, material, and comfort, while the demand for assisting functions was not high, simple changes such as lowering work surface and adjusting the softness of the cushions could meet their requirements.

The Device-helping Aged People were those limited in their ability to take care of themselves and relied on assisting devices. Therefore, the first thing which needed to be too considered was the assisting function of the furniture, such as handrails, wheelchairs, and crutches to complete self-care. The auxiliary function of the furniture should be considered first, followed by the appearance.

The Under Nursing Aged People were those who were completely incapable of taking care of themselves, mainly relying on others to look after them, thus the furniture was used less frequently (Luo Shan, 2016). The daily activities of the Under Nursing Aged People were mainly focused on the bedroom and toilet. The bed was one of the most frequently used furniture, while the use of other furniture was significantly reduced. Eating, going to the toilet and other activities might be completed on the bed, which required the auxiliary facility to roll up to complete the corresponding behaviour. It should be pointed out that this type of elderly was highly dependent on their caregivers, so the demands of the caregivers on furniture should also be considered.

China's “9073” Pension plan which refers to 90% of the elderly stay at home, 7% enjoy community care services and 3% at nursing institutions, as well as the traditional

concepts has resulted in most of China's elderly preferring to live at home, until they became Under Nursing Aged People. They would then enter the nursing institutions, and the nursing home lifestyle is very different from the home lifestyle. There should be a separate study on this category of elderly because their furniture would be classified as commercial or institutional furniture for the elderly. Therefore, the research participants for the current study were the Self-helping Aged People and Device-helping Aged People because they form the majority of the elderly living in China.

It should be emphasised that ageing is a gradual process and that the needs of the Self-helping Aged People, and Device-helping Aged People are not the same, therefore furniture design should be forward-looking and flexible.

3.2.2 Determination of Research Geographical Area

Shanghai, China was chosen as the research geographical area for this study because of the following reasons. Firstly, it is the city with the most serious ageing degree in China, it is the most ageing city in China, both in terms of urban and rural population (Xiao et al., 2024), in addition, as mentioned in chapter1, it is characterised by deep ageing, small family structure and empty nesting. It has entered the ageing society since the late 1970s and currently, the ageing rate has exceeded 30%. Its ageing situation represents the trend of ageing in China, and in a few years' time, other cities would go through similar process like Shanghai.

Secondly, the researcher lives and works in Shanghai. In recent years, the researcher has been engaged in research on ageing-friendly retrofitting and has undertaken a number of research projects from the Shanghai Municipal Government and was familiar with the current situation and history of retrofitting in Shanghai.

Third, with the opening of its port in 1843, Shanghai has been significantly influenced by Western ideology and culture. This has resulted in the undergoing evolution of the traditional family concept in Shanghai. The intergenerational relationship was gradually weakening, and the family structure was becoming increasingly de-core and de-intergenerational, which represented the ageing trend of the population in majority cities in China.

3.2.3 Case study: Kitchen Cabinet

In this study, kitchen cabinet was selected as the research subject, which was representative of the operating furniture. This was because there were many kinds of furniture, which could be divided into sitting and lying furniture, storage furniture, leaning furniture, display furniture, and operating furniture according to functions, and each category could be subdivided into many types of furniture. Here, operating furniture refers to furniture to help people to complete household chores in home scenario, for example, kitchen cabinet, laundry cabinet. In order to conduct this study within the stipulated time, only one type of furniture was the focus.

Secondly, the kitchen cabinet is the basic home furniture that could help the elderly to achieve necessary activities at home. It also met the requirements of the elderly in terms of home activities and functions such as storage, housework and even for display. It is a representative of a single product for home furniture.

Thirdly, the purpose of this research was to propose an optimal design approach for elderly furniture, which could be extended to other categories of furniture. This should then be a general design approach suitable for all EHF, so as to activate the market of elderly furniture, and provide technical support for furniture manufacturers, the elderly, and the

relevant authorities. One representative furniture was enough to illustrate the research progress, and which was easy to go in-depth.

3.3 Research Approach

3.3.1 Documentary Research Method

The documentary research method was done to gain an understanding of the scientific recognition through the study of literature. Specifically, this was done through the collection, identification, organisation of literature, and study of literature to form a scientific understanding of the reality, which was a traditional yet vital method of scientific research. The general process of documentary research method consisted of five basic processes, namely: proposing a topic or hypothesis, proposing a research design, collecting literature, organising the literature, and conducting literature review.

In this research, documentary research method was one of the important methods used to answer RQ1 and RQ2.

i. Research ideas

Existing research materials on elderly furniture were collected, identified, and collated. These research materials included journal articles, newspaper literature, dissertations, published books and internet publications, etc. This was done to comprehend the current status of research on this subject matter and to compile related literature review. Besides that, this step was also necessary to collect the current situation of elderly furniture market and the challenges it was facing, as well as to discover the physiological, psychological, and behavioural characteristics of the elderly. This would serve as supplementary information to the results of the subsequent field investigation and

questionnaire survey. These materials would also be coordinated and verified with the primary source of information.

ii. Research tools

Domestic and foreign literature were collected through different leading academic platforms, including CNKI, Cqvip, Wanfang database and Baidu Scholar for domestic platforms, as well as Web of Science, Google Scholar for foreign platforms.

iii. Research process

To obtain information related to the “Research Ideas,” the researcher selected keywords such as "elderly furniture, ageing furniture, age-friendly furniture, elderly home products, elderly furniture design, elderly furniture research", which were then entered into the Chinese and English academic platforms respectively, and the search results were then arranged according to the relevance of the literature.

The collected information was then identified and classified into themes such as the authenticity of the market of elderly furniture and the needs of the elderly. By using Zotero software, the researchers grouped the data according to three categories: literature review, market for elderly furniture and characteristics of the elderly, in order to answer RO1 and RO2. Figure 3.2 summarised the documentary research process:

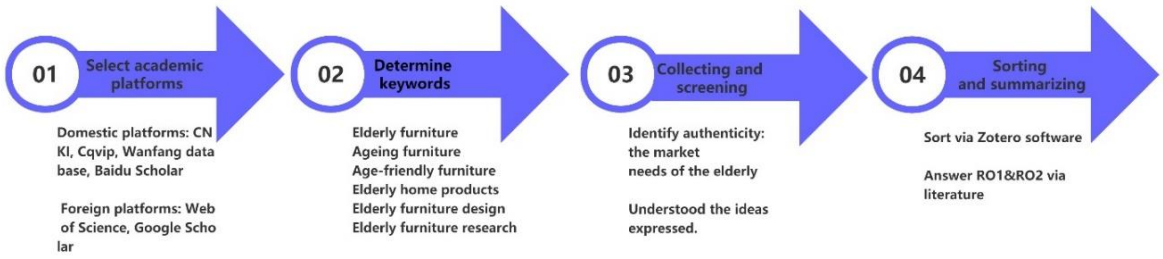


Figure 3.2: Flowchart of Documentary Research Process

3.3.2 Field Investigation Method

Field investigation method, also known as fieldwork study, is a widely used research method. Its application in the field of humanities began in the field of Anthropology and later became an important method for scholars in various Humanities field to collect first-hand information and understand the nature of human beings. It advocates the spirit of seeking truth from facts, with the ultimate goal of finding the truth, discovering the law, establishing the idea of humanism, and realising the dialectical unity of science and value, commonality, and individuality (Li, 2015). One of its most important methods is participant observation. It requires the investigator to spend a period of time with the subject to observe, understand, and know their society and culture. Field investigation could be divided into five stages: preparation stage, beginning stage, investigation stage, writing research report stage, additional investigation stage.

In this research, field investigation method was used to answer RQ1.

i. Research ideas.

In this study, the field investigation method was mainly used to obtain information on the current situations and challenges faced by elderly furniture manufacturers and the market for elderly furniture.

There were two focuses in this step, namely elderly furniture enterprises and elderly furniture market. For the first focus, it included contacting elderly furniture enterprises to gain more information about their product lines, marketing strategies, sales channels, market shares, and other information, as well as the enterprises' recognition and prediction of elderly furniture, and the main challenges they were currently facing.

The second focus, which was on elderly furniture market investigation, included visiting the main furniture malls in Shanghai to learn about the share and sales of elderly furniture products, product deficiencies and opportunities, as well as collect feedback from the retailers.

ii. Research tools

Photographs, videos, audio recordings, and notes were the essential data which needed to be gathered in fieldwork. Therefore, the tools required in the field included laptops, digital cameras, voice recorders, notebooks, and other related devices.

iii. Research process.

In this field investigation, research was carried out using the following procedure: (1) selecting investigation objects, (2) designing investigation contents, (3) conducting investigation, (4) writing investigation report, (5) additional investigation (if necessary).



Figure 3.3: Flowchart of Field Investigation Method Process

For the investigation on elderly furniture enterprises, the following leading enterprises in Table 3.1 were selected as the research objects. These enterprises consisted of domestic enterprises in China, and agents of foreign brands in China. Their selection was based on the China Elderly Service Report, leading online sales platforms such as Taobao, Jingdong, Little Red Book, etc, and elderly home furnishing exhibitions.

Table 3.1: Elderly Furniture Enterprises Selected

Domestic enterprises	Foreign brands in China
Guangzhou Yongai	Britain SIDHIL
Shanghai Yiju Yige	Germany Tekvorcare
Poly Heping	Japan Fujiejia
Shanghai Muheng	Japan Paramount
Zhongjian Fu	America Newport

The domestic brands are located in Shanghai, Beijing, and Guangdong Province, which are the most economically developed regions in China, and could represent the highest level of China's elderly furniture. The foreign brands are from the United Kingdom, the

United States, Germany, and Japan, which are the most developed countries in the ageing industry in the world and could represent the international level development of elderly furniture.

i. Design investigation content

The investigation focused on product lines, marketing strategies, sales channels, market share, company perception and forecast of elderly furniture, especially major challenges they were facing.

ii. Conducting investigation

Given that enterprises often set up offices or branches in first-tier cities such as Shanghai, the researcher tried to use on-site visits where possible, and for remote enterprises, a combination of video conference, telephone interviews and website research were part of the investigation methods.

iii. Writing investigation

Writing investigation report based on the content of the investigation, including enterprise and product description, challenges and opportunities identified, etc., The report was written for research purposes.

iv. Additional research.

Additional investigations were conducted only if there was a need.

For the investigation on elderly furniture malls, the following terminal sales stores for furniture were selected as research objects. This was because they occupy a major share of China's furniture market, and most of them have sales outlets in Shanghai which is reflected in Table 3.2:

Table 3.2: Furniture Malls Selected

Ranking	Furniture mall	Brand origin	Number in China
1	Macalline	Shanghai	476
2	Easyhome	Beijng	428
3	Kinhom	Guangdong	298
4	Yuexing Furnishing	Shanghai	195
5	B&Q	Britain	51

i. Design investigation content

The investigation focused on the share and sales of elderly furniture products, product deficiencies and opportunities, as well as feedback collected from the retailers.

ii. Conducting investigation

The researcher conducted field investigations in person, observed the current situation of elderly furniture being sold, and interviewed the salespersons to learn about the selling situation as well as recorded the information with a camera.

iii. Writing investigation

Writing investigation report based on the content of the investigation, including enterprise and product description, challenges and opportunities identified, etc., The report was written for research purposes.

iv. Writing investigation

Additional research. Additional investigations were conducted if there was a need.

3.3.3 Questionnaire Survey Method

Questionnaire survey is a method of collecting information by developing a detailed and well-formulated questionnaire on the basis of which participants were asked to respond. The questionnaire is a set of questions related to the research objectives, and research questions. It is a common instrument used by researchers to collect information in social research activities. With the help of this instrument, researchers could make accurate and specific measurements of the process of social activities and employ sociological statistical methods to describe and analyse the quantities (Xiao, 1995).

Questionnaires, depending on the medium used, could be categorised into paper-based questionnaires and web-based questionnaires.

Overseas survey website "Survey Monkey" provided a web-based questionnaire survey, while in China, the "Questionnaire Network, Questionnaire Star" provided this. Due to the high popularity of mobile phone and internet among the elderly in Shanghai and considering the convenience of later analysis, this research adopted web-based questionnaire via Questionnaire Star website.

In this research, the questionnaire survey method was one of the important methods to answer RQ2.

i. Research ideas.

The participants of this research were the elderly over 60 years old, residing in the Shanghai community, i.e., the target customers of the elderly furniture. The questionnaire was divided into three parts: the first part consisted of basic information of the elderly, the second part was the current situation of the elderly's furniture use, and the third part was the

elderly's demands for the elderly's furniture. In order to match the research objects (operating furniture), the second and third parts of the questionnaire were also designed according to the scenario.

Through the questionnaire survey, this research aimed to obtain the habits, preferences, difficulties, tendencies and demands of the elderly in using furniture from the consumers' point of view, which could be used as the core indicators for the subsequent optimisation of furniture design approach.

ii. Research tools

As described above, the questionnaire for this research was distributed via web-based survey. After designing the questionnaire on the Questionnaire Star website, a QR code was then generated as shown in Figure 3.4, which could be scanned by WeChat users to link them to the Questionnaire Star webpage. It was more convenient to distribute, fill in and collect these questionnaires via WeChat since WeChat is a very popular instant messaging and social media platform in China, compared to WhatsApp.



Figure 3.4: QR Code Generated by Questionnaire Star

The use of QR code questionnaire has overcome the shortcomings of traditional face-to-face questionnaires, telephone questionnaires, postal questionnaires, and e-mail questionnaires in terms of the equipment and time used as well as environmental limitations. Participants could scan the code to attend the survey anytime and anywhere via the mobile terminal device they carry, thus greatly reducing the resistance and cost of survey participants. Through the Breakpoint Renewal Function (after answering part of the contents of participant could continue to answer the remaining contents when logging in next time), participants could also effectively use the piecemeal time of the survey participants.

Nevertheless, the researcher was always prepared with paper questionnaire in case there was a need.

iii. Research process

This could be divided into three steps: questionnaire design, questionnaire distribution and questionnaire analysis.

iv. Questionnaire design

Questionnaire I was designed for Elder-friendly Furniture and had 46 questions (see Appendix A for details). The questionnaire was divided into three parts. The first part included the basic information about the elderly, including their gender, age, income, physical and residential conditions.

The second part was on the condition of furniture used by the elderly, which aimed to understand current furniture status of elderly people, focused on the use of operation furniture according to space scenario.

The third part of questionnaire was about the elderly' demand on elderly furniture. The aim of this part was to obtain the elderly's core needs for furniture, including the dimension, structure, material, colour and so on. The questions asked in the questionnaire were based on spatial scenarios.

To obtain more accurate information about the difficulties and requirements in the process of furniture use for the elderly, the questions in the questionnaires were either ranking questions or multiple choices questions. These quantitative data could provide a more accurate picture of the core elements for furniture design. Below is an example from Questions 20 and 46 from the questionnaire:

Question 20 in Scenario-based problems – Cabinetry, is…

20) Your difficulties when using cabinetry (Ranking question, please select in descending order of difficulty)

A. Inconvenient to take item.

B. Inconvenient of cabinetry door opening

C. Inappropriate table height

D. Standing posture.

E. memory difficulty for inner items

F. shortage of storage space

G. low illumination

H. Limited making area

I. Difficulty in reaching corner space.

J. forget cooking time / electric valve and so on

K. Others (Pls indicate)

Question 46 in Scenario-based problems –Wardrobe, is …

46) Your demands for improving wardrobe design? (Multiple options, please select in descending order)

A. Adjustable division board

B. easy access to item

C. increase storage space

D. internal lighting

E. use of corner space

F. reasonable function zone

G. item visualization

H. other (please specify)

The questionnaire for this research was distributed and tabulated using the Questionnaire Star software. The scoring rules for the ranking and multiple-choice questions are explained below:

Scoring Rules for Ranking Questions. The average composite score of the options of the ranking questions was automatically calculated by the questionnaire Star system according to the ranking of the options of all the fillers, which reflected the overall ranking of the options. The higher the score meant the higher the overall ranking of the front. The calculation method used was:

Average composite score of options = (Σ frequency × value) / number of times this question was filled in.

The value of the weight was determined by the position in which the options were ranked. For example, if there were three options in the ranking, then the first position in the ranking of the weight value was 3, the second position weight value was 2, the third position weight value was 1.

For example, if a question was filled out 12 times, and option A was selected and ranked in the first position 2 times, the second position 4 times, and the third position 6 times, then the average composite mark for option A = (2 x 3 + 4 x 2 + 6 x 1) / 12 = 1.67.

Note: Here the score is related to the number of options. For example, if there were 3 options to rank, the first score would be 3 points. If there were 30 options, the score for the first place would be 30 points, and this score was not affected by the "Please select * items to sort".

Calculation of Multiple Choices Question Percentage. The multiple choices questions were calculated in terms of their percentage:

Percentage of multiple-choice options = the number of times the option was selected ÷ the number of valid answer sheets.

The number of times the option was selected refers to the number of people who filled in the proportion. For the multiple-choice questions, the percentage may add up to more than one hundred per cent. For example: 10 people filled out a multiple choices question, of which 6 chose A, 5 chose B, and 3 chose C. The percentage of those who chose A was 60 per cent, the percentage of those who chose B was 50 per cent, and the percentage of those who chose C was 30 per cent. The three percentages add up to 140 per cent.

v. Questionnaire distribution

The questionnaires were distributed by the researchers via the WeChat app in the Shanghai community, activity centres for the elderly, community parks and other channels, which are places where the elderly are often found. Considering the characteristics of wide distribution of the elderly and individual differences in Shanghai, a total of 246 web-based questionnaires were distributed. Among them, 150 questionnaires were distributed in the community, which constituted the main part of the questionnaire, and the communities were selected in the following ways.

In order to comprehensively understand the elderly in Shanghai, this study selected different types of residential communities in Shanghai to issue questionnaires, these are Community A, Community B and Community C that elderly live in. When selecting the communities, the factors taken into consideration were as follows: should represent typical model of Shanghai residence, covering different construction periods, the living conditions can be divided into good, average, and poor, should include high-rise, small high-rise and multi-storey buildings, the residence layout is representative in Shanghai, and the elderly should have a good degree of cooperation.

Table 3.3: Summary of Communities Selected

Community characteristics	Community A	Community B	Community C
Completion date	2010	2005	1988
Type of residence	Commercial community	Economic community	Demolition community/Lane
Number of households	958	570	656
Residence area (m2)	88—135	65—120	38—78
Residential layout	Apartment with 2-3 bedrooms	Apartment with 2-3 bedrooms	1-2 bedrooms without living room
lift	have	Have partly	Have not
Floors	high-rise building	Multi-floor building	Multi-floor building
Residence condition	Good: Sub-new housing, fully equipped with auxiliary facilities, good property management	Medium: Beginning to add garages, gardens, and other facilities, some with lifts.	Not good: Good location, small and old house, poor greenery, tight parking, etc.
Picture of community			
Number of older people	188	236	289
Number of older people selected	50	50	50

The communities in Table 3.3 represented the three basic types of residential models in Shanghai, which were also the more concentrated elderly communities. Due to the gradual miniaturisation of Chinese families and the fact that most young people moved out of their

original homes after marriage, most elderly were more willing to live alone in order to reduce the burden on their children, avoid conflicts arising from long-term living together and avoid interference with their own activities. Coupled with the rising prices of urban residences, the new trends in the property market also showed that small and medium-sized apartments (60-130 square metres) have gradually become the main type of residence for the elderly. This research, therefore, adopted the use of elderly furniture in small and medium-sized apartments scenario.

vi. Questionnaire analysis

Data analysis was mainly conducted using EXCEL and SPSS software. The data gathered from the questionnaire were input into EXCEL and SPSS to obtain the information of using status and demands of EHF for the elderly, and the data were extracted for statistical analysis. The analysis for questionnaire I would be discussed in detail in Sections 4.3 to 4.5.

3.3.4 Interview Method

The interview method is a research method that uses conversations between the interviewer and interviewee to understand the psychology and behaviour of the interviewee. It is also done to collect objective and unbiased factual information based on the interviewee's answers, in order to accurately illustrate the general population that the sample is intended to represent.

Common interview methods include face-to-face interview, telephone interview, individual interview, and group interview. According to the standardisation of the content of the interview, it could be divided into structured and unstructured interview. The former is characterised by a directed standardised procedure, usually with the use of questionnaires or surveys, the latter refers to free conversation without a directed standardised procedure.

The steps in the interview method for this study included designing the outline of the interview, questioning appropriately, capturing information accurately, responding appropriately and recording information. Table 3.4 describes the steps of the interview method used in this study:

Table 3.4: Steps of the Interview Method

No.	Steps	Contents
1	Designing outline	Based on the content of the study, the interviewee, to design interview outline, so as to guarantee the effectiveness of the interview.
2	Questioning	Use open-ended questions, closed-ended questions, follow-up questions, listening and confirming, and organising questions according to topics, to help interviewers obtain accurate information.
3	Capturing information	Listen attentively and confirm responses if there is any doubt about them.
4	Responding	Affirmative responses, body language, response summaries to interviewee, to establish positive interactions with interviewee
5	Recording information	Recording content of the interviews by means of audio, visual recordings, or notes

In this research, the interview method was used to answer RQ2.

i. Research ideas

The interview method, as a qualitative research method, was used in this research as a supplement to the quantitative research method, which was the questionnaire, to gather in-depth information that the questionnaire may have not captured. The researcher used one-on-one, face-to-face, semi-structured interviews, and limit the content of the interviews to

elderly cabinets. To encourage the elderly to talk, more informal questions were asked such as "What is your main activity in the kitchen? What problems in the kitchen do you most want to solve and why? How do you organise your three meals a day? (see Appendix 2 for the interview outline).

To better coordinate the quantitative research with the qualitative research, this research limit the participants of the questionnaire and the participants of the interview to the same group of people, i.e. among the elderly people in the three communities who participated in the questionnaire, three elderly people from each community were selected according to their age and physical condition, then a total of nine elderly participated in the interview, to ensure the validity and feasibility of the data.

The interviewees selected for this study consisted of those from different communities and were named as Community A (commercial community), Community B (economical community), and Community C (demolition and lane community). Those selected were between 60 to 85 years old, had clear consciousness, were Self-care or Device-care Elderly with various situations, and frequent users of furniture.

Table 3.5: Participants Selected for Interview

	Interviewee	**Ages**	**Gender**	**Physical condition**
Community A (Commercial community) 50 people	A-1	62	Male	Relatively healthy and can move around freely.
	A-2	75	Female	Relatively healthy, mildly deaf and wearing hearing aids.
	A-3	81	Female	High blood pressure, diabetes, vision and hearing decreased.

Table 3.5 continued

Community B (Economic community) 50 people	B-1	67	Female	Healthy and volunteering at charity shop, hearing and vision are good
	B-2	73	Male	Sedentary lifestyle leading to lumbar and cervical problems, presbyopia, leg weakness.
	B-3	80	Male	Retired worker, arthritis, memory problems.
Community C (Demolition community/Lane) 50people	C-1	68	Female	Retired administrative staff, no severe illness, but loss of limb strength and memory
	C-2	76	Male	Retired driver, had several operations, spends much time at home, living in isolation.
	C-3	85	Female	Elderly living alone, with gout, requiring wheelchair and crutches for assistance.

ii. Research tools

Before the interview, it was necessary to prepare an outline of the interview as a guideline. The interview sessions were recorded using an audio recorder and camera to capture the audio and visual data. Besides that, other tools which were used during the interview sessions included computer, notebook, and other relevant and necessary tools. The information obtained from the interviews were then analysed using the NVIVO software.

iii. Research process

This could be divided into three steps: interview outline design, arrangement of item analysed and data analysis. The interview outline for the elderly in Shanghai was designed and the details could be seen Appendix 2. The researcher conducted face-to-face interview sessions with the elderly in their homes or in the community centres after their noon naps

and when they were free. The interviews were conducted according to the designed outline and were limited to one hour in order to focus on obtaining information efficiently and as to not burden the elderly. The data from the interviews were then analysed in NVIVO.

3.3.5 Observation Method

The observation method is widely used in the field of anthropology and sociology as a method of collecting data and analysing them by directly observing the behaviours and traces of the subject. This is an important method which could help in understanding the human social phenomenon and its essence, as well as analysing the trend of its development and change. There are two types of observation methods: participant observation and non-participant observation (Lu & Du, 1995).

The participant observation method involves the observer entering into the living community of the subject, observing their behaviour and changes, and gathering information for analysis and conclusions. The observer should try to avoid substantial contact with the subject. If the subject knows that his or her behaviour is being observed and studied, he or she would often change his or her behaviour in response, making it difficult for the observer to obtain accurate and valid results. Therefore, participant observation methods need to consider how to reduce or eliminate reactive changes in the subject's behaviour. This could be done either by having the observer live in the subject's environment for a long period of time (weeks or even months) so that the subject becomes accustomed to the observer's activities, or by keeping the subject unaware of the observation. This method would be easy if the observer is a member of the community.

Non-participant observation method, on the other hand, means that the observer does not participate in the activities of the object of observation, while observing traces of the

object's behaviour, such as words, works, products, etc. Since the non-participant method of observation does not interact with the subject of observation, there is no issue of reactive change in the behaviour of observation.

The basic steps in gathering information through observation, especially participant observation, are as follows.

Table 3.6: Steps of Observation Method

No.	Steps	Contents
1	Preparation	After selecting the observation site and the subject, prepare to enter the site. Understand the basic conditions of the site and prepare sufficient research tools.
2	Entering the site	Familiarise oneself with the basics of the research site as soon as possible, introduce oneself to the observed person in a reasonable manner in order to minimise reactive behavioural changes, and do not infringe on academic ethics.
3	Collection of information	Ongoing observation of the subject, with video and audio recording and, if necessary, informal interviews, recorded through memories in the form of diaries, work journals, observation logs, coded records, etc.
4	Analysis of results	The information gathered by the observation method is mainly qualitative and can be analysed using conventional methods of qualitative data analysis.

In this research, the observation method was used to answer RQ2.

i. Research ideas

The aim of the observation method was to observe the behaviour, operating procedures, and even unconscious behaviour of elderly when they were using the furniture around them. These habitual behaviours, which the elderly themselves may not be aware of

and which could not be obtained through questionnaires and interviews, were an important complementary in discovering the core elements of EHF.

To obtain the above information, participant observation was considered as the best choice. This was because, the researcher could join in the research scenario by selecting the elderly in their own homes as the research participant, so that the elderly could be observed naturally and continuously in daily life. The second was to select older people whose home was equipped with a surveillance system and who were comfortable living with cameras due to the constant use of cameras for other factors such as security.

ii. Research tools

In the observation methods the researcher themselves were the research tool, which required the researcher to continuously observe, record video and audio, as well as conduct informal interviews where necessary. Therefore, to gather these data, tools such as digital camera, voice recorder, surveillance systems, notebook and computer were used.

iii. Research process

The researcher followed each participant for about one day and spent 3-6 hours recording the observed behaviour of the elderly in their homes. As far as possible, the researcher observed these participants in different spatial situations, such as the living room, kitchen, study, bedrooms, balconies and so on, taking into consideration the follow-up research which focused on kitchen behaviour. In addition, the behaviour of the elderly in different time situations, such as when the whole family was having a meal, when they were talking to friends, when they were doing leisure activities and when they were cooking, etc., were also observed. Besides that, the researcher also took the cooking times as the main

time period to be studied. The information obtained was imported into the NVIVO software for analysis.

3.3.6 Design-based Method

Design is a highly practical discipline and one of its aims is to solve practical problems in design and life as well as to innovate. Design-based method involves making changes to certain design factors under the control of the researcher to observe the changes in the designed product and verify its effectiveness. Part of the design could be carried out under experimental conditions and part must be carried out in the production environment. It is the researcher who tests, adjusts, and then develops interventions in theory to solve practical problems in practice.

Design-based research method, aims to adopt the "step-by-step" design method through the formative research process, put the initial design into practice, test the effects, and continuously improve the design according to the feedback from practice, so as to form a more reliable and effective design. It has its own set of procedures, namely "Design Purpose Analysis - Design Programme - Production and Implementation - Evaluation and Feedback".

i. Research ideas

In the case of this research, the aim of the design was to identify the gaps between the furniture for the elderly on the market and the furniture expected by the elderly, and then to find solutions to these gaps from the perspective of active ageing. On this basis, a design proposal would have been made, using sketches in the form of drawings in connection with the design theme of the elderly cabinet. The computer aided means would then be developed from sketches to effect drawings and scene demonstrations. In view of the use of the elderly

cabinet scene, this study adopted 3D modelling and VR scene presentation, which would greatly improve the intuition of the design and the experience of the elderly, and compared them with the static text, which was also more vivid and thus a more appropriate presentation method. Finally, through the questionnaire design II, the feedback of the elderly on the elderly cabinet was gathered to verify the research results.

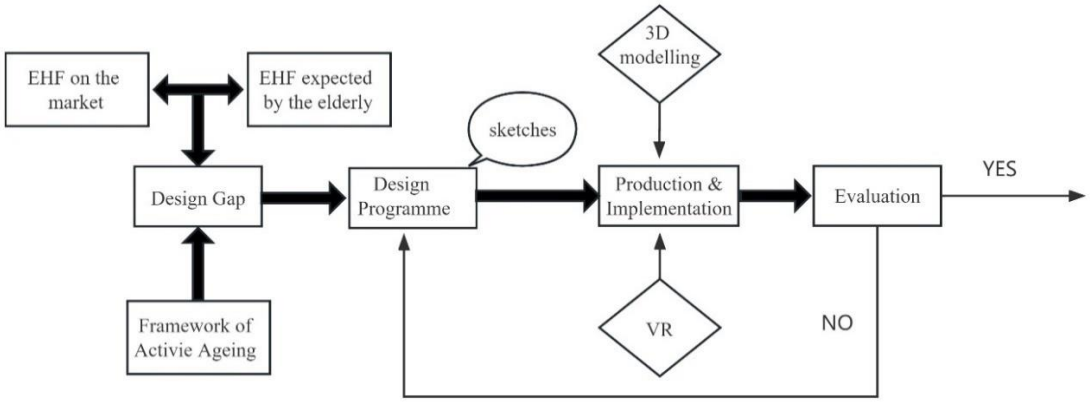


Figure 3.5: Idea and Process of Design-based Method

ii. Research tools

The design-based method required the personal participation of the researcher; hence the researcher was the main design tool. In the programme stage, drawing tools needed to be used to draw sketches, while in the production and implementation stage, the use of 3DMAX, a VR production software to present the design, and in the evaluation of the feedback stage, was needed to design the questionnaire again.

iii. Research process

As mentioned, the design-based method involved the steps of "Design Purpose Analysis - Design Programme - Production and Implementation - Evaluation and Feedback".

3.4 Chapter Summary

Chapter 3 discussed the methodological design of the research and the specific research methods used.

The research methodology design was divided into four steps. The first step was to sort out the current situation and challenges of EHF market, followed by the second step which was to analyse the core elements of EHF. The third step was to propose an optimal design approach for EHF from the perspective of Active Ageing, and finally, the fourth step was to verify the feasibility of the approach.

Based on the above methodological design, the researcher adopted specific research methods combining both qualitative and quantitative approaches, including: (1) documentary research method, (2) field investigation method, (3) questionnaire survey method, (4) interview method, (5) observation method and (6) design-based method.

The documentary research method and field investigation method were adopted to analyse the current situation and challenges of EHF market. While the documentary research method, questionnaire, interview, and observation method were adopted to analyse the core elements of EHF. To propose the optimal design approach of EHF, the design-based method was adopted. Overall, it combined the qualitative and quantitative analysis, theories, and practices, and achieved the synthesis and complementarity of research methods.

Chapter 4 will discuss the data collection and analysis based on the above-mentioned methods, targeting the challenges of EHF market and the core elements of EHF, and laying the foundation for the proposed design approach for EHF.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 Introduction

This chapter discussed the data collected and analysis used in this study. Based on the research framework stated in chapter 1 (Figure 4.1), this chapter would discuss the findings in relation to the first two research objectives of this study: Research Objective 1: To investigate current situation and challenges of EHF, and Research Objective 2: To Analyse core elements of EHF design, so as to lay the foundations for chapter 5, in which the design approach would be proposed.

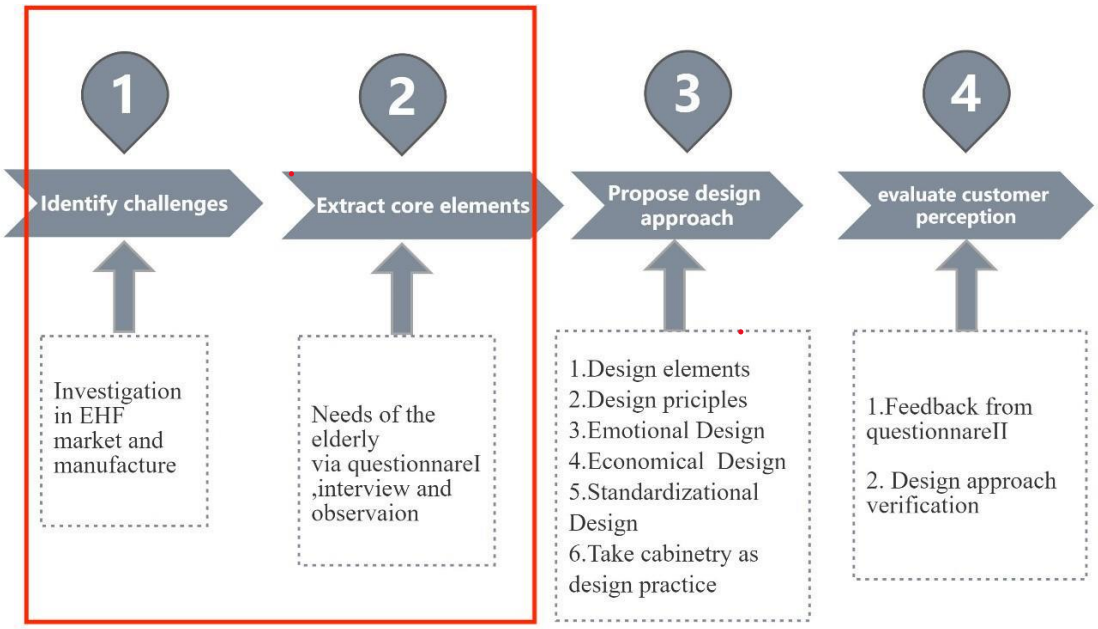


Figure 4.1: Research Objectives of the Study

To illustrate the above two research objectives, a total of four sections are arranged whereby the information in these four sections were obtained using different research methods in chapter 3. The research flowchart for Chapter is shown in Figure 4.2.

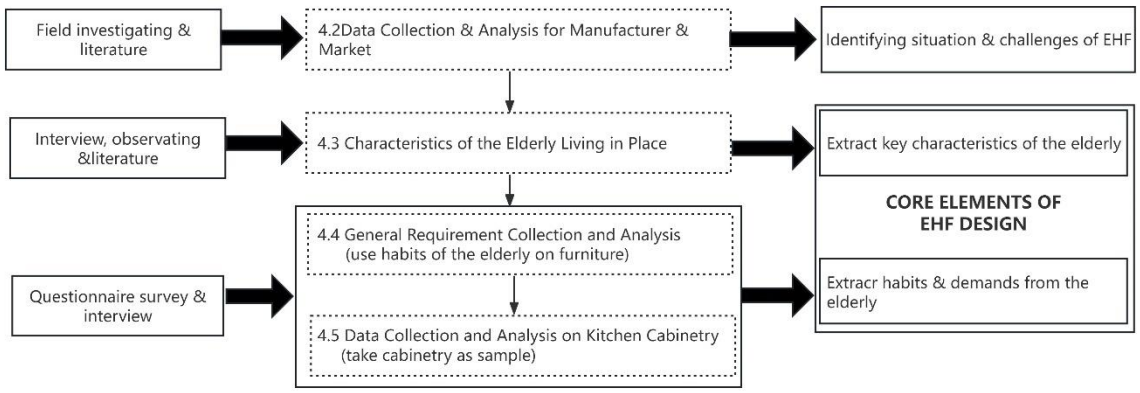


Figure 4.2: Research Flow Chart of Data Collection and Analysis

4.2 Data Collection and Analysis for Manufacturer and Market

With the increment of the ageing society, the demand for products for the elderly is bound to increase rapidly. With the development of China's elderly furniture market, companies that could participate in it would also have greater opportunities in terms of the demand for the furniture. In Shanghai, a survey was conducted on the shopping desires of the elderly, for both the elderly and their relatives. The result showed that 83% of people were interested in products for the elderly, and 12% of them had no issue with the price of the products as long as the product met the needs of the elderly. They all agreed that utility, quality and brand were the crucial elements of the products for the elderly (Shu, 2004).

However, manufacturers seemed to be less enthusiastic about this huge consumer market. Research showed that 89% of the elderly in China were not satisfied with the current

elderly products, mainly because manufacturers did not conduct accurate market research, making it difficult for them to understand the real needs of the elderly groups. As a result, the current products that could meet the needs of the elderly were both insufficient in quantity and too simple in classification (Luo, 2014). Generally, in terms of Chinese elderly products market, 60%-70% of the products are health care products (Qian, Jiang & Chen, 2014). Although there is a corresponding market, other assistive devices such as assistive walking products, functional beds and so on, the production is quite limited. Through the field investigation of furniture stores, enterprises and some of the large-scale elderly industry exhibition, it was found that there were only a handful of these enterprises dedicated to the field of elderly-friendly furniture.

In the past 10 years, academic and media circles have taken the lead in showing their concerns and desires to explore the elderly furniture market. However, China's elderly furniture market has not shown a promising situation in terms of both sales and purchases. In the building materials and home products market, various styles of general furniture and children's furniture have reached more than 90% of the market share. Young people, middle-aged people and children are still the mainstream consumer groups, elderly-friendly furniture is less and less. The development of the elderly-friendly furniture market is still at the stage of media intervention and academic research, but has not formed a truly matured market chain.

Based on the investigation objectives designed in Chapter 3, the mainstream elderly furniture manufacturers in China and abroad were investigated, and the data collection as well as analysis are detailed below.

4.2.1 Data Collection and Analysis for Manufacturer

As explained in Chapter 3, the following leading enterprises were selected as research objects and they are mainstream domestic enterprises in China which are Guangzhou Yongai, Shanghai Yiju Yige, Poly Heping, Shanghai Muheng and Zhongjian Fu. Additionally, foreign brand agents were also investigated, including Britain's SIDHIL, Germany's Tekvorcare, Japan's Fujiejia, Japan's Paramount, and America's Newport, to obtain data on the current situations and challenges in the development of EHF from the perspectives of manufactures.

At present, Chinese furniture enterprises are frantically expanding product lines in the horizontal direction to gain higher market share, but lack the competitiveness of focusing on product quality in the depth direction. In terms of new product development, furniture enterprises should not only consider market segmentation and product positioning, but also combine the guidance of national policies and the trend of consumption hot spot whereby in this case, elderly furniture is a good starting point.

There is still no strong brand in China's elderly-friendly furniture sector. The current situation of China's aging population and consumption upgrading has created a huge development space for elderly-friendly furniture. However, due to the late start of research and development, most furniture manufacturers misunderstood that the requirements of elder-friendly furniture in terms of design, production, function, etc. are much higher than those of general furniture, which would inevitably lead to an increase in cost, thus this has led them to continue focusing on general furniture. Enterprises' understanding of elderly-friendly furniture is only in terms of appearance. This has resulted in the lack of numbers of elderly furniture and professional furniture manufacturers. According to the National Bureau

of Statistics and Zhiyan Consulting Statistics (2021), by the end of 2021, there were 6,544 furniture enterprises in China. However, only a few of these companies have invested in research and development of elderly-friendly furniture and only in a few developed areas, such as Beijing, Shanghai and Guangzhou, are there specialized elderly furniture companies, but there are no strong brand-leading companies.

In terms of product lines, elderly-friendly furniture in China mainly focused on beds and sofas, while other categories were not much developed and a complete product line has yet to be formed. There are a few elder-friendly furniture enterprises, and based on the field investigation conducted, the results could be summarized as shown in Table 4.1:

Table 4.1: The Schedule of Investigation

The First Investigation			
Time	10/12/2021--31/12/2021	**Researcher**	Junli Zhang
Destination	Yongai showroom of Guangzhou Yongai Pension Industry Co, LTD Poly Hepin Shanghai branch		
Purpose	Understand their product line, marketing strategies, sale channel and major challenges they are facing.		
The Second Investigation			
Time	05/01/2022—15/02/2022	**Researcher**	Junli Zhang and assistant
Destination	"Yiju Yige", Shanghai Hujing Furniture Co., LTD Shanghai Muheng Industrial Co., LTD Zhongjianfu Health Industry Co., LTD		
Purpose	Understand their product line, marketing strategies, sale channel and major challenges they are facing.		

Table 4.1 continued

The Third Investigation			
Time	08/09/2022—15/10/2022	**Researcher**	Junli Zhang and assistant
Destination	Branches of British SIDHIL, Germany Tekvorcare, Japanese Fujiejia, Japanese Paramount Bed and the Newport of United States		
Purpose	Understand their product line, marketing strategies, sale channel and major challenges they are facing.		

i. The Yongai brand of Guangzhou Yongai Pension Industry Co, LTD

The Yongai brand of Guangzhou Yongai Pension Industry Co, LTD. mainly focuses on the integration of elderly-friendly products, including the overall solution of six categories of elderly-friendly products, such as furniture, household goods, health and bath items, intelligent system, rehabilitation care, as well as leisure and entertainment. Its furniture is mainly for nursing bed. The company's headquarters is in Shunde and has branch offices in Beijing, Tianjin, Shanghai and Guangzhou.

Cui Jingxue is the chairman as well as the chief designer of the manufacturer. In 2012, Cui Jingxue gave up the real estate industry and entered the field of senior care. He believes that senior care is a rising industry. Gradually, he puts his R&D direction into the field of home care and intelligent elderly care.

In 2018, the Yongai online medical and nursing store established an online sales chain for products, becoming one of China's largest B2B internet stores for nursing supplies. Currently, Yongai offers over 6,000 products and serves nursing institutions and rehabilitation hospitals.

Yongai is dedicated to enhance the quality of life of elderly individuals through design by enhancing social services efficiency and liberating carers from their workload, which, according to Cui Jingxue, is the true responsibility of designing products for the elderly.

Cui Jingxue considers that the current ageing products are still in the exploration of moving forward and there is need for all parties to participate in the common social forces. Firstly, a development plan and the introduction of supportive policies are needed to cultivate and encourage leading enterprises. Secondly, regulations and the establishment of industry standards would optimise the industry's development environment. The third strategy is to promote information technology strategies of ageing products, to carry out basic research, product development, and strengthen the protection of intellectual property rights of ageing products.



Figure 4.3: Showroom of Guangzhou Yongai

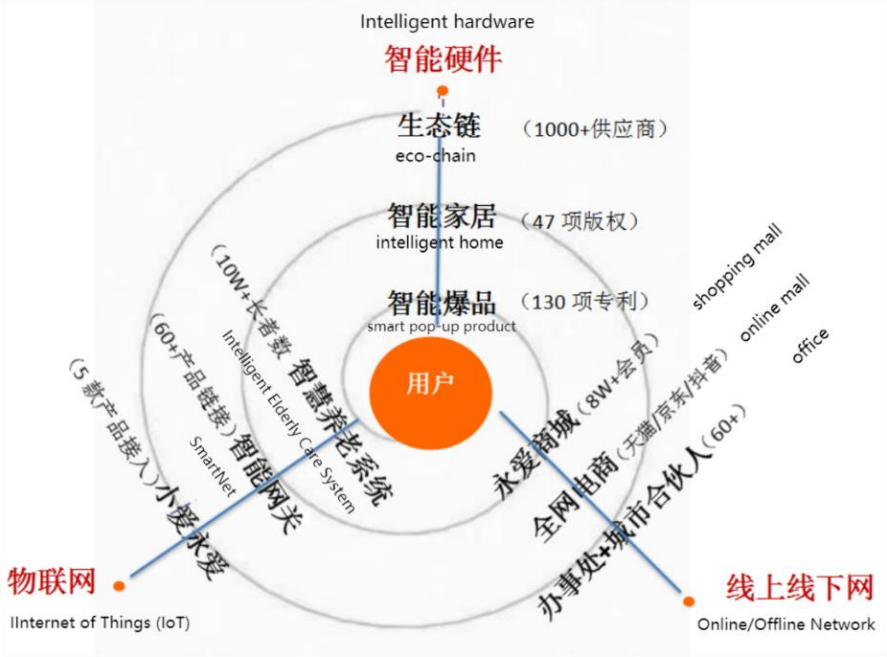


Figure 4.4: Business Mode of Guangzhou Yongai (Resources: https://www.yongaierp.com)

ii. "Yiju Yige" of Shanghai Hujing Furniture Co., LTD

"Yiju Yige" is the brand of Shanghai Hujing Furniture Co., LTD. which has a number of international experiences combined with China's national conditions and their sales target are the elderly institutions, community and elderly families. Their products focus on elder-friendly, environmental protection and nature. Currently, they have launched six ranges of medical and care furniture: "Modern Simple", "Classic American", "Contemporary Chinese", "Scandinavian Style", "Accessible/Cognitive Disability" and "Medical Office".

This brand was introduced to the Chinese market in 2014, their products are mainly sofas, whereby the wheelchair sofa was their original product, which realized position exchange between wheelchair and sofa, and it is convenient for communication. In addition, they also produced a small number of nursing beds, dining tables and chairs.



Figure 4.5: Wheelchair Sofa of "Yiju Yige (Resources: https://www.yjyg.com)

In addition, there are some Chinese furniture enterprises that have entered the elderly furniture segmentation but have limited production capacity such as Poly Hepin, Shanghai Muheng and Zhongjian Fu.

Poly Hepin is an elderly furniture brand owned by Poly Group, a large central enterprise in China. It promotes the production concept of "less is more". Shanghai Muheng Industrial Co., LTD. advocates the concept of "invisible aging design and universal design", comprehensively considers the "standing" and "sitting" problems of the elderly, using OEM production. Guangdong Zhongjianfu Health Industry Co., LTD., whose business field includes elder-friendly design and renovation, elder-friendly service and furniture, is dedicated to providing one-stop comprehensive services for the elderly, such as strategic consulting and product supply, by integrating the industrial chain. These furniture enterprises concentrate on products such as sofas, dining tables, chairs and beds, and the product types

of each category are within 1-2 digits, and have not yet to form power influences in the market.

iii. Poly Hepin

Poly Hepin's product line has four categories, namely sanitary ware / barrier-free handrails, nursing beds, elderly furniture, and rehabilitation aids. Figure 4.6 shows all its nursing beds and elderly furniture products, elderly furniture products consisting of the elderly dining tables, chairs, sofas, headboards, wardrobes, and nursing beds are for the nursing home. However, the category is limited and there are not many choices from Ploy Hepin. The service object is oriented to the nursing home, community and home setting.

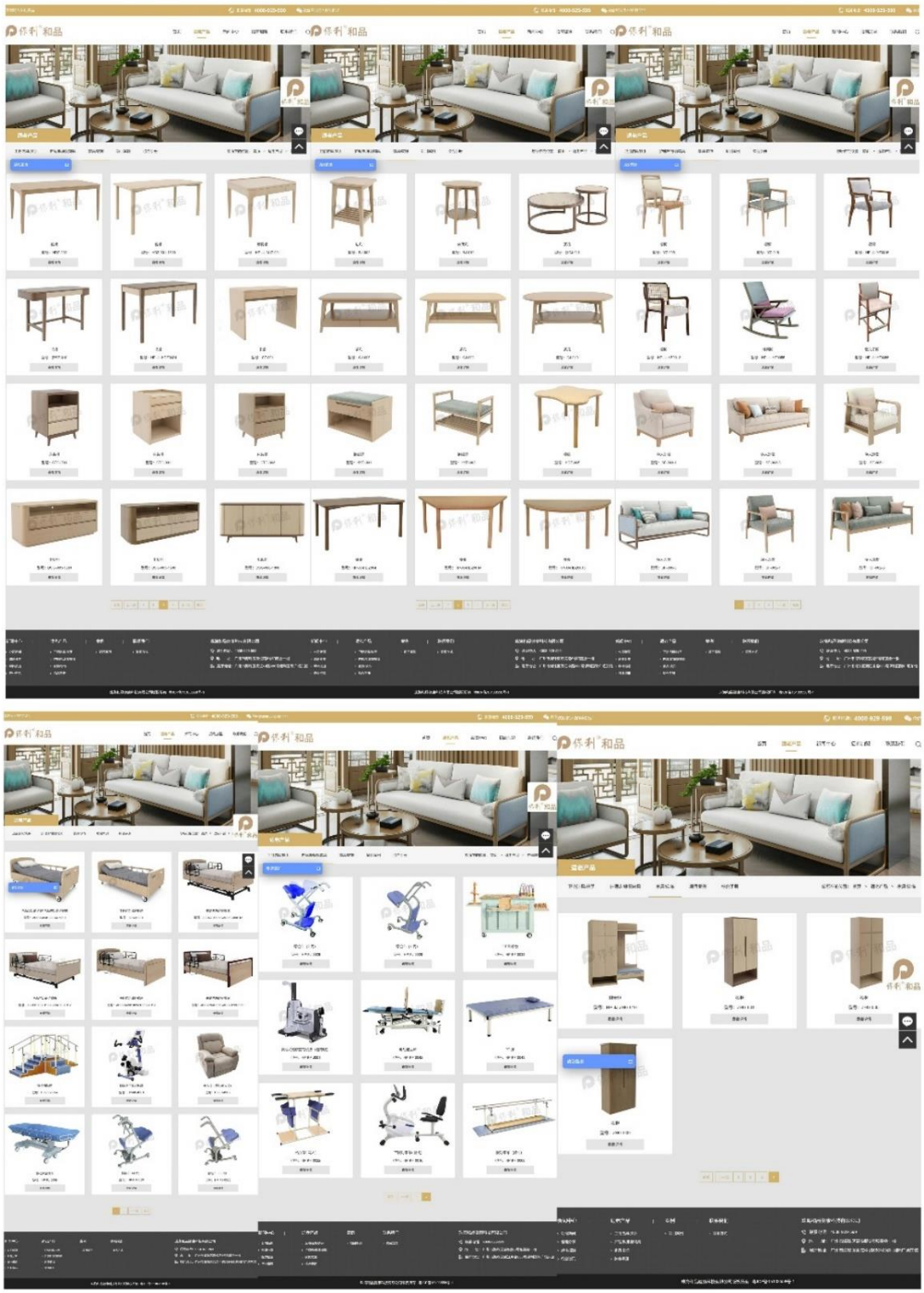


Figure 4.6: Nursing Bed and Elderly Furniture of Poly Hepin (Resources: http://www.chinahepin.cn)

In terms of marketing channels, Poly Hepin adopts B and C channels to drive together. For the B-side, they provide proposals to meet the ageing of the operating space, optimization solutions, whereas for C-end consumers, since 2022, they have opened “Jingdong”, “Tmall” and other online shopping mall, sub-product operation. At present, the Poly Hepin business has implemented the core layout of four districts, including Beijing, Shanghai, Guangzhou and Chengdu.

The general manager of Poly Hepin, Ms. Hongying Xie believes that, the problems in current market are as follows:

Lack of elderly products, and lack of supply. On one hand, the range of products available for the elderly is limited, making it difficult to meet their diverse needs. On the other hand, the supply is clearly insufficient, leaving much room for improvement in both the quantity and quality of products for the elderly. Therefore, it is necessary to strengthen research on elderly products and upgrade the variety and quality of products.

The majority of products are of low-quality. The current level of knowledge on elderly ’products is lacking, while the consumption ability is not high, and the profitability of elderly service organisations is not encouraging. This has resulted in the small number of sales of high-end products. She believes that R&D and innovation of products together with its suitability for the elderly needs investment, and systematic solutions are lacking.

For enterprises gathering at the B sales channel, the market is chaotic and competitive. At present, for China’s elderly products, there are not many professional enterprises. This often comes from the transformation of traditional furniture or established elderly-friendly segment to enter the market, to the B sales channel, which has low barriers to entry, lack of

unified government supervision, industry chaos, and low-priced bidding accounted for more than 90%.

Based on her more than ten years of practical experience in the elderly care industry, she believes that China's elderly care products industry needs the cooperation of the government, capital, designer and enterprises to work together.

iv. Shanghai Muheng Industrial Co, Ltd

Shanghai Muheng Industrial Co, Ltd was established in 2014, and its main business includes interior design and soft decoration design for the elderly, R&D, design and production of furniture for the elderly. The company's R&D centre is located in Nanjing, Jiangsu Province, while the marketing centre is located in Yangpu, Shanghai and the production base is located in Huzhou, Zhejiang Province.

Muheng adheres to the five design principles of elderly furniture: "safety, comfort, practicality, suitable for operating and aesthetical" and the design concept of "invisible ageing and universal design". Muheng has set up its own R&D workshop to sample new products and materials, standard drawings and product components, as well as OEM production. The company's customer consists of B-channel of nursing home and elderly care centres.

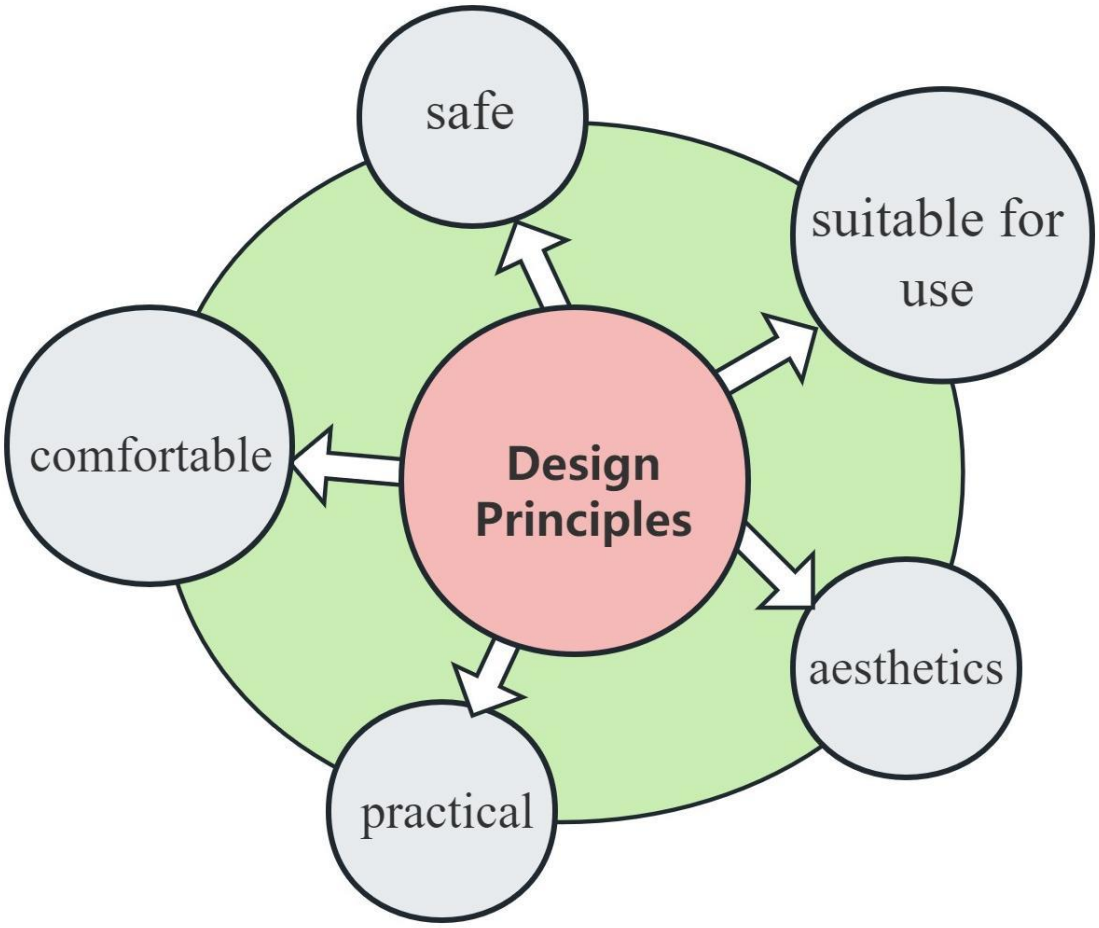


Figure 4.7: Five Design Principles of Muheng

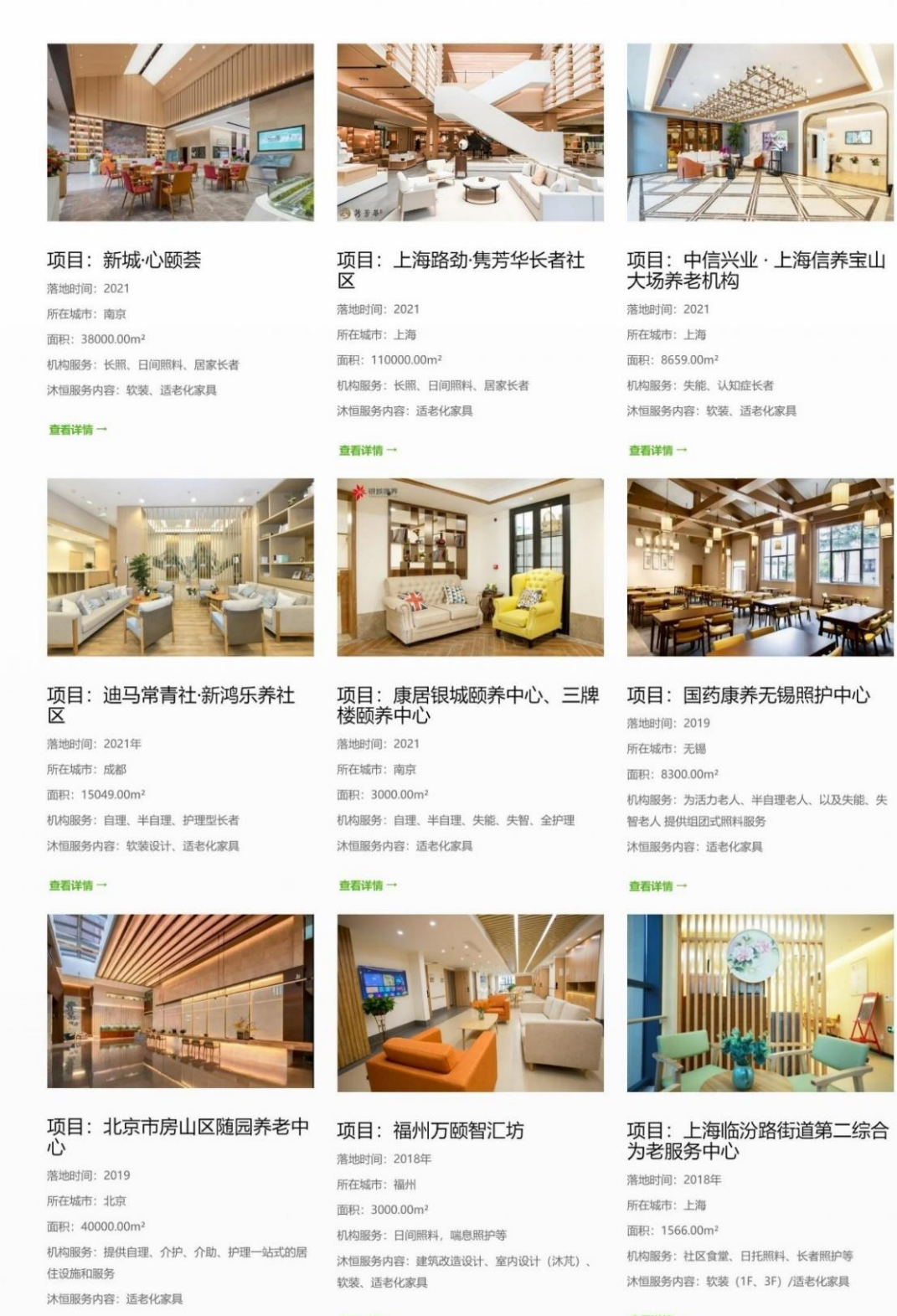


Figure 4.8: B-channel Customers of Muheng (Resources: http://www.morhome.com.cn)

Muheng co-founder, head of Muheng Furniture business segment Lu Huazhen stated that first of all, China's furniture imitation phenomenon is serious and that the elderly furniture is a new industry. Therefore, the R & D cost is high and difficult and fewer people are willing to invest in it. This, coupled with China's weak intellectual property rights protection has resulted in serious homogeneity in the furniture industry. Muheng insists on building a team and getting the parallel multi-disciplinary departments to work together. In addition, Standardized production is the most important problem to be solved in the R&D workshop.

Secondly, Muheng insists on making good products that are "suitable for the elderly and at a good price", for example, high quality and low cost. This is to create a closed loop from design, sampling, production and use.

Figure 4.9 is Muheng Furniture's showroom at No.1866 Hutai Road, Baoshan District, Shanghai and Figure 4.10 showed their participation in the International Exhibition of Senior Care, Rehabilitation Medicine and Health Care Shanghai in 2023



Figure 4.9: Showroom of Muheng in Shanghai



Figure 4.10: Muheng at Senior Exhibition in Shanghai

v. Zhongjiangfu Health Industry Co., LTD

Zhongjianfu Health Industry Co., LTD, is committed to R & D, production, sales, and service as a whole of the aging products and services as well as the aging industry chain comprehensive service-oriented technology enterprises. Its business scope covers the fields of ageing furniture, ageing products, ageing renovation, and operation services for the elderly, targeting B-channel elderly institutions, and so far, it has reached cooperation with more than 2,000 elderly institutions.

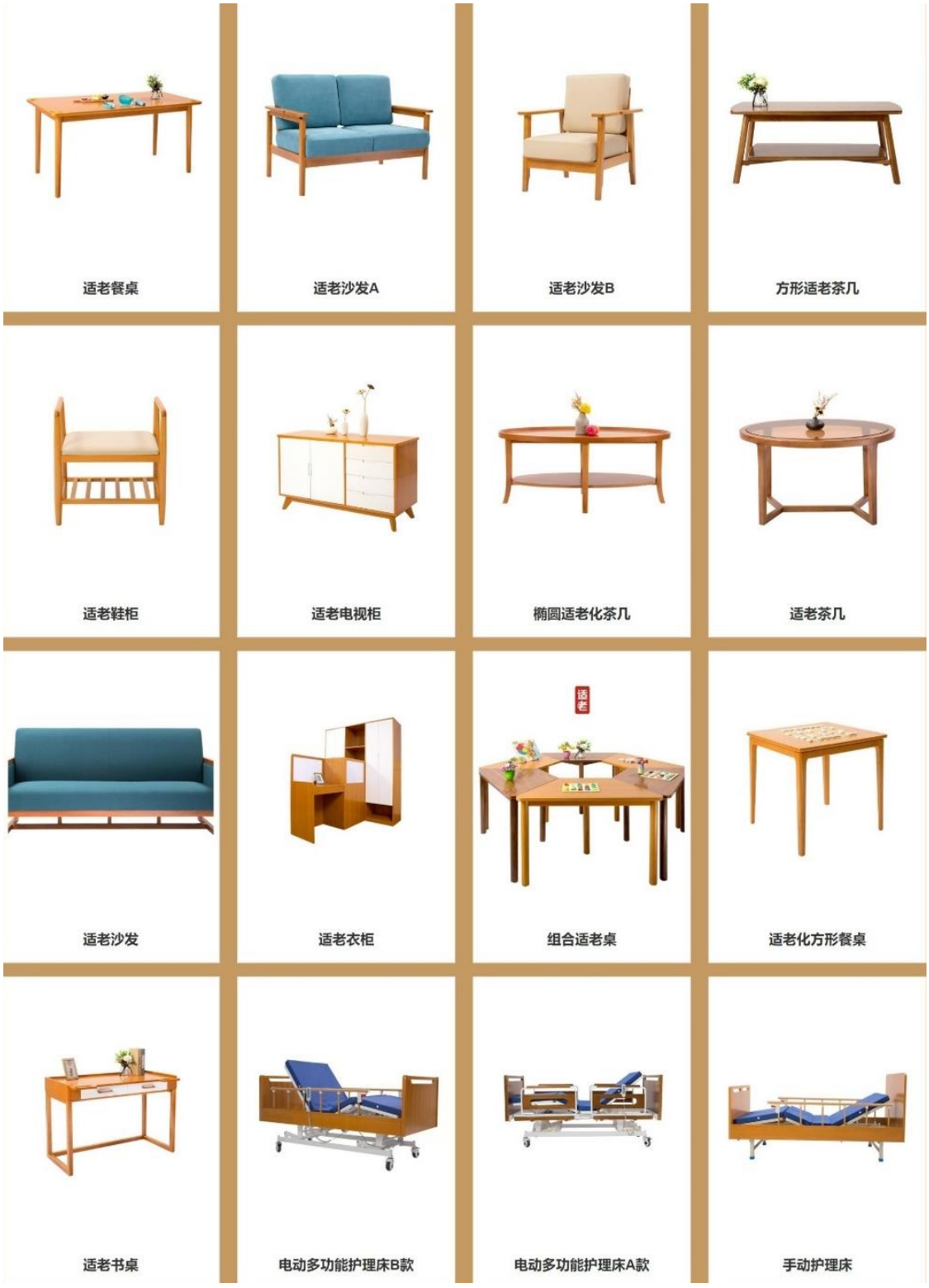


Figure 4.11: Elderly -friendly Furniture of Zhongjiangfu (Resources: http://www.zjfsl.cn/about/company.html)

Zhongjiangfu was established in 2004, primarily dealing with office and hotel furniture. In 2016, Li Zhiye, the chairman of the board of directors, well aware of the aging trend in China, decided to lay out the pension industry. In 2018, Li Zhiye found that the market demands for aging supplies was growing, and there was an urgent need to set up a research and development team to face the exuberant and pursuit of market differentiation. Therefore, Li Zhiye made a bold and decisive choice to establish the Guangdong Institute of Aging Industry. This decision served not only their own enterprises but also the entire pension industry. The Institute platform brings together colleagues in the pension circle to discuss and resolve pain points and challenges in the sector.



Figure 4.12: Showroom of Zhongjiangfu

Realising the unlimited potential of the home care market, Zhongjiangfu started to rebuild the home care segment. In 2020, a dedicated branch office was established with a focus on the renovation of living spaces for the elderly.

Zhongjiangfu holds the view that ageing-friendly products require Standardization. Their research institute has been involved in formulating several national standards, including the creation of "Basic Requirements for Ageing-friendly Retrofitting of Homes"

and the editing of "Norms for Ageing-friendly Infrastructure Configuration and Services in Homes". They believe that the design of age-friendly furniture should consider age-friendliness, ergonomics, safety, comfort, pleasure, memory design, etc., to meet the needs of the elderly in their daily lives.

In an era of an ageing population, Zhongjiangfu has focused on producing products that cater to the specific needs of older age groups. The company is committed to the belief that this market would continue to flourish.

Apart from local Chinese brands, other enterprises are foreign brands who have agents in China, including British SIDHIL, Germany Tekvorcare, Japanese Fujiejia, Japanese Paramount Bed and the Newport of United States.

vi. British SIDHIL

SIDHIL, based in Britain, is the world's oldest and most renowned manufacturer of nursing bed. The company specializes solely in nursing beds. Known for their wide range of forms and functions, these beds could be adapted to various scenarios and served an ever-changing market. In China, Zhejiang Jiaxing SIDHIL Import and Export Co., Ltd. represents the brand and is responsible for promoting the brand, selling the products, and rendering after-sales services.

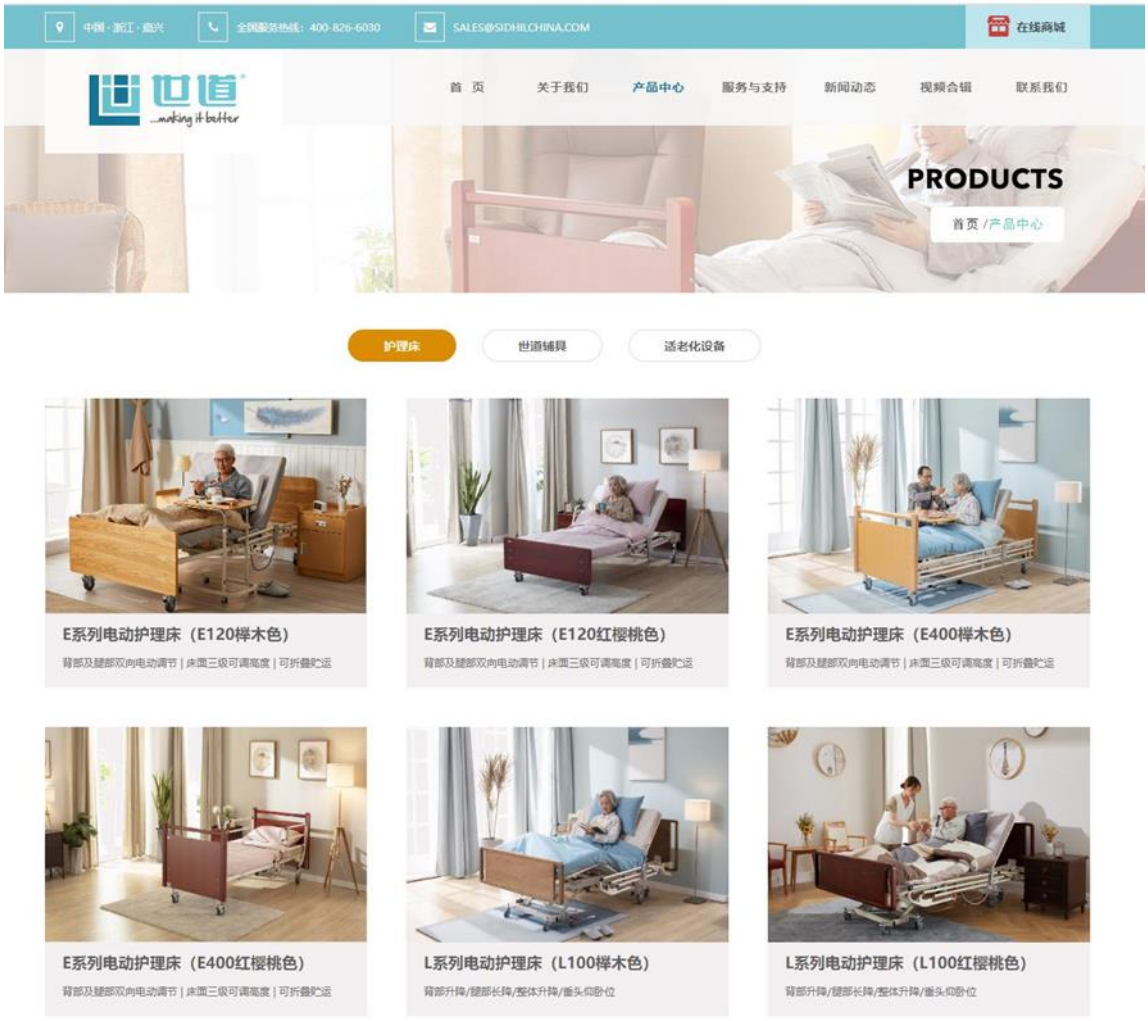


Figure 4.13 : Nursing Bed of Britain SIDHIL (Resources: http://www.shidaocn.com/nursing-bed.html)

SIDHIL 's nursing beds challenge conventional design by incorporating raw wood to create a homely feel, without compromising on functionality. With a variety of styles available, the beds are designed to seamlessly blend in with their surroundings. Through advancements in technology and design, the company has created a range of nursing beds with increased functionality, including a bed that can be adjusted from a standing position

and a folding nursing bed. These innovations make the beds more thoughtful and less rigid. The production process adheres strictly to British regulations.

SIDHIL has introduced targeted solutions for elderly people of various age groups and vitality values, investigating individual requirements within the general standard. This includes the option to freely change the material of bed frames and choose appropriate guardrails based on the degree of disability. This aims to achieve a fair balance for the elderly whilst providing tailored solutions to meet their individual needs, ultimately reducing the carer's workload. Implementing variable design would enable an extended product life cycle.

Initially, SIDHIL primarily targeted the foreign trade market by introducing British-style mechanical nursing beds. To accommodate the Chinese market, the company collaborated with nursing care facilities and hospitals to expand their line of products to include a diverse range of mechanical, hand-cranked nursing beds, positioning themselves in the high-level market.

In the field of nursing home care equipment, technological advancements have certain limitations to better serve China's elderly population, the development of C-channel care beds has become a global necessity. Currently, intelligent electric beds and home care beds for the C-channel are the focus of SIDHIL 's research and development, and their aging electric care bed leads Tmall's market with a 31% share.

When interviewing Ms. Zhang Xiuru, the General Manager of SIDHIL China, Ms. Zhang stated a desire to provide the elderly with more high-quality products, ultimately resulting in a more dignified life. This focus on dignity was a central point in Ms. Zhang's entrance into the elderly care industry. In the initial stage of collaboration with the British organization, what inspired Ms. Zhang Xiuru the most was not merely its impressive

manufacturing capabilities, but its profound humanistic concern - exemplified by its deep "respect for individuals" ethos. This ethos prioritizes user welfare and reflects in-depth visits to nursing homes and attentive listening to the views of the elderly. Consequently, the company devises products that cater precisely to their needs.

Ms. Zhang Xiuru believes that the elderly care market is a gradual release of the market, and there would continue to be a dividend overlay. It is a relatively safe and conservative industry. In China's underdeveloped elderly care market, it is better to put more energy into educating the market and finding people who are willing to agree with the product concept. She believed that by effectively coordinating all aspects, including products and services and not to be driven by the market, would eventually attain success.

vii. Tekvorcare

Tekvorcare is a German-based company that specialises in producing electric nursing beds. Since 1984, the company has visited over 6,000 medical institutions and home users over six years and has developed an ergonomic nursing bed known as Tekvorcare, which became its brand. Its agent enterprise in China is Zhejiang Jiaxing Senuo Machinery Co. Tekvorcare has two production bases located in Bosnia and China, as well as three marketing centres in Germany, China, and the United States. Tekvorcare has a German design team that creates high-quality rehabilitation and home care beds for the elderly. These beds have received praise throughout Europe and the United States, thanks to their exceptional comfort and safety features. Therefore, Tekvorcare has established itself as a leader in the field of European and American nursing beds. In addition, the company produces wardrobes and electrical lifting tables, but to a lesser extent.

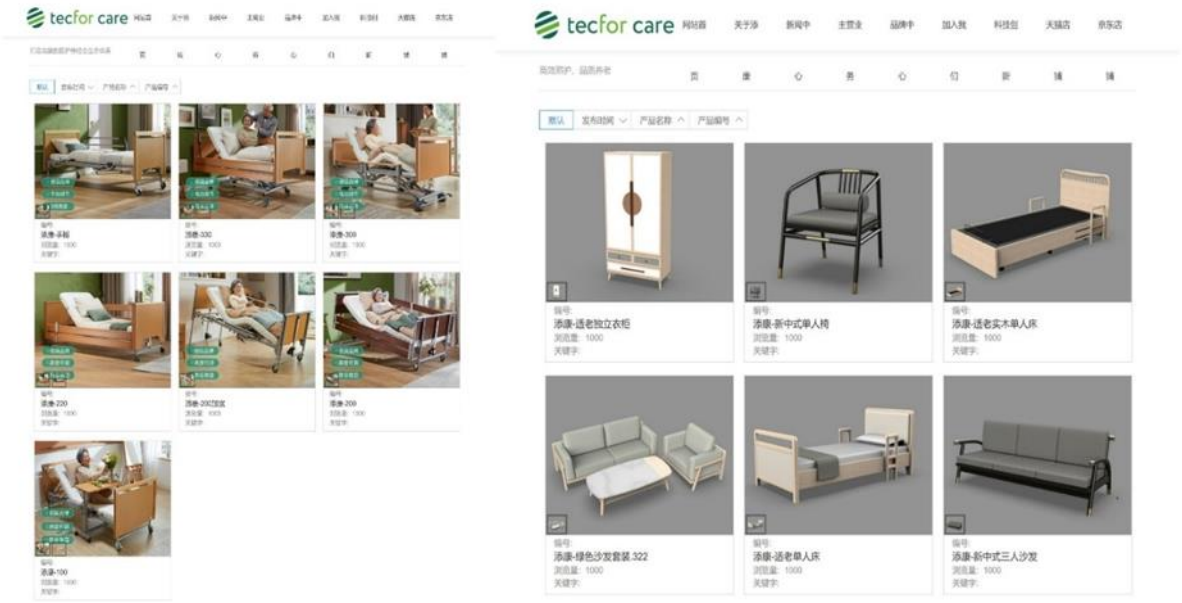


Figure 4.14: Products of German Tekvorcare (Resources: https://www.tekvorcare.com/Contact.html)

In Europe, Tekvorcare's nursing beds enjoy widespread use across various sectors, including home care, institutional care, and insurance leasing. In response to the growing elderly care industry in China, Tekvorcare established a sales team in China in 2017 to introduce their European nursing bed products to the Chinese market. In addition to nursing beds, there are also a limited quantity of assistive gadgets. In 2021, they became one of China's early providers of ageing products and digital intelligent recreation and care total solutions. The targeted customers are senior institutions that fall under the B-channel. After two years of development, the company has established strategic partnerships with several prestigious institutions. They have successfully executed numerous government pension and real estate healthcare projects.

Tekvorcare electric nursing bed integrates medicine, ergonomics, and artificial intelligence, focusing on medical care and smart homes. It is available on Tmall and

Jingdong's online shopping mall, 2022.6.30 Germany Tekvorcare and CCTV reached a strategic cooperation, landing in China Central Television to promote its products.

Tekvorcar's corporate vision is to provide trouble-free care, ensuring users the freedom to live with dignity. This involves designing products that are suitable for both carers and those being cared for, considering their specific needs and perspectives. They provide user-friendly, modular, and Standardized design through proven technology systems.

Humanization. The nursing bed's external dimensions and functional attributes should be designed in full compliance with relevant ergonomics standards.

Modularization. The combination of functions, hierarchical division, production of different functional attributes, and control mode of nursing beds should follow certain standards for modular division.

Standardization. Strict adherence to relevant production standards, such as using only environmentally friendly boards of the appropriate grade, ensures product Standardization and universality.

Although the potential for elderly care consumption is substantial, Tekvorcare argues that the current challenges are insufficient development of the local healthcare industry, a lack of awareness among consumers and an insufficient level of industrialisation. Furthermore, nursing beds on the market exhibit significant variation in terms of their function, quality, and cost. Despite similarities between low- and high-priced products, there are substantial differences in reality. The market is currently not yet developed for mature products to cross the barriers.

viii. Fujiejia

Japan is among the few nations in the world that has transitioned into the super-aging society. Its needs for elderly care are substantial, and it has demonstrated excellence in the design, research, and development of elder-friendly furniture. Japan's care products for the elderly are not only tailored to their needs but also to those of the caregivers. The products are designed to be user-friendly and convenient for both parties.

Fujiejia, a matured furniture company in Japan, manufactures materials for building, furniture, and consumer goods in the nursing field. The company designs furniture for caregivers based on user requirements. Furniture and care items served not only to enhance the elderly's comfort, but also to facilitate their caregivers. The range comprises of wooden tables and chairs which boast simple yet functional designs. A notable example is the Droko chair (Figure 4.15), featuring a rotatable seat surface and backrest, in addition to a warm, harmonious colour scheme and straightforward practicality. It is a seating device designed for carers who often help older people to stand up and bend down to lift heavy objects. The device enables the user to rotate their body, facilitating a range of movements, and affords a comfortable resting position that alleviates physical strain.

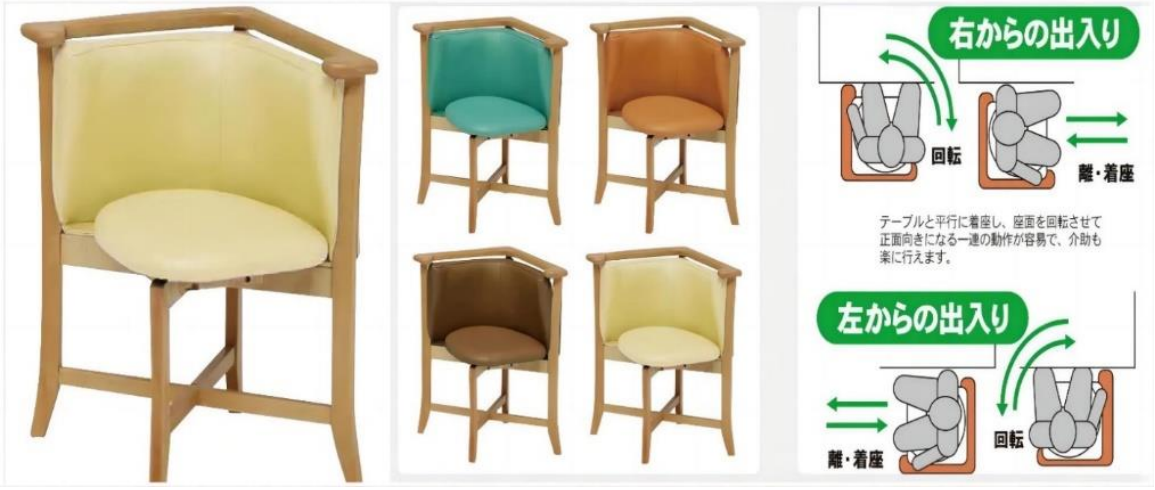


Figure 4.15: Droko Chair of Fujiejia (Resources: http://www.fukusukeya.com)

Headquartered in Nagoya, Japan, Fujiejia is the oldest among the country's senior furniture companies. It was established in 1945 before the formation of the Japanese senior care products market. also, company provides products not only for elderly institutions but also for general consumers, catering to the physiological needs of the elderly without emphasizing the label of high-quality products for the elderly.

Its marketing model has three main characteristics. Firstly, it is a general trading company with the most comprehensive product portfolio in Japan. It also manufactures interior building materials and furniture, providing products suitable for each market segment. Secondly, the company produces its own building materials and furniture, which satisfy customer demands. This is achieved by combining clear, distinct product concepts with competitive pricing to meet a wide range of customer needs. Thirdly, the company has established a sales-focused enterprise with no membership fees or royalties, allowing individuals to operate from either a shop or home. The head office handles cash flow, purchasing, collection and ordering.

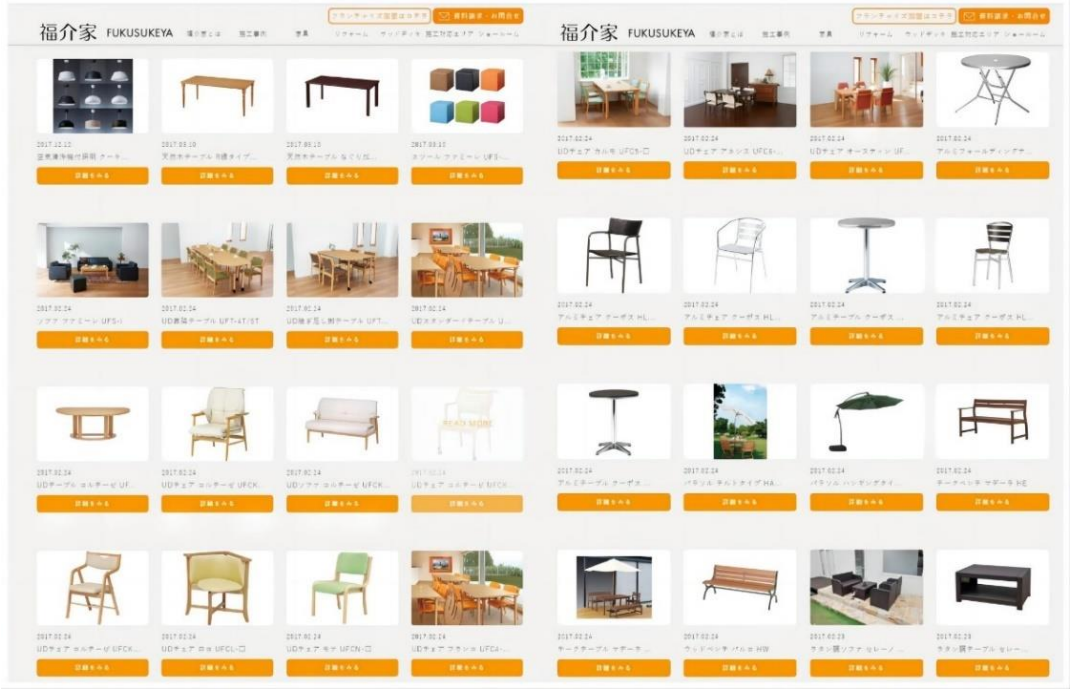


Figure 4.16 : Elderly- friendly Furniture Product Line-1 of Fujiejia (Resources: http://www.fukusukeya.com)

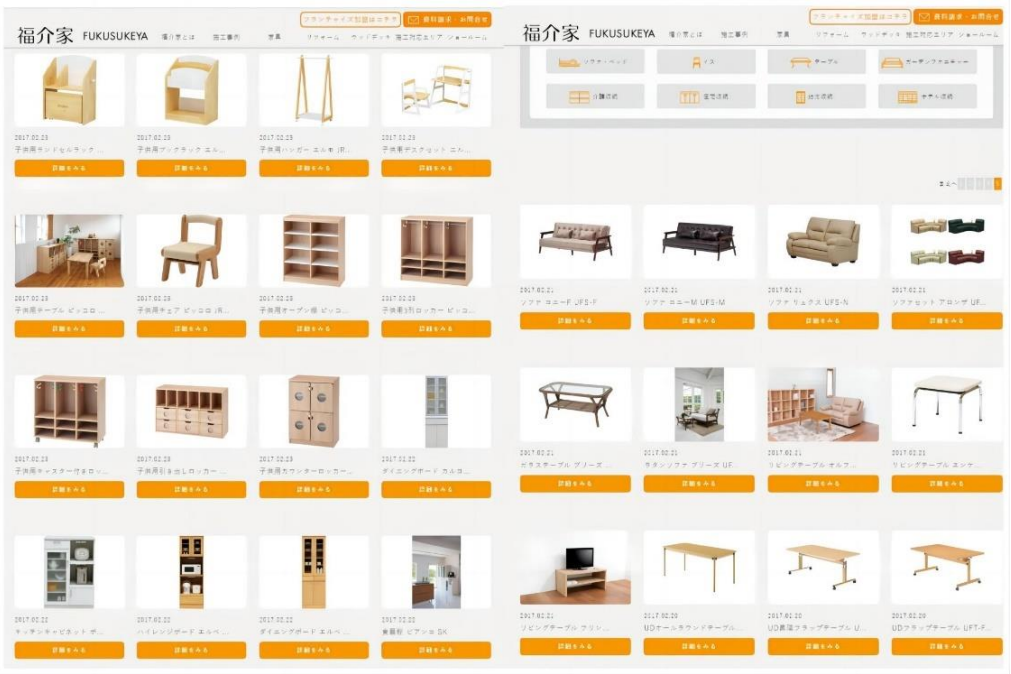


Figure 4.17 : Elderly- friendly Furniture Product Line-2 of Fujiejia (Resources: http://www.fukusukeya.com)

ix. Japan Paramount

Established in 1947, Japan Paramount is a globally renowned medical bed manufacturer, operating 6 factories worldwide. In March 2004, Paramount initiated operations of a factory in Wuxi, China, importing all its production lines. In April 2005, the Shanghai Branch was established, previously known as the Shanghai Representative Office of Japan Paramount Co.

Paramount covers elderly care facilities and home care, as well as a wide range of medical ancillary services, with a wide range of sales markets. In Japan, the market share for hospital beds and home care beds surpasses 70% and 60% respectively, and the market share for nursing homes surpasses 70%, and it sells to more than 100 countries and regions. The Wuxi factory sells to over 100 cities in China and has established partnerships with more than 1,500 hospitals and nursing homes (Sichuan International Health and Senior Care Industry Expo, 2021). However, its sales volume on the online E-commerce platform is not high.

Paramount 's product range in China comprises medical beds, medical accessories, home care products, and various other accessories. Among them, the CQ series of electric home care bed is the most popular. It is designed based on the physiological structure of the human body, not only meeting the user's care requirements but also facilitating their self-care needs. In addition, Paramount specialises in producing upholstered furniture for elderly individuals. Due to the fact that bedridden elders often suffer from bedsores, the company has developed mattresses composed of anti-decubitus silicone material. These mattresses conform to the sleeping posture requirements of the elderly, while also providing breathability and water permeability, thereby making them easy to clean.

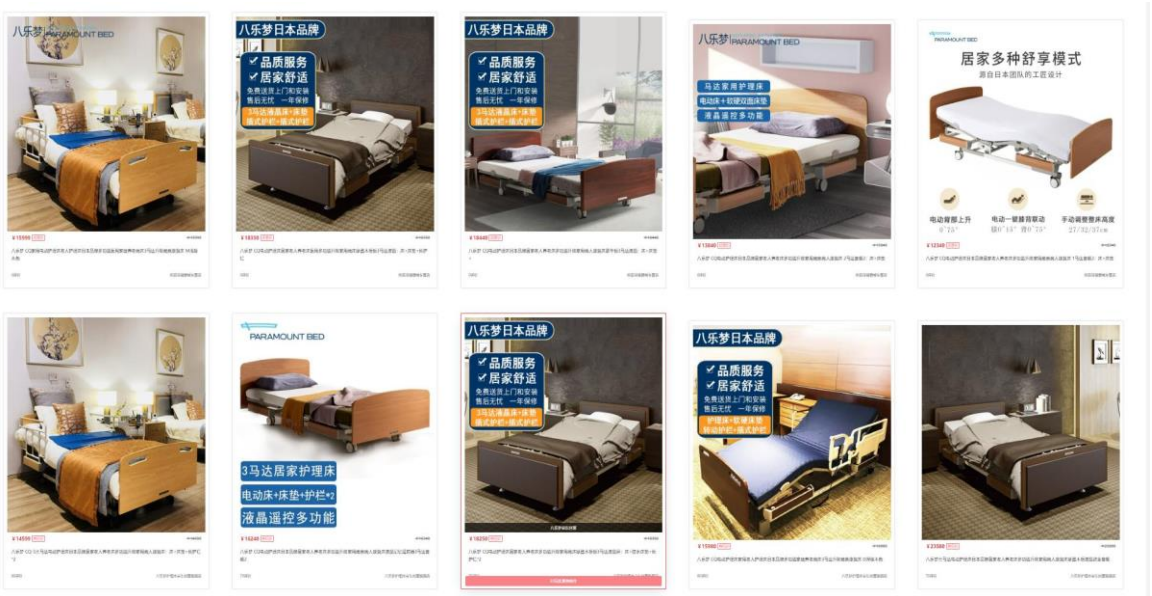


Figure 4.18: Medical Bed of Paramount (Resources: http://www.paramountbed.com/count)

The vision of Paramount is to be committed to implanting Japanese craftsmanship in the global medical bed industry, and to insist on creating a comfortable care environment with professional technology and stable quality. The company's primary goal is to prioritise user perspectives and needs, translating these into practical research and development systems.



Figure 4.19: Operation Mode of Paramount

x. Newport

Newport is a US home furnishing brand owned by SIG Furniture Group, which has been a leader in the US middle-class home furnishings industry for more than 60 years. Its primary product is an elderly-appropriate functional sofa, exceptionally suitable for human body comfort, and especially in line with the elderly's use habits. This sofa overturns traditional narrow understandings and brings pleasant user experiences to the elderly. Newport entered the Chinese market with its main product range including functional sofa, sofa designed for the elderly, and set up experience hall in Shanghai and Hangzhou.



Figure 4.20: Products of Newport (Resources: http://www.baidu.com)

Table 4.2 is a concise summary of the product lines, target customers, distribution models and challenges faced by domestic and foreign companies in the field of age-friendly furniture.

Table 4.2: Summary of Data Collection of Elder- friendly Furniture Manufacturers

Manufacturer	Product line	Target customer and Sale channel	Major challenges
Yongai 永爱	Nursing bed, household goods, health, bath items, intelligent system, rehabilitation care	B-channel customer Online and offline	1.Less Cooperation 2.Less Supportive policies 3.Require industry standards 4.Intellectual property rights
Yiju Yige 壹居壹格	Sofa, Wheelchair sofa	B and C-channel customer Offline	NA
Poly Hepin 保利和品	Sanitary ware, nursing beds, elderly furniture and rehabilitation aids	B and C-channel customer Online and offline	1.Lack of elderly products 2.Low-quality products. 3.Enterprises gathering at B sales channel
Shanghai Muheng 沐恒 MorHome	Interior design, soft decoration design for the elderly, elderly furniture	B-channel customer Online and offline	1.High cost of R D 2.Intellectual property rights 3.Homogeneity 4. No Standardized product

Table 4.2 continued

Zhongjianfu	Whole aging products and services	B-channel customer Online and offline	1.Require standardization 2.Less research team and then set a research institute
British SIDHIL	Nursing bed	B and C-channel customer Online and offline	1.Less energy on educating the market 2.Not want to be driven by the market
German Tekvorcare	Electric nursing beds	B-channel customer Online and offline	1.Insufficient development of local healthcare industry 2.Lack of consumer awareness 3.Insufficient industrialisation level
Japan Fujiejia	Materials for building, furniture, and consumer goods in nursing field	B and C-channel customer Online and offline	NA
Japan Paramount	Medical beds, medical accessories, home care products	B and C-channel customer Online and offline	NA
US Newport	Elderly-appropriate functional sofa	B and C-channel customer Online and offline	NA

The above-mentioned enterprises are taking the lead in the field of elderly furniture in China and has become the innovation promoters in this field. Based on the information collected, it could be inferred that the current furniture enterprises catering to the elderly primarily engage in specific types of furniture, such as electric nursing beds and electric sofas. However, there is nothing focusing on kitchen cabinets specifically for the elderly. The range of elderly-friendly furniture is limited, indicating a need for further clarification and positioning of elder-friendly furniture in China.

The above-mentioned enterprises are taking the lead in the field of furniture for elderly people in China and are becoming the innovation drivers in this field. Based on the information collected, it could also be inferred that Britain, Germany, and Japan, alongside other developed countries, have entered an aging society earlier. As the aging process of society has gradually accelerated, some countries have even entered the stage of being a "super-aged society". As a result, these developed countries have been researching and developing elderly care products for a long time. Through the elderly furniture market research, it is evident that foreign enterprises primarily focus on designing and developing specific types of furniture, with a preference for functional equipment, such as electric nursing beds and electric sofas.

When foreign brands enter China and encounter the emerging elderly market, even though they have better products, it is still difficult for them to be accepted by ordinary elder people due to their single product line and high price. As a result, they target B-channel customers to ensure sale scale. There are two primary reasons for promoting the B-channel of the aging transformation pilot. Firstly, national policy supports it and it generates considerable profits from high demand and government subsidies for furnishing enterprises. Secondly, the B-channel market offers a wide range of options, excellent capital strength and a large customer base, making for a favourable market outlook.

As the number of customers on the C-channel market has increased, these brands have also started to develop for the B-channel customers, but in the face of serious plagiarism, the accumulation of low-quality products in the market, and immature senior customers, they hope to cultivate a more mature market, improve the awareness of senior citizens, and guide the market to develop in a healthy and well-ordered way.

Domestic enterprises are involved in manufacturing furniture for the elderly, with a wide range of business types mainly focused on producing products for elderly institutions and nursing home, some manufacturers expanded to EHF based on nursing home furniture, products focused on beds, tables, chairs, sofas. The target customers are also based on B-channel customers, gradually expanding to C- channel customers, and most of them adopt the online and offline marketing approach. These enterprises face various obstacles, including the lack of industry standards and policy support, the high cost of R&D for elderly furniture, resulting in the production of randomly collected large low-class products. Lack of intellectual property protection for elderly furniture, results in prevalence of imitation in the market, lead to serious consequences such as product homogeneity. Many enterprises have gathered in the B-channel consumer market, resulting in malicious competition. Although businesses recognize the consumption potential of C-end customers, while limited R&D capability leads to few products and low-quality competitiveness.

These findings indicated that the concept and positioning of EHF in China requires further clarification. The design concept has not yet been scientifically formulated, the furniture category is not yet comprehensive, the degree of Standardization is not yet sufficient, the degree of cooperation between the parties is not adequate, and is still in the early stages of development, especially the operational furniture segment.

It is particularly noteworthy that both domestic and foreign enterprises are hardly involved in the product development of kitchen cabinet. Since kitchen cabinet is a frequently used home furniture, it is better to optimise the design of Elderly-friendly Home Furniture., from the entry point of kitchen cabinet, in this absence of Elderly-friendly Home Furniture product line nowadays.

It should be noted that, although there are various issues, manufactures believe that with the acceleration of ageing and changes in consumer awareness, the EHF market would be a new blue ocean. The fast develop market would bring further segmentation of the design of furniture for the elderly, and the elderly furniture industry would gradually enter the stage of deep cultivation of the market.

4.2.2 Data Collection and Analysis for Market

As discussed in Chapter 3, the following furniture retail stores were selected as research objects to obtain data on the current situation and challenges in the development of EHF from perspective of market. The selected furniture retail stores were Macalline, Easyhome, Kinhom, Yuexing Furnishing and B&Q

These malls were chosen because they possess a significant share of China's furniture market. In addition, offline channels value the experience and product selection, as consumers tend to prefer to personally view and touch the items before making purchase decisions. Hence, offline channels align better with the mainstream furniture consumption habits.

Among them, Easyhome and Kinhom do not have stores in Shanghai, and their official customer service were interviewed by phone and WeChat platform. As for the remaining three retail stores, a combination of offline and online surveys was used to obtain the required information. This investigation focused on the market share and sales of EHF, product shortcomings and opportunities, and gathering feedback about EHF from retailers.

i. Macalline

Macalline is a national operator of home decor and furniture malls with the largest operating area, highest number of malls, and the widest geographical coverage in China. The company's primary business involves operating, managing, and providing professional consulting services for home decor and furniture malls, offering self-management and entrusted management options. Shanghai serves as the headquarters for Macalline, with seven malls located throughout the city: Macalline mall of Wuzhong, Wenshui, Zhenbei, Jinqiao, Hunan, Pujiang, and Jinshan.



Figure 4.21: Macalline Stores Located in Shanghai

The newest store of Macalline which is the Jinqiao store in Pudong New Area was observed for the purpose of this study. The floor guide map indicated that the only furniture segregated by age was the children's furniture, which was located on the third floor and seven floors (Figure 4.22), but there was no elderly furniture. When asked about elderly furniture, the shop manager stated that this was because the price of the furniture is not cheap and that a set of furniture may costs tens of thousands of yuan. Therefore, the elderly do not want to spend so much money on furniture. In contrast, many young parents are willing to purchase children's furniture for their kids. At present, major furniture brands tend to be designed in accordance with styles, even if they are children's furniture, which is basically a scaled-down

version of the adult furniture, but the colour is much more reddish pink. The shop manager stated that mahogany furniture tends to have a more traditional style, which would suit the elderly customers.



Figure 4.22: Jinqiao Store of Macalline Shanghai and Floor Guide Map

Although Macalline does not sell elderly furniture, its' headquarter in Shanghai hosted and participated in the conference on the revision of the standard entitled "Guide to Safety Technical Requirements for Elderly Furniture" in October 2021, which was organised by the Shanghai Furniture Industry Association. The conference was led by the Shanghai Furniture Industry Association, and the revised standard could effectively guide and standardise the safety technical parameters for the production of elderly furniture and improve the safety and reliability of elderly furniture. Macalline was among the participating enterprises (Shanghai Furniture Industry Association, 2021). This indicated that Macalline, being a leader in the furniture industry, has started to pay attention to and participated in the development of the elderly furniture market.

ii. Easyhome

Easyhome was established in March 1999 and the company operates as a large-scale state-owned joint-stock enterprise in which 33 shareholders, including China National Hualian Commercial Building Co Ltd. and Beijing Zhongtian Industry Investment Management Co Ltd., invested jointly. Easyhome operates 97 stores directly and has an additional 330 licensed stores in China. Their largest store, located on Beijing's North Fourth Ring Road, serves as the company's headquarters. Presently, Easyhome does not have any stores located in Shanghai.

The official customer service was approached through the WeChat platform of Easyhome, and when asked whether they have elderly furniture, the customer service staff did not understand what the elderly furniture refers to. After being explained what elder-friendly furniture is and asked again, the customer service staff provided the phone number of the store in the fourth ring of Beijing to get the consultation, or via the store's official APP query. The investigation was unable to find any Elderly Home Furniture for sale upon telephone and APP enquiry，but the App only showed a few bathroom handrails and firmer mattress (Figure 4.23).

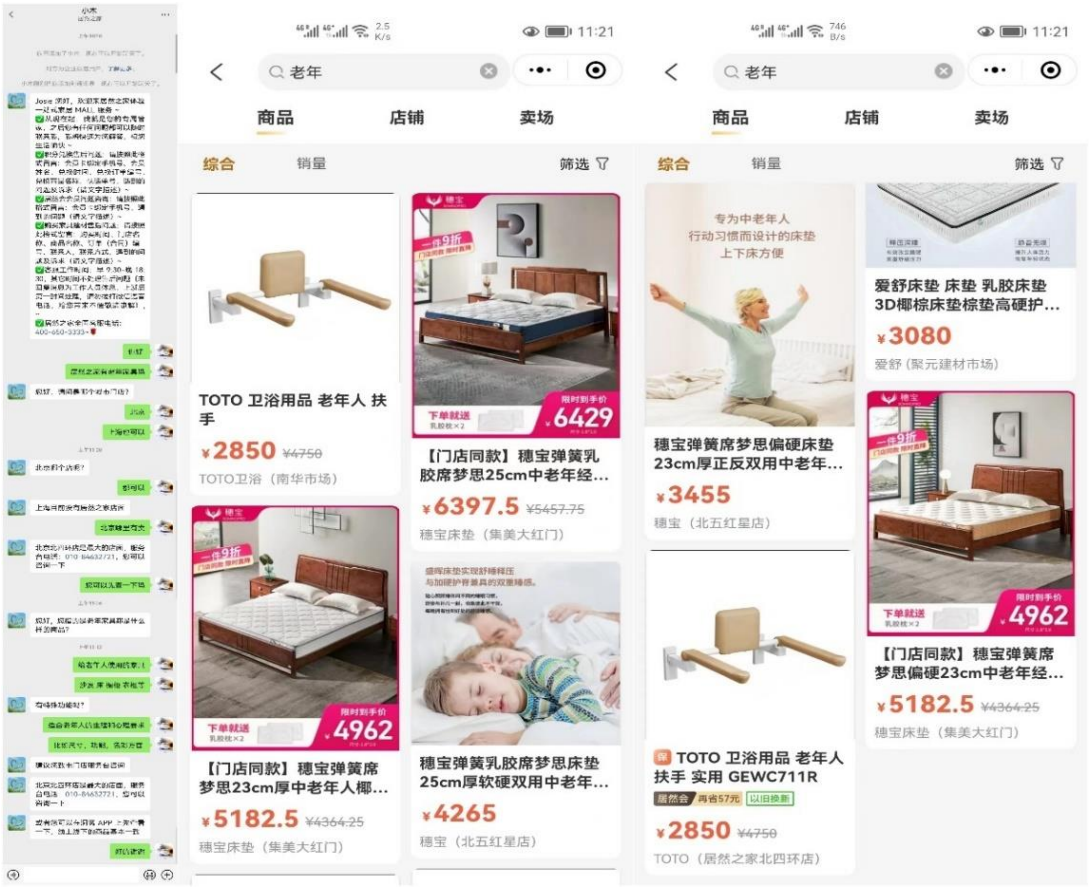


Figure 4.23: Wechat Official Sevice and APP Enquiry Results for Easyhome (Resources: https://www.juran.com.cn, Easyhome on wechat)

Through the network investigation (China Furniture Report Public, 2016), it was discovered that in 2016, Fukang Elderly Products Experience Centre which was opened under Easyhome and located in Beijing lize, was established on the fourth floor of Easyhome. This is China's first construction materials supply mall which launched special shops for the elderly, based on the response to the national appeal to take an important step forward with the practical action. It offers residence renovation, home products, and expanding services for the elderly, covering the entire elderly industry chain, of which more than 90% are imported products, such as Panasonic, Kindware, RUSSKA, etc., however, it is not a specialized shop for elderly furniture (Figure 4.24).



Figure 4.24: Fukang Elderly Products Experience Centre Opened under Easyhome

iii. Yuexing Group

Founded in 1988, the Yuexing Group operates in various business sectors such as retail, home furnishings, hotels and cross-border trade. As of 2022, Yuexing Group has been consistently listed as one of the "Top 500 Private Enterprises in China" and "Top 100 Shanghai Enterprises" for 24 consecutive years. Yuexing Furnishing Mall has branches in China's major cities.

The investigation revealed that the Yuexing Furnishing Macau Road Store have never heard of elderly furniture. Macau Road store stands is the largest shop of Yuexing in Shanghai. It was found that there is no elderly furniture for sale. The section highlighted in red on the third level of the navigation map (Figure 4.25) is the children's furniture section, the only category of furniture in the mall that is differentiated by age.



Figure 4.25: Navigation Map of Yuexing Furnishing Macau Road Store (Resources: https://www.yuexing.cn)

In one sofa shop, when asked if there was any furniture for the elderly, the clerk replied, "This sofa doesn't differentiate between the elderly and the young. The darker colours are very suitable for the elderly." In other furniture stores, the "colour" differentiation is employed as a criterion for categorizing furniture. Those salespersons have not heard of the elderly furniture, and at the same time, said that the elderly do not need special furniture, but only stated that furniture with solid wood sofa, bedding, stable colour, durable material are all very suitable for the elderly.

The bedding sales area had a similar situation, with one branded mattress salesperson telling the researcher: this mattress is relatively hard, the elderly can sleep on it, many people come to buy for their parents, we recommend it". "Many customers buy it for their parents and we highly recommend it.

As for the criteria applied by most furniture sellers to define elderly furniture, materials, colours and styles are the most important factors. They also displayed indifference to 'elderly furniture', arguing that "the needs of the elderly are not very different from those of young people".

Table 4.3: Investigation Results in Yuexing Furnishing Macau Road

Elder Furniture Investigated	Feedback from Salespersons
Sofa	Consider elderly sofa no differences from ordinary one, except for colours. Have not heard of the elderly furniture, suppose the elderly do not need special furniture.
Bed and Mattress	Suppose hard mattress suits the elderly, and recommend it to researcher.
Criteria for Salespersons to Define Elderly Furniture	Materials, colours and styles Suppose needs of the elderly are basically same from young people

iv. KINHOM

KINHOM is a prominent brand in China's home furnishing retail industry and operates as a cross-province, cross-region chain of furniture agents and distributors. The company's headquarters is based in Shenzhen, with a number of stores in South China and stores in Shanghai.

Through an interview with the Marketing Manager of the KINHOM Shanghai Pudong flagship shop, it was learned that there is no special furniture for the elderly on sale, only children's furniture. According to the manager: "The elderly are accustomed to thrifty living and have low requirements for life, often making do with what they have, hence the demand for specialized furniture is limited." The Marketing Manager also stated that the financial returns on the production of furniture for the elderly is estimated to be less than that of children's furniture, which does not generate a quick financial return.

He was also confused, "Now the main consumer of mahogany furniture is the elderly, what exactly constitutes a new category for mahogany furniture, given that the main customers are the elderly?" Unlike children's furniture, the size of elderly furniture is not dramatically different from ordinary furniture. However, the elderly tend to prefer solid wood in darker shades or antique-style Chinese furniture. Then the term "elderly furniture" could be replaced by "mahogany furniture" or "antique furniture". Those wishing to buy can only in the mass of furniture, from the colour, shape and material, etc. to choose suitable for the elderly products.

v. B & Q

Founded in 1969 in Southampton, UK, B&Q is a well-known international and domestic large-scale building materials retailer and decoration service provider. Since establishing in China in 1999 and opening its first flagship store in Shanghai, B&Q has expanded to 10 stores in Shanghai, with building materials supermarkets forming the core of its business, in addition to decorative design and internet-based home decoration services.

The official customer service of B&Q was contacted. He, however, recommended that the decoration business be directly contacted. When the researcher said that she wanted to know about the elderly furniture, the customer service did not respond. When the researcher visited the Shanghai Jinqiao store at No. 518 Lantian Road, Pudong New Area, Shanghai, she did not find elderly furniture for sale.

When the researcher asked the salespersons about their knowledge of elderly furniture, they replied that they were not sure because Chinese elderly people have always had the traditional concept of "valuing their savings more than consumption, and valuing their children more than themselves". They said that the elderly often buy furniture based

on whether their children like it or not, and they were not sure whether they had the willingness to buy.



Figure 4.26: Investigation on B&Q ((Resources: https://www.bthome.com)

The five stores that were selling generate furniture, including children's furniture, were found to lack suitable furniture for the elderly. When asked about plans to introduce furniture tailored for the elderly, the home furnishing stores indicated that currently, there is no plan to introduce. Table 4.4 presents a summary of the Elder- friendly Furniture market investigation.

Table 4.4: Summary of Data Collection of Elder- friendly Furniture Market

Retail store	Methods of investigation	EH for sale or not	Salesperson's feedback to elderly friendly furniture
Macalline	Online and on-site investigation	No	1.Supposed elderly not have consumption capacity 2.Misunderstand mahogany furniture suits the elderly 3.Participated in the conference on revision national standard of EF
Easyhome	Official WeChat and online investigation	No	1.Not understand what the elderly furniture is 2.Elderly Products Experience Centre set in 2016
Yuexing furnishing	On-site investigation	No	1. Not heard of it. 2.Supposed the elderly do not need special furniture 3.Material, colour and style determine elderly furniture
KINHOM	Telephone investigation	No	1.Supposed demands for elderly furniture is limited. 2.Confused by the difference between mahogany furniture and elderly furniture
B&Q	Official WeChat and on-site investigation	No	1. Not heard of it. 2.Not sure if it is best seller

By comparing the information obtained on furniture enterprises and furniture stores, it is evident that despite various challenges, furniture enterprises maintain an optimistic outlook on the potential of elderly furniture as a future development direction. On the contrary, furniture stores do not sell the elderly furniture, and the production and sales of furniture showed a situation of disconnect.

None of the five major stores sell furniture suitable for the elderly. The salespersons'' attitude towards elderly furniture could be categorised into three: first, they do not understand it, in this case, the salespersons from B&Q, Easyhome and Yuexing furnishing. The second is the misinterpretation of the concept of elderly furniture especially by Macalline and KINHOM sales staff, thinking that mahogany furniture is equivalent to the elderly furniture, Yuexing furnishing thought that the difference between the elderly furniture and ordinary furniture lies in the colour, material and style. Thirdly, although they have heard of the elderly furniture, yet, they are not optimistic about its development., For example, the salespersons from Macalline and KINHOM thought that the elderly do not have consumption ability, thus, have limited market demand. Similarly, the Yuexing Furnishing salesperson assumed that the elderly do not require specialized furniture. There is also uncertainty among the salespersons about whether the elderly furniture would become popular or not.

4.2.3 Analyse the Reasons for the Challenges faced by EHF

The Chinese government is releasing positive signals for the development of the elderly industry, in the face of the emerging trend and demand for EHF. However, it seemed that the furniture market is slow to respond, and only a few furniture manufacturers are interested to enter the field of Elder-friendly Home Furniture. The reason for this could lie in the following factors based on the analysis of the development situation and the major challenges of EHF.

Insufficient cognitive awareness of EHF. The concept, category and function of EHF are not clearly defined, and EHF is often mistaken for traditional furniture, medical furniture and rehabilitation devices. Although the situation has improved with the intervention of

academics, the speed of change is still in serious imbalance with the speed of ageing in China. China has the world's largest elderly market and the elderly population is increasing at a rate of ten million people per year, but at present, for both sellers and the elderly, EHF is still in the early stages of cognition, meaning that they are still not clear on what is the real elderly furniture, how to design and its production, is still in the exploration stage, naturally, thus could not meet or even lead the consumption needs of the elderly.

Manufacturers are too conservative in their estimation of the market. Manufacturers unilaterally believed that the elderly consumer market is small thus they are not willing to conduct research, develop and sell products related to the elderly. In addition, they stereotypically believed that the elderly lack consumption ability, thus making furniture for the elderly means raising the cost, and are not profitable. This wrong perception has led to furniture manufacturers to reduce the willingness to enter the market.

Insufficient R&D ability of existing furniture enterprises. Currently, the majority of Chinese furniture enterprises are still small and medium-sized industry, and that product research and development level is not high. Moreover, elderly furniture enterprises face constraints in terms of small scale, limited financial resources, and insufficient manpower to innovate and create. This has resulted in the inability to consider all aspects in product development, manufacturing, sales, and service processes. Furthermore, most enterprises categorized EHF as "non-mainstream" products rather than a key area for R&D. In the academic research area, the pertinent issues and patented technologies are existing on a theoretical level, hampering the transformation into applicable project. This is also a notable factor in the lack of EHF.

Lack of categories of EHF. The current market is filled with a large number of general and youth furniture, only a few EHF, but there is still " pseudo-elderly furniture "," labelled elderly furniture "and unilateral pursuit of high-tech bad development trend, which has not yet been explored. As mentioned earlier, according to the traditional concept of China, the elderly choose to age in place, but their facilities and conditions are not yet ready to meet such a large number of people.

EHF industry is lacking in scientific guidance. According to Zhu Changling, the Chairman of the China Furniture Association, the Chinese EHF market is nearly blank not due to a lack of demand rather a lack of scientific guidance. Most Chinese furniture enterprises are small and medium-sized, lacking forward-looking and strategic development. Consequently, although elderly furniture market development prospects are promising, many companies focus solely on short-term benefits, but the loss of long-term planning. Due to the absence of scientific guidance, the market for elderly furniture has been established with unscientific designs that have negatively impacted both economic benefits and the enthusiasm of manufacturers. Given the increasingly significant aging society, it is essential that relevant authorities and industry associations work together to plan the development and management of EHF.

Insufficient attention has been given to EHF. According to data, China's potential consumption for the elderly has reached 30 billion yuan. However, the reality is that the proportion of consumer goods tailored for the elderly is less than 0.5%, with a significant 70% of those products consisting of healthcare medicines (Yuan, 2004). An 89% satisfaction rate was reported by the elderly group with regards to China's current market for elderly products. The primary reason for dissatisfaction was inadequate market research conducted

by relevant authorities, and the lack of a comprehensive understanding of the market and the needs of the elderly group. In recent years, although the government has issued a number of policies to promote the development of the elderly industry, but biased guidance, lack of relevance and practical operation, difficult to implement, and did not play a substantial role in promoting the development of the elderly market (Liu, Wang & Guo, 2014).

Lack of national standards and norms. China has not established any national standards or industry norms for elderly furniture, elderly building standards also do not include elderly furniture, resulting in furniture enterprises in the development of elderly furniture without standards and basis, it is difficult to start, manufacturers only apply the general furniture production standards for the production of elderly furniture, according to their own understanding of the adjustments, which will inevitably lead to the lack of science, each for their own production standards, but also make the output of products between the lack of universality, limiting the health and long-term development of the elderly furniture industry.

Limitations of the consumption concept of the elderly**.** Historically, many people in their 70s and 80s have the habit of thrift, consumer attitudes are mostly " high savings, low consumption ", coupled with the price of existing elderly furniture is not cheap, and objectively also limits the expansion of the furniture market for the elderly. Furthermore, influenced by traditional consumer attitudes, the majority of the elderly tend to be humble, taking into account the feelings of their children, in the choice of furniture, often to the needs of their children as the priority, so, the elderly on the demand for furniture is basically replaced, dissolved and ignored by general furniture.

4.2.4 SWOT analysis of entering market of Elder-friendly Home Furniture

SWOT analysis is used to assess the strengths (S), weaknesses (W), opportunities (O), and threats (T) of an enterprise. Its goal is to determine the enterprise's strategic positioning in order to maximize advantages and opportunities, while minimizing weaknesses and threats. Performing SWOT analysis requires knowledge, experience, sufficient information, strategic thinking, and business intuition. As a significant tool in strategic analysis, SWOT analysis is also a method of strategic thinking. It has been utilised in many other fields such as product design and positioning.

Evaluating the market potential for EHF products using a SWOT analysis is necessary to ensure the smooth growth of the industry. The focus is on producing furniture that meets the needs of the elderly and is marketable. The analysis is predominantly based on the current state of China's aging population, the purchasing power of senior citizens, and the current market conditions. The results of the analysis are as follows.

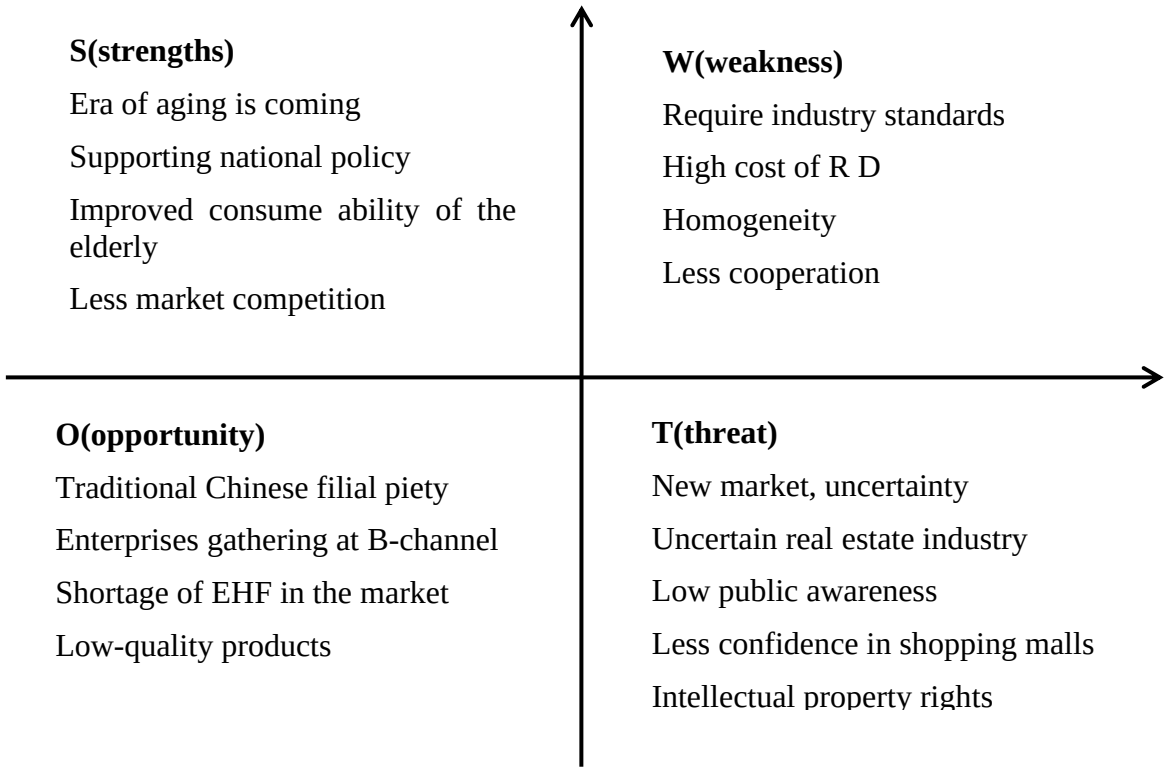


Figure 4.27: SWOT Analysis of Elder-friendly Home Furniture Industry

4.3 Characteristics of the Elderly Living in Place

With aging, the bodily functions of older individuals gradually decline, giving rise to a sequence of physical features. Due to the weakening of muscle strength and decreased physical flexibility, the elderly experience a gradual decline in action ability. Their movement range is reduced, making it difficult to control their hands and feet, and their responsiveness to the outside world becomes dull. As a result, completing activities such as standing up, sitting down, bending, or retrieving items by climbing become more challenging for the elderly.

In addition to physical changes, the elderly experience complex changes emotionally and mentally. Gradual physical decline and illness lead to feelings of insecurity in the elderly. After retirement, older individuals transition from a working status to a more leisure status. Changes in family and social roles may contribute to a sense of loss and emptiness. At the same time, older individuals have fewer opportunities to interact with their children and may even become estranged from them, resulting in feelings of loneliness and depression. The psychological state of the elderly is a significant factor that should not be overlooked in furniture design.

Quantitative and qualitative methods have distinct characteristics and limitations. In this study, the questionnaire method, and the interview method, two mainstream sociological research methods, are combined to achieve a more holistic and complementary result, supplemented by the documentary method, the observation method and the design-based method.

The questionnaire and interview methods complement each other, as seen by their shared subject matter and the creation of a smooth transition mechanism between questionnaire and interview questions. The questionnaire provides quantitative data while the interview delves into the significance of the actions quantified. This is achieved by converting the descriptive questions of the questionnaire (What is it) into the exploratory questions of the interviews (Why), thereby enabling the use of both methods to investigate the same issues from varying perspectives and enabling the two methods to be aligned and validated.

The second research objective of this study, i.e. the core elements of EHF design, is based on the analysis of the characteristics of older people, the habits of furniture use, and

the demands of furniture use. The physical and psychological characteristics of senior citizens were obtained by using literature, interview and questionnaire. The findings are discussed in sections 4.3.1-4.3.2. Additionally, behavioural characteristics were obtained using observation, and is in section 4.3.3.

In section 4.4, general requirement of the elderly for furniture are obtained by means of questionnaire and interview.

Section 4.5 comprised of an analysis of the elderly's kitchen cabinet use habits and demands by means of questionnaire and interview.

According to the discussion in the third paragraph of this section, to realise the complementarity of the questionnaire method and the interview method, it is necessary to make the design of the questionnaire and interview outline coincide with each other, and the design of the questionnaire and the design of the interview outline of this study were arranged according to the following considerations.

i. Characteristics of the Elderly
ii. Furniture Use Habits
iii. Furniture Use Demands.

See Appendix B-C for details.

4.3.1 Physiological Characteristics of the Elderly

The physiological changes in the elderly are predominantly caused by the ageing process, which is a sequential and varied decline in function. The loss of some mobility can limit the use of certain products for the elderly. A detailed analysis of the physiological

characteristics of the elderly is necessary to address any issues that arise when using the furniture.

The human body is a complex physiological system with two primary systems relevant to furniture products: the sensory and movement system. Firstly, the elderly comprehend the visual characteristics of furniture through sensory organs such as the eyes, which are processed by the central nervous system. This information is then operated upon by the movement system, such as the hand (Pu Yu, 2009). The elderly perceive furniture through sensory organs such as colour, style, and modelling. This perception of furniture is often biased and largely perceptual. Thus, it is crucial to analyse the perceptual characteristics of the elderly to accurately understand their emotional needs. Additionally, the brain processes this information before the body's movement system can act on it. In this process, objectivity is paramount and informed by direct experience and rational judgment. Thus, it is imperative to analyse the movement characteristics of the elderly in order to improve their comfort.

The first one is the perceptual characteristics of the elderly.

With age, older individuals may experience reduced perceptiveness. This may be caused by weakened synthesis and metabolism of central nervous system transmitters, resulting in reduced cognitive function and sensory abilities. Common symptoms include slow response, inattention, and decreased hearing and vision. These impairments are generally reflective of reduced organ sensitivity (Zhong, 2016).

i. Decreased Visual Acuity

Approximately 80% of human sensory information is gathered through the sense of vision. As age advances, visual function declines (Xu & Gao, 2017). In elderly adults, diminished visual function mainly manifests as the reduced ability to discriminate between different levels of light and shade, diminished visual field, weakened depth perception, reduced colour discrimination ability, and decreased object or image recognition. On the other hand, numerous pathological disorders arise in the eyes of older individuals, including cataract, glaucoma, retinal arteriosclerosis, optic atrophy, and other typical eye afflictions in the elderly that also cause declines in visual perception ability. These declines are primarily manifested through reading challenges, colour differentiation problems, extended visual adaptation times, and reduced adaptation to darkness. "Presbyopia" hinders older individuals from accessing crucial or cautionary information, such as words displayed on furniture or equipment, which they frequently overlook.

Zhang Hong (2012) discovered a link between gender and the prevalence of low vision and double blindness among individuals aged 70 years or above. Females exhibit higher occurrence rates than males. Cataract incident is the leading cause of visual impairment. The design of furniture products can enhance the visual experience of the elderly by considering the form, material, light, and colour of the product. These factors can assist in enhancing the identification of visual information.

ii. Decreased hearing

A decline in hearing warrants attention. Hearing is considered an essential sensory organ, second only to vision. While a Chinese colloquialism, "eyes can see six directions, ears can hear eight directions," highlights the significance of hearing, its practicality extends

beyond this saying. Hearing is key to staying in touch with our surroundings and identifying natural phenomena, facilitating adaptation to the environment. Furthermore, it enables communication between individuals. However, not every elderly person has normal hearing ability as hearing loss is considerably common among the elderly population. Hearing impairment can seriously affect the two-way communication of elderly individuals, as they may need others to speak loudly during conversations. Some household items, such as kettles, microwaves, and ovens, that have audible signals can pose a danger if the elderly cannot hear them properly. Statistics indicate that the prevalence of deafness amongst the elderly lies in the range of 12%-14%, with figures among the over-eighties exceeding 50%. Males are more likely to be affected than females (Li, Hou & Wang, 2000). According to the Statistics and Information Centre of the Chinese Ministry of Health (2008), 29.3% of the elderly population suffer from hearing loss, with 7.3% experiencing serious difficulty in hearing. An additional 22% require others to raise their voice in order to be heard. In addition, it is important to acknowledge that the physical deterioration of the elderly can impact their hearing capacity. Thus, incorporating visual aids such as appropriate colour schemes and adequate lighting can help compensate for this decline.

iii. Dull sense of touch

Touch is the most direct feeling between human senses and the outside world. It has multi-dimensional perceptual representation, including perception of temperature, skin and pain. In book named Cognitive Psychology, Eysenck (2009) defines touch" the psychological feeling and physiological reaction caused by mechanical stimulation of human skin by external objective substances". It can be divided into contact sensation and pressure sensation according to the intensity of stimulation. The slight stimulation to skin can produce contact sensation. In addition, touch also exists in human touch, which mainly refers to the

combination of touch and muscle movement. It can perceive not only the surface smoothness of objects, but also the size, volume, and geometric shape of objects. For the elderly, due to nervous system decline and body cell degeneration, the elderly's sense of touch becomes dull, which is specifically manifested as weak sensitivity to pressure, slow response to hot and cold temperatures, increased response time to pain, and poor accuracy of tactile location.

While designing furniture, designers should also take special consideration of the elderly. For example, when selecting furniture material, designers can choose materials with a rougher surface to enhance the sense of touch. In seat design for instance, increasing the touch between the elderly's back and the back of the chair, as well as between their hand and armrest, can enhance their experience of using the furniture.

iv. Reduced memory and cognitive abilities

Reduced memory and cognitive abilities arise when recalling information. The process of recalling involves recognizing stimuli, as illustrated in Figure 4.28. External stimuli trigger the brain, which records sensory input and generates a response. As shown in Figure 4.28, when the sense of progression is registered, people first develop short-term memory and then it would gradually become the long-term memory.

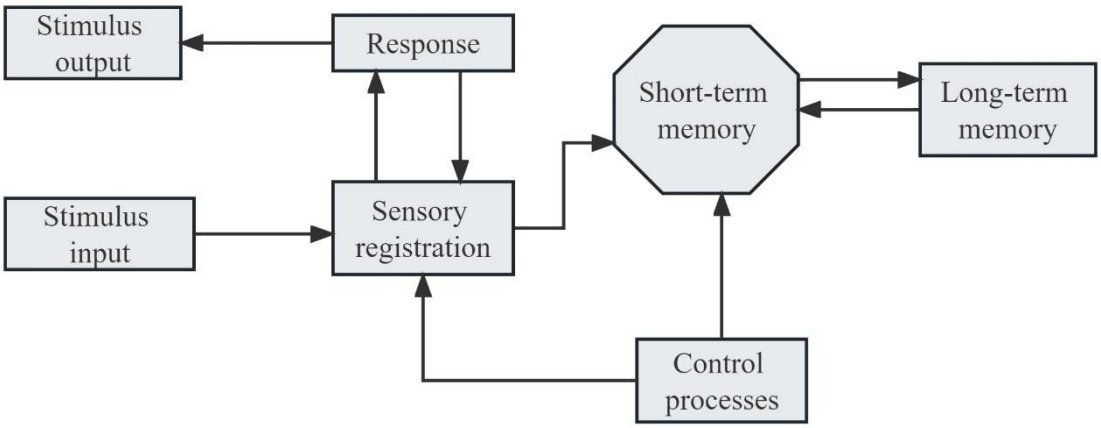


Figure 4.28: Information Processing Flowchart for Memory Processes (Resources: Yu Liwen, Psychology)

Memory ability is primarily associated with the function of the brain, which is the highest control system among human nerves. As stated by Zhang (2011), the shape of the brain alters significantly as individuals age, particularly after turning 75 years old, whereby the number of brain cells reduces sharply. Moreover, nerve conduction around the brain slows by 15 to 30 percent, which can result in memory loss, stagnant thinking, and concentration difficulties in old age. Diseases and genetic predispositions can impact the memory capacity of older individuals. Additionally, as their sense of self-identity diminishes, receiving information intended for their age group at a subconscious level can also reduce memory retention.

Older individuals exhibit certain characteristics of memory. For instance, the short-term memory ability is greater in the elderly compared to long-term memory. The subconscious memory ability of the elderly remains better, while the ability to remember decreases when the brain is more involved in processing information.

The simple recall ability of the elderly is weak. However, if prompt information is added in the form of space environments, event scenes, or other aspects, their cognitive ability improves significantly.

Intrinsic recall abilities hold greater value than mechanical recall abilities. Elderly individuals, for instance, might have difficulty remembering place names, building numbers, and numerical data. However, when something meaningful happens in their life, their memory retention is better.

The cognitive decline of elderly individuals is determined by their thinking characteristics. On the one hand, mental flexibility and reasoning skills are reduced in older individuals, and their process of forming concepts is longer and more prone to errors. As a result, it is more challenging for the elderly to learn new information and adjust to new situations. Additionally, they may reject new experiences, which can make it hard to adapt to ever-changing life circumstances. On the contrary, the thought processes of the elderly tend to be rigid and inflexible, with outdated ideas that do not keep pace with the changing times. This hinders their ability to tackle novel issues effectively, as they tend to rely on past experiences, habitual thinking patterns and existing knowledge structures to grasp new concepts.

Therefore, furniture designed for the elderly should be uncomplicated and straightforward to use, aiming to minimise the time spent handling the furniture. It is important to reduce the number of operating steps, to keep the operation simple and clear, to emphasize universal design, to reduce logical thinking, to use the subconscious thinking mode, and to reduce the learning cost for the elderly as much as possible.

The second one is the movement characteristics of the elderly.

With advancing age, the body's mobility functions undergo changes commonly known as "ageing". This decrease means that elderly people have weaker mobility than when they were young, which leads to impaired movement. For instance, compared to young and middle-aged people, the body size of the elderly decreases, and bones and muscles decrease in number. Additionally, tendons, ligaments, and other parts atrophy, leading to reduced flexibility in elderly limbs. Arthritis and other conditions affecting the elderly, such as periarthritis of the shoulder, can greatly limit their range of physical activity. Moreover, due to their low endurance and susceptibility to fatigue, elderly individuals often find it difficult to engage in physical labour or stand for prolonged periods (Zhao & Zhu, 2015). Thus, when designing furniture for the elderly, these factors need to be taken into consideration. This mainly involves ensuring that furniture is suitable and comfortable for their needs.

i. Reduction in Height

Individuals between the ages of 45-64 typically experience a slight decrease in height, while those between 65-75 experience a more obvious reduction. As individuals enter old age, there is a decrease in bone growth cells in comparison to aging cells, leading to changes in bone structure which directly result in reduced height. According to statistical data, people tend to reach their maximum height between the ages of 28-30, after which height gradually decreases. Usually, the height of elderly people at the age of 70 is 2.5% to 3% lower than that of younger individuals, and the maximum reduction in height can reach 6% (Liang, 2018).

Further studies have shown that, due to the decrease in bone density, muscle atrophy, and other factors affecting the elderly body, height gradually decreases with age. The data

demonstrates that men's height decreased on average by 2.25% and women's height by an average of 2.5% from the ages of 30 to 90 years old (Zhong & Shen, 2018). Additionally, the elderly often stoop due to the bend deformation of the spine, which also contributes to a reduction in height. As height is a noticeable external characteristic that can be directly observed, it must be considered first in the design process.

As people age, the range of motion in the hands and feet of the elderly decreases. Joint mobility and muscle strength weaken, resulting in decreased grip and leg strength (Figure 4.28). Bone degeneration often leads to bone loss, particularly in men. In addition, a series of issues arise for the elderly including muscle atrophy, elastic band weakening, joint stiffness, and others, greatly impacting their quality of daily life. An example of this is when everyday items are placed in locations which are easily accessible for younger individuals but not for the elderly.

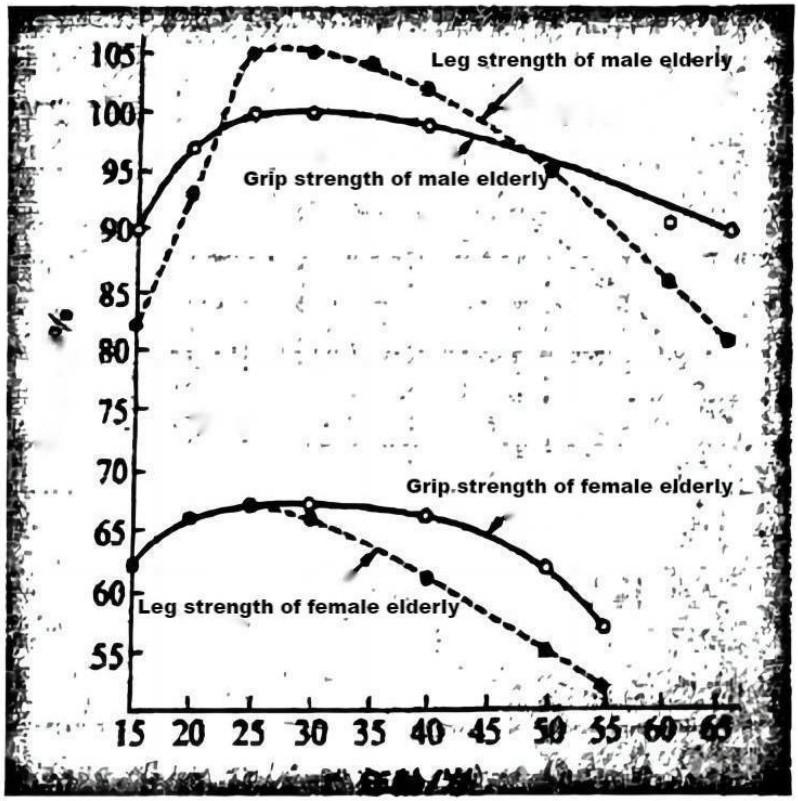


Figure 4.29: Grip and Leg Strength with the Change of Ageing (Resources: Cheng Ruixiang, Interior and Furniture Design Ergonomics)

ii. Reduction in balance

Generally, young people possess good balance and are capable of maintaining balance when altering their body positions, leading to a decreased likelihood of falling. Nevertheless, people's balance begins to deteriorate from the age of 45 and this becomes increasingly pronounced from the age of 65, causing movement to become more challenging. Especially during exercise or under external forces, the elderly may experience reduced ability to adjust their bodies, resulting in difficulty maintaining certain postures (Wang, Xu & Guo, 2015). There are numerous factors that can influence balance loss in older adults, including weight gain, lower limb muscle strength, visual impairment, and long-term

medication use. Due to a decline in balance ability, elderly individuals face numerous obstacles when using furniture. For example, prolonged sitting can lead to danger when bending or tiptoeing to reach objects. Therefore, furniture designers should consider the decline in balance ability and incorporate appropriate assistance and auxiliary features into their designs.

iii. Slow movement and increased risk of falling

These are common issues among elderly individuals due to the natural degeneration of joint mobility and muscle strength. As these abilities decline, walking speed and endurance also decrease, making it challenging to maintain a proper gait and posture. Elderly individuals may experience decreased flexibility when transitioning between positions such as lying, sitting, squatting, and standing. This can result in the need to rely on upper body strength to slow down movement. Moreover, abnormal gait and vision loss in the elderly pose a risk of falling and potentially lead to serious injuries such as fractures. Table 4.5 summarized the Physiological Characteristics of the elderly.

Table 4.5: Physiological Characteristics of the Elderly

	Physiological Characteristics	**Specific Performance**
Perceptual features	Decreased Visual Acuity	Presbyopia, object recognition decreased
	Decreased hearing	Deafness, difficulty in communication
	Dull sense of touch	Weak pressure sense, slow reaction to heat, cold and pain, poor touch sense
	Reduced memory	Memory loss, stagnant thinking, reduced intelligence, difficulty concentrating
	Decreased cognitive	Reasoning ability decreased, slow reaction, learning difficulty, thinking set

Table 4.5 continued

Movement features	Reduction in Height	Height reduction by 2.25%~3%, stooping, smaller range
	Reduction in balance	Hard to stay in same position, reduced flexibility
	Slow movement and increased risk of falling	Slow movement and inflexible transfer of action

In addition to reviewing related literature, 246 questionnaires were distributed in this study to inquire the elderly if they have any physical problems such as vision impairment, hearing impairment, upper limb impairment, lower limb impairment, waist pain, neck pain and other problems. Based on the data collected, the physiological obstacles of the elderly are shown in Figure 4.29.

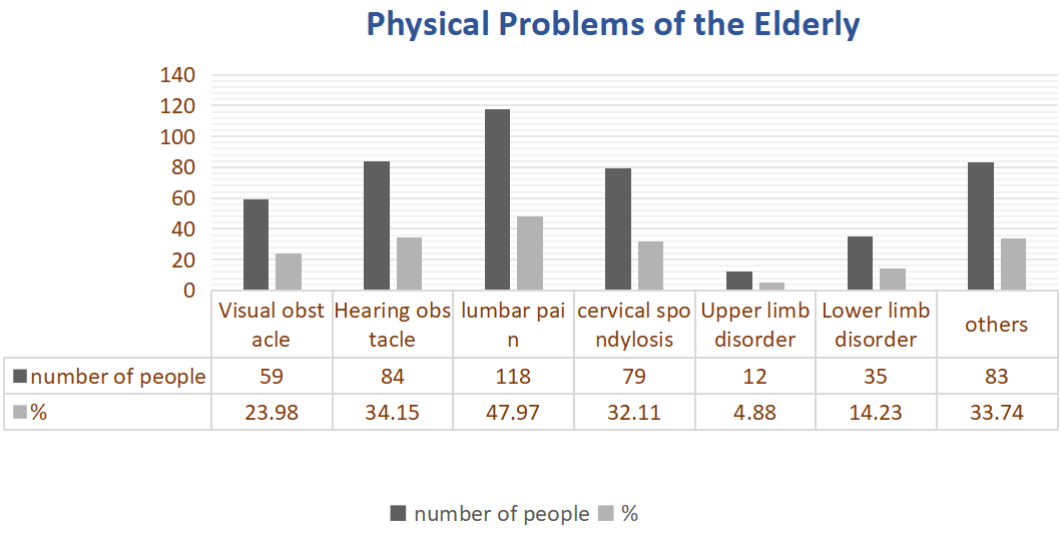


Figure 4.30 : Physiological Disorders of the Elderly from Questionnaire

Based on the data shown in Figure 4.30, the highest number of elderly people with lumbar pain was 118, followed by hearing impairment and other problems with 84 and 83 people respectively. There was also a considerably high number of elderly with cervical spondylosis which was 79, and those with visual impairment were 59. 35 elderly had lower limb problems, and the least was 12 elderly had upper limb problems, which was basically in line with the results of the documentary research, which again shows that the physical impairment of the elderly is mainly caused by the decline of back and leg functions, vision and hearing, which need to be compensated by corresponding design approach.

4.3.2 Psychological Characteristics the elderly

Physiological changes are inevitably going to affect the mental state of older people. With the shift in their social roles from serving society to being served by society, the elderly may become introverted, lonely, and emotionally anxious. This can lead to an unwillingness to communicate with others or engage with new experiences, resulting in increased conservatism and decreased curiosity for novel things. Additionally, they may tend to analyse things based on past experiences and be more stubborn in their viewpoints. On the other hand, upon the elderly returning from employment to their family, their monetary standing becomes less significant, and their leisure time increases, while they have less time for family communication. The elderly face difficulty in occupying their time, which may lead to psychological issues.

Empty Mind. Some elderly individuals who retired from important and busy work transition from a hectic life to a lack of routine, struggling to adapt. Consequently, they experience a sense of emptiness and perceive life as lacking flavour, which leads to feelings of restlessness and instability.

Helplessness. Limited interests, inactivity, cognitive and physical fatigue, negative feelings, and loneliness are common among elderly individuals. Separation or loss of spouse can compound feelings of helplessness, particularly when adult children live apart.

Many elderly individuals display strong self-esteem and stubbornness. Having achieved success in their youth, and enjoying a relatively smooth life and career, they still seek respect from society and those around them during their retirement years. They tend to rely on their experience when making decisions and may find it challenging to take advice from others.

Suspicion. Older individuals often draw on their rich life experiences to interpret their surroundings but may also display a lack of trust in the abilities of others, resulting in increased suspicion. These concerns are compounded by a heightened focus on personal health, leading to preoccupation with any health-related issues that arise.

Personality Change in Elderly Individuals. Elderly individuals may exhibit changes in personality compared to their younger counterparts. These changes include impatience, complaints, verbosity, introversion, loneliness, emotional anxiety, reluctance to communicate with others, reluctance to try new things, and increased conservatism.

Psychology of Embracing Positive Aging. In China, the retirement age for men and women is typically between 55-60 and 50-55 years respectively. Many older individuals remain robust, healthy, and exhibit a continuing ambition for their careers. Their drive towards their dreams and purposeful pursuits extending beyond 60 years of age. They work harder, study more, and do not perceive themselves as being inferior or limited by age-related mental or physical changes.

Colour Psychology of the Elderly. Colour is the primary information received by individuals. Furniture serves not only a utilitarian purpose but is also an integral decorative component of the interior space. Additionally, it can be seen as a means of evoking the memories of elderly individuals and stimulating their nostalgic emotions and sense of identity (Zhang, 2013). Colours have psychological implications. Some colours can be stimulating and activate the senses, whereas others can be calming, soothing, and evoke feelings of nostalgia or melancholy.

It should be noted that the anatomical structure of the human eye changes with age, resulting in a gradual deterioration of vision. Senescence of the cornea and lens trigger variations in colour discrimination among the elderly, as their light transmission functions weaken. Consequently, older individuals experience yellowish visual sensations, making it challenging to distinguish blue and green hues. Conversely, colours such as red and yellow are easily discernible.

Secondly, in comparison to monochrome colours, the elderly prefer medium-bright colours because the elderly's visual ability is weakened, and medium-bright colours look more vivid. Typically, older individuals prefer bright colours, particularly those with warm hues such as red and orange, that are easily perceived.

Thirdly, elderly individuals often prefer vivid colours that satisfy their psychological needs, favouring warm colours which subconsciously remind them of vibrant life, youth, and vitality. These factors should be fully considered when designing elderly-friendly furniture, i.e. using a medium saturation and brightness colour as furniture colour will not stimulate the elderly's vision, nor will it make the elderly confused. In addition, it should be

avoided to use scarcely distinguishable colours such as white and yellow, blue and grey, or blue and green, among others.

Consumption psychology of the elderly. With the rapid growth of China's economy, people's standard of living has vastly improved, and the income of the elderly has increased. This has resulted in a shift in the consumption behaviour and patterns of the elderly. Furthermore, their children have become independent, and their financial burden has reduced. They are no longer solely concerned with thriftiness but are taking care of their own needs. The survey questionnaire revealed that the main demand of the elderly in furniture consumption is convenient to use, easy to learn and use, reliable function and quality, and they do not like flashy products.

Secondly, older individuals are price-sensitive and appreciate economical products. When making purchases, they prefer to compare multiple options and do not make hasty decisions.

Thirdly, older individuals tend to base their evaluations on past experiences, often trusting specific products that they have previously used or have a particular fondness for. However, as times have evolved, elders have shown greater curiosity for new environments and emerging commodities. They seek to compensate for their past failed consumption endeavours due to formerly limited conditions. There is a significant consumption interest in clothing, healthy food, and travel among the elderly, which is known as Compensatory Consumption.

Finally, the elderly aim to consider health and environmental concerns. However, they also prioritize popular styles, collectability, and frequent changes, which aligns with the prevailing Chinese elderly consumer idea of realism and modesty. Environmental-protection

initiatives and eliminating formaldehyde pollution have been actively promoted by the media in recent years, and the elderly have also shown interest in these matters.

Table 4.6: Psychological Characteristics of the Elderly

Psychological Characteristics	Specific Performance
Empty mind	Restless, unstable mood
Helplessness	Less communication, depression, inferiority, easy to negative
Strong self-esteem and stubborn	Judge by experience, not listen to other's advice
Suspicion	Prone to feelings of insecurity and distrust, excessive focus on physical health
Personality change	Unstable, verbose, introverted, reserved
Embracing Positive Aging	Keep on learning and working
Colour psychology	Preference to medium brightness warm colours, difficult to identify blue and green
Consume psychology	Utility, easy to use, reliable quality, affordable, healthy function, environment-friendly, compensation consumption

The questionnaire also surveyed factors that the elderly are concerned with when purchasing furniture, and the data collected is shown in Figure 4.31.

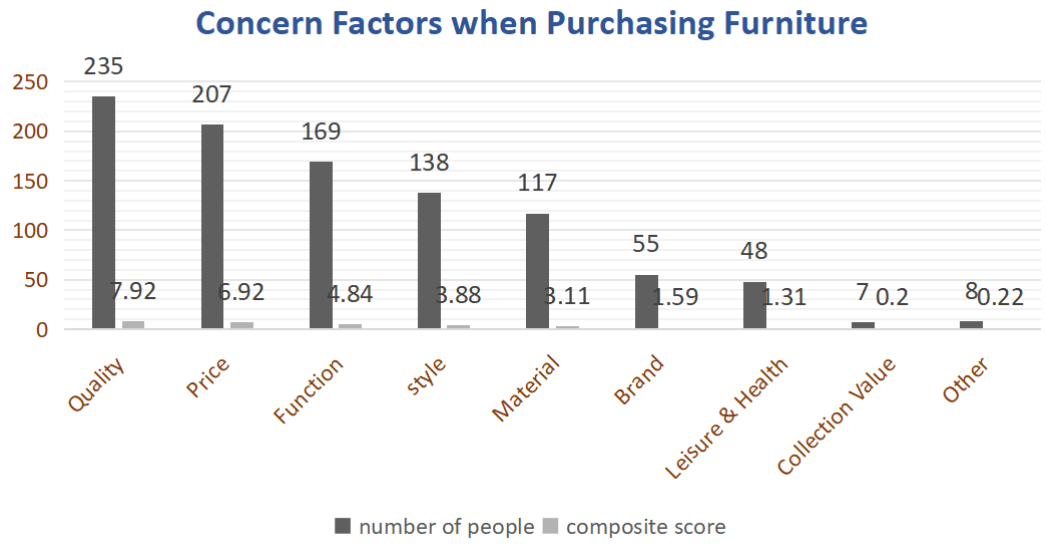


Figure 4.31: Consumption Psychology of the Elderly from Questionnaire

The data indicated that the elderly prioritised quality （235） and price (207) as the key considerations when purchasing furniture, Followed function (169) participants citing this as their most important consideration. Additionally, style and material were identified as important factors to around half of the elderly people surveyed, with 138 and 117 participants respectively. Only a small proportion of the elderly respondents, 55, were concerned about brand and 48 were concerned about leisure and health. Finally, collection value and other were the least concerning factors, as only 7-8 participants selected these options. When proposing a design approach, the first consideration should be quality, price, and function. While style and material should not be ignored, they should not take priority over these key factors.

So far, society has often overlooked the elderly due to their unique lifestyle in China. The elderly tend to hold a humble attitude towards life, are concerned about being a burden to their children, and wish to accomplish something in order to gain respect from others and

feel a sense of self-worth. They are not willing to acknowledge the waning of their physical strength and energy, which is an integral part of elderly culture. With the growth of China's economy and the overall enhancement of the population's quality of life, the elderly require not only essential material goods but also enrichment from spiritual and cultural activities. Given the pressure to survive across all societal classes, it is challenging to meet the elderly's need for respect, which the designer should pay attention to.

According to the aforementioned characteristics, the design of Elderly-friendly Home Furniture should pay attention to the visual, tactile, auditory and balance abilities of the elderly, and focus on the psychological needs of the elderly. For instance, Elderly-friendly Home Furniture must provide appropriate support to compensate for the limited balance and body strength of the elderly. It should offer a stable grip and be resistant to tipping over in order to reduce the risk of falls due to dizziness, balance problems, and delayed response. Furniture should also avoid sharp edges that could pose a risk to elderly individuals with visual impairments. Additionally, furniture should avoid excessively complex surface patterns and textures that may cause difficulties for elderly individuals with visual spatial perception. Attention should be paid to colour balance and the use of rough surfaces to minimise glare and improve perception when in contact with the furniture.

In conclusion, the physiological perception and cognitive characteristics of the elderly are completely different from those of the young due to ageing, and the change in social status due to retirement is likely to make the elderly feel lost, lonely and frustrated (Luo, 2018). The elderly desire recognition and respect from society and seek sources of support and enjoyment in their later years. Specific to furniture design, the focus should be

on creating a balanced and visually pleasing aesthetic that meets the physiological and psychological needs of elderly consumers.

4.3.3 Behavioural Characteristics of the Elderly

i. Behaviour

The concept of behaviour is defined in different disciplines, with different emphases depending on the field. According to Ma Guoquan et al (1992), in the Dictionary of New Words in New Era, behaviour denotes the actions and potential of individuals or collectives, as well as the means by which they accomplish their objectives. Behaviour manifests intent, enterprise, variation, adaptability, among other attributes, and represents the interplay between individuals and their surroundings. This definition implies that behaviours are interconnected with the surrounding environment and do not exist in isolation. Nonetheless, due to the complex nature of behaviours, characterized by diversity and initiative, research encounters considerable challenges, such as uncertainty and randomness.

It is apparent that behaviour is diverse and complex due to different subjects and changes in the environment, so researchers need to extract the basic characteristics that are representative and have specific guiding effect. This research takes the elderly as the subject of behaviour and the home environment as the scope of behavioural activities to explore the behavioural characteristics of the elderly in the home environment. For furniture design, the connection between "individuals" and "objects" arises in the product design and usage process. Analysing user behaviour patterns could assist designers in gaining insight into the actual and possible needs of users, thus identifying innovative furniture design concepts, and proposing suitable solutions. Based on this, this research adopted the behavioural

characteristics of elderly people in the home environment as the starting point for analysing elderly-friendly home furniture design.

ii. Behaviour characteristics of the elderly in place

The maintenance of established behaviours is a key aspect of the behaviour system among the elderly population. The aim is to encourage initiative, diversity, flexibility, and plasticity, whilst fostering common behaviours that support their daily activities. For instance, older adults tend to decrease their participation in social activities due to declining physical function, resulting in a gradual reduction of interpersonal communication and, subsequently, a heightened sense of psychological loneliness. During their later years, seniors generally prefer a peaceful environment, away from the hustle and bustle. Often living alone, the elderly receive less care from their children who are preoccupied with their jobs. Therefore, the elderly couple typically assist each other with daily tasks, including cooking, laundry, cleaning, and shopping. Elderly individuals are often frugal, have ample time to cook themselves, and utilise their kitchen extensively whilst also paying close attention to the nutritional value of their food. As a result of declining health, the elderly often experience physical weakness and frequent usage of the toilet. Due to a decline in memory ability, the elderly may sometimes forget to turn off gas, water pipes, range hoods, and important items' locations. The elderly often enjoy watching TV and listening to the radio and tend to sleep early at night. Due to changes in body function, the elderly often feel tired and experience insomnia at night.

To improve comprehension of the behaviour of the elderly in place, the behaviour of the elderly at home were classified according to the frequency of occurrence by assigning values. Some of the common home behaviours such as sleeping, resting, toileting,

housework, cooking, cleaning, jogging, daze and reading etc, were listed to 9 interviewees who came from Community A (commercial community), Community B (economical community), and Community C (demolition and lane community). These behaviours were rated on a scale of "often do, sometimes do, occasionally do, never do", with corresponding values of 4, 3, 2, and 1. Using a weighted average method, the value for each behaviour was calculated and the elderly participants' home behaviours based on their frequency of occurrence were classified.

Based on the survey of occurrence frequency, it could be concluded that the Essential Activities of elderly individuals residing at home included resting, napping, using the toilet, performing household chores, eating, and cooking, accounting for 95% of occurrences. Additionally, some Recreational Activities, such as watching television, listening to the radio, playing cards, sunbathing, browsing the internet, participating in morning exercise, and walking, are also prevalent, in addition, communication behaviours, such as chatting, calling, and family visits, account for 85% of the frequency of occurrence. With a small number of self-fulfilling Activities such as studying and looking after children accounting for 57%. These types of activities are progressively shifting from survive-oriented to leisure-oriented and, ultimately, towards enrichment-oriented activities.

Among them, Essential Activities are those that are necessary for daily life and can be divided into basic physiological behaviours, such as eating, sleeping, and washing, and daily supporting behaviours, such as cooking, laundry, and cleaning, which occur most frequently. Recreational Activities pertains to voluntary leisure activities of older adults that take place under permit conditions, such as morning exercise, walking, and jogging. Self-fulfilling Activities, such as calligraphy, reading newspapers, and participating in public

welfare activities, allow older adults to realize their values and gain psychological satisfaction. Obviously, when comparing Essential Activities and Recreational Activities, Self-fulfilling Activities are not the primary behaviours in the daily life of older adults. Thus, this research focuses on operational furniture (choose cabinet as sample) that can help the elderly to achieve Essential Activities, on the foundation of this basic research, the designer can gradually expand and refine to other types of furniture categories in the future.

Table 4.7: Classifications of Elderly People's Behaviorus in Place

Activity type	**Activity contents**	**Frequency of occurrence**
Essential Activities	Basic physiological behaviour: eating, sleeping, resting, toileting	95%
	Daily activities that assist basic physiological activities: housework, cooking, cleaning	
Recreational Activities	Watching TV, playing cards, morning exercise, walking, jogging, daze, surfing internet, chat, phone, family visiting	85%
Self-fulfilling Activities	Studying, calligraphy, reading newspapers, public welfare activities, etc	57%

The elderly also were asked to describe their main activities each day in sequence, from waking up in the morning to going to sleep at night. The key words for the activities of the nine elderly interviewed were washing up, taking breakfast, morning exercise, shopping or seeing doctor, socialising or leisure, watching TV, taking lunch, taking a nap, relaxing, preparing dinner, walking or relaxing, washing up, going to bed. Apart from essential grocery shopping and medical treatment, the majority of older people's activities took place in their own homes and communities.



Figure 4.32: Daily Basic Behaviours for the Elderly by Interview

Observation is the optimal research method for obtaining detailed data on the behaviour of older individuals in a given setting. As previously discussed in Chapter 3, two elderly were selected as observation participants, one being a family member of the researcher and the other being an older person whose home is equipped with a surveillance system. The researcher observed each participant for one day and recorded their behaviour every hour. The obtained data are shown in Figure 4.33 and 4.34.



Figure 4.33: Daily Behaviours of Observation Participant I

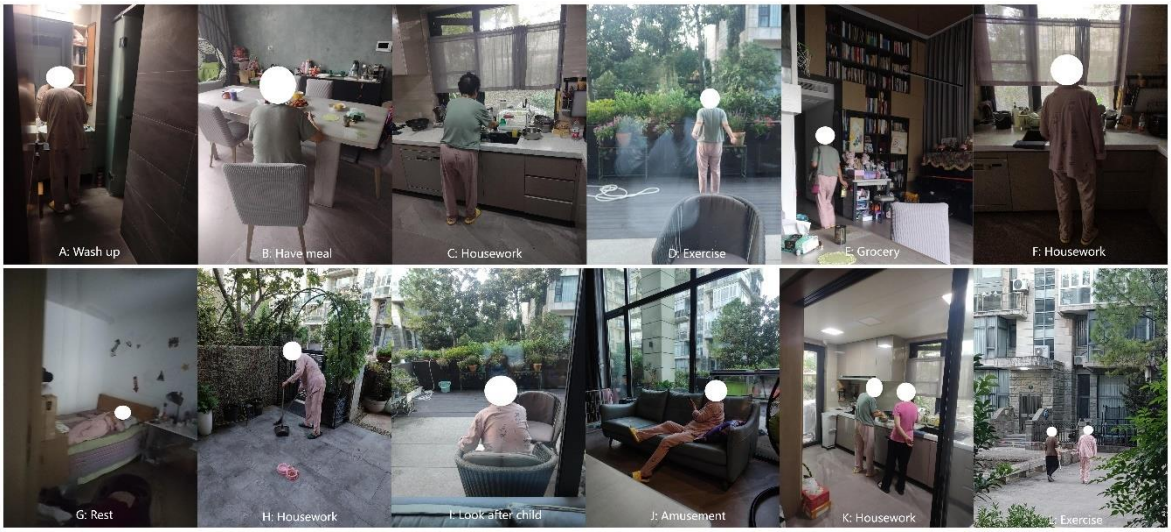


Figure 4.34: Daily Behaviours of Observation Participant II

Table 4.8 : The Daily Behaviours Summary of Participants I and II

Time	Have meals	Sleep	Rest	Wash up	Grocery	House work	Exercise	Amuse-ment	study	Look after children
6AM				*						
7AM	*			*						*
8AM					*	*	*			
9AM					*	*	*	*	*	
10M			*			*		*	*	
11M	*					*		*	*	

Table 4.8 continued

12M	*									
1PM			*							
2PM								*	*	
3PM			*			*		*	*	
4PM						*				*
5PM	*					*				
6PM	*					*	*			*
7PM							*	*		
8PM								*	*	
9PM		*	*						*	
10PM		*	*							

Note: Bule boxes indicate behaviours tend to not use kitchen cabinet (64%). Orange boxes indicate behaviours tend to use kitchen cabinets (36%).

It is evident from Table 4.8 that the daily routine of two elderly individuals were as follows: (1) waking up early, (2) performing morning hygiene tasks, (3) having breakfast either at home or outside, (4) engaging in grocery shopping or morning exercise, doing household activities, (5) spending leisure time at the elderly activities centre, such as chatting, playing chess or exercising in community park, (6) returning home and preparing lunch, (7) taking an afternoon nap, (8) watching television/cell phone etc., (9) having dinner, (10) going for walk after dinner, (11) cleaning face and teeth and going to bed.

It could be concluded from Table 4.7 that, a total of 45 different types of behaviours were observed throughout the day for both older people, of which 16 were related to the kitchen cabinet, e.g. eating, housework, accounting for 36% of the total type of behaviours, and 29 behaviours were not related to the kitchen or cabinet, accounting for 64% of the total

type of behaviours. This suggests that kitchen cabinet are a frequently used piece of furniture for the elderly among many pieces of home furniture.

iii. Behaviour Parameters of the Elderly in Place

The elderly body's dimensions form the fundamental basis for designing furniture tailored for the elderly. As stated in Chapter 1, this research focuses on elderly individuals in Shanghai. Therefore, it is appropriate to reference the findings of Chinese scholars when considering ergonomics parameters. The average dimension of the elderly in China, as depicted in the Figure 4.35, provides a reference for this purpose.

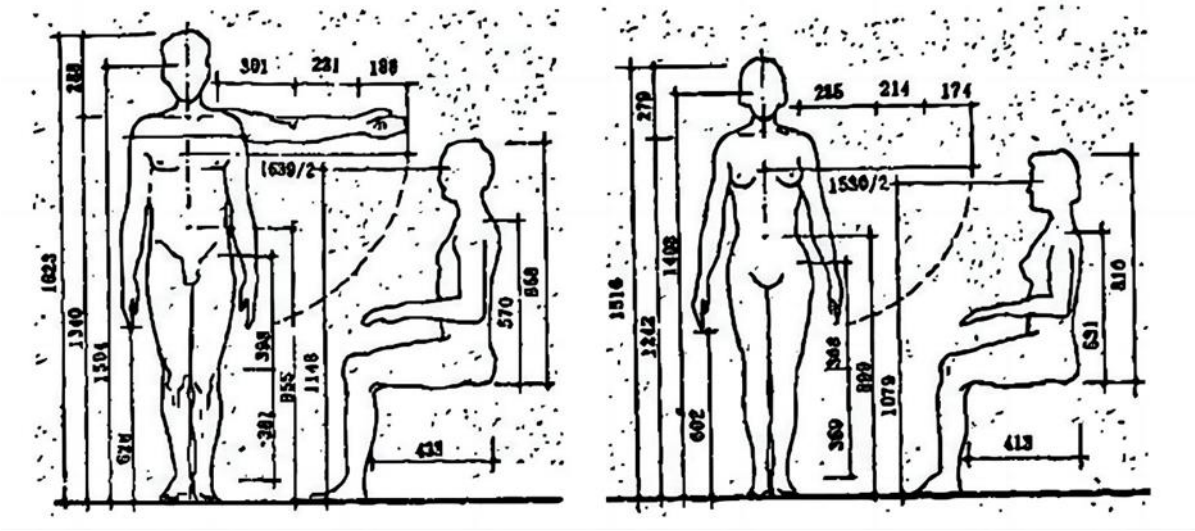


Figure 4.35: Body Dimensions of Elderly Males (left) and Females (right) in China (Resources: Hu Yenlu & Ma Guang, Design of Living Environment for the Elderly)

Hu & Ma (1995) found that the average static height of Chinese elderly men is between 1630 to 1700 mm, and the average height of Chinese elderly women is between 1530 to 1610 mm. Based on the static touch height (vertical touch height of the arm when standing), the average height of elderly males is between 2033 to 2061 mm, while the

average height of elderly females is approximately 1883 mm. These heights are lower than the general touch height of young adults. Therefore, the top height of furniture designed for the elderly should be reduced to prevent inconvenience and falls when reaching for items in high places.

In addition to Self-helping Aged People, this study also focused on the human mobility dimensions of Device-helping Aged People, the dimension parameters for wheelchair users are presented in Figures 4.36.

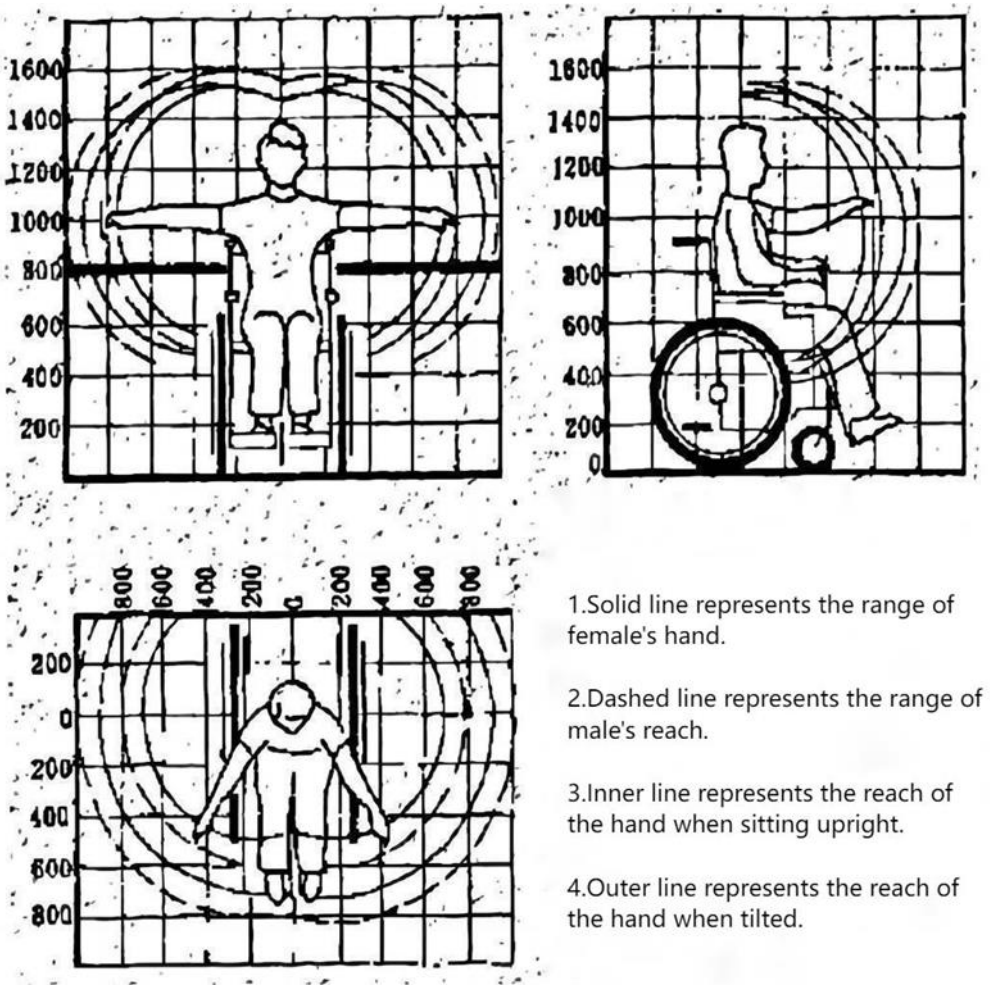


Figure 4.36: Body Dimensions of Wheelchair Users (Resources: Zhang Yiman, Architectural Design Sourcebook)

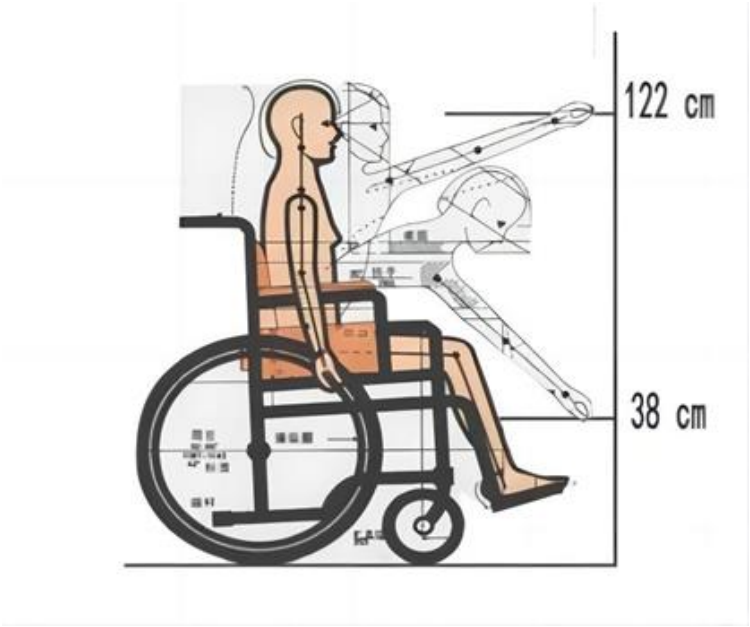


Figure 4.37 : Arm Upper and Lower Scope of Wheelchair Users (Resources: Wang Yanling, Art Exploration)

For wheelchair-bound elderly individuals，their range of motion in their upper and lower extremities is restricted. Based on the measurements in Figure 4.37, the upper height range for elderly individuals in wheelchair is 122cm, while the lower height range is 38cm from the ground. Consequently, furniture with height between 38cm and 122cm is the most suitable for Device-helping Aged People in wheelchair, as they could access items easily (Wang, 2008).

4.4 General Requirement Collection of the Elderly for Furniture

The data collection and analysis in sections 4.4 and 4.5 were mainly derived from the questionnaire, therefore the reliability and validity of the questionnaire is of utmost importance. the questionnaire is divided into three parts, which are:

i. Characteristics of the Elderly

ii. Furniture Use Habits

iii. Furniture Use Demands

SPSS software was used to check the reliability and validity of the questionnaire. The result of the reliability analysis is shown in the Table 4.9.

The Cronbach's Alpha analysis was used to assess the reliability of the questionnaires. This index is normally used when there are multiple choice or ranking questions in a questionnaire that form a scale, and the researcher wishes to determine if the scale is reliable. Cronbach's alpha ranges from 0 to 1, and values above 0.8 consider to be a high level of reliability, values between 0.7 to 0.8 consider to be good and values above 0.6 is acceptable for exploratory research, while values below 0.6 are considered as not acceptable.

Table 4.9: Detailed Results of Reliability analysis-- Cronbach's alpha to Questionnaire

Question category	**Cronbach's alpha**		
	Highest	**Lowest**	**Average**
Part I: Characteristics of the Elderly	NA	NA	NA
Part II: Furniture Use Habits	0.930	0.745	0.862
Part III: Furniture Use Demands	0.908	0.638	0.785

According to the reliability analysis of the questionnaire in Table 4.9, the Part I comprised of demographic questions, which were not applicable (NA) for the reliability analysis. Questions in Part II have high level of reliability as evident by the highest value of 0.930 and lowest value of 0.745, which are relatively high. The average value is 0.862, which

was within the good range. The reliability of the questions in Part III was also generally high, with a maximum value of 0.908 and a mean value of 0.785, which was also within the good range. The minimum value, although slightly lower at 0.638, was still acceptable. In other words, the questionnaire of this research has a good level of reliability.

To assess the validity of the questionnaires, the KMO（Kaiser-Meyer-Olkin）analysis was performed. It was proposed by Kaiser, Meyer and Olkin in 1974 to assess the validity of factor analysis. The index is normally used when there are multiple choice or ranking questions in a questionnaire that form a scale, and the researcher wishes to determine if the scale is valid. KMO ranges from 0 to 1, and values above 0.8 are considered to be a high level of validity, values between 0.7 to 0.8 are considered to be good and values between 0.6 to 0.7 are acceptable, while values below 0.6 are considered not acceptable.

Table 4.10: Detailed Results of Validity analysis-- KMO to Questionnaire

Question category	**KMO (Kaiser-Meyer-Olkin)**		
	Highest	**Lowest**	**Average**
Part I: Characteristics of the Elderly	NA	NA	NA
Part II: Furniture Use Habits	0.948	0.605	0.814
Part III: Furniture Use Demands	0.895	0.704	0.802

Based on the validity analysis of the questionnaire in Table 4.10, Part I comprised of demographic questions, which were not applicable for the validity analysis as well. The questions in Part II achieved a maximum validity score of 0.948 and a minimum of 0.605, which was slightly lower but above the acceptable level, with an average score of 0.814, indicating that the overall validity of this part was high. The highest and lowest validity

values for Part III of the questionnaire were 0.895 and 0.704 respectively, which meant that the values clustered in a relatively high range, resulting in an overall validity value of 0.802 for this part, which was a high level of validity. So, the questionnaire of this research has a good level of validity.

4.4.1 Characteristics Analysis of Participants

As designed in Chapter 3, 50 elderly individuals over 60 years old from three residential communities respectively in Shanghai were chosen as the participants for the questionnaire. These three communities (A, B, and C) represented typical community types in Shanghai, which were: A commercial community, B economical community, C demolition community and Lane. The remaining participants were selected randomly from public environments such as parks, community centres, etc.

The questions for participants were set based on demographic factors such as gender, age, income (with or without a pension), and so on. The data collected is presented in Figure 4.38.

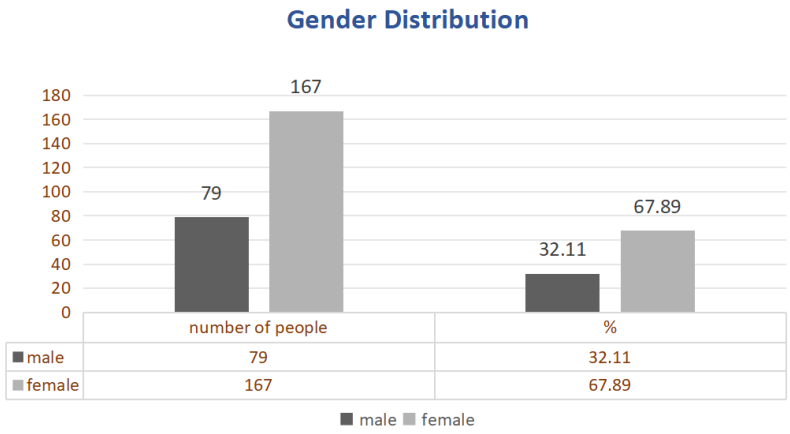


Figure 4.38: Gender Distribution of the Elderly in Questionnaire

Gender Distribution: The questionnaire had 246 participants, 79 of whom were male, making up 32.11%, and 167 were female, accounting for 67.89% of the total demographics. There were nearly double the numbers of elderly women than elderly men.

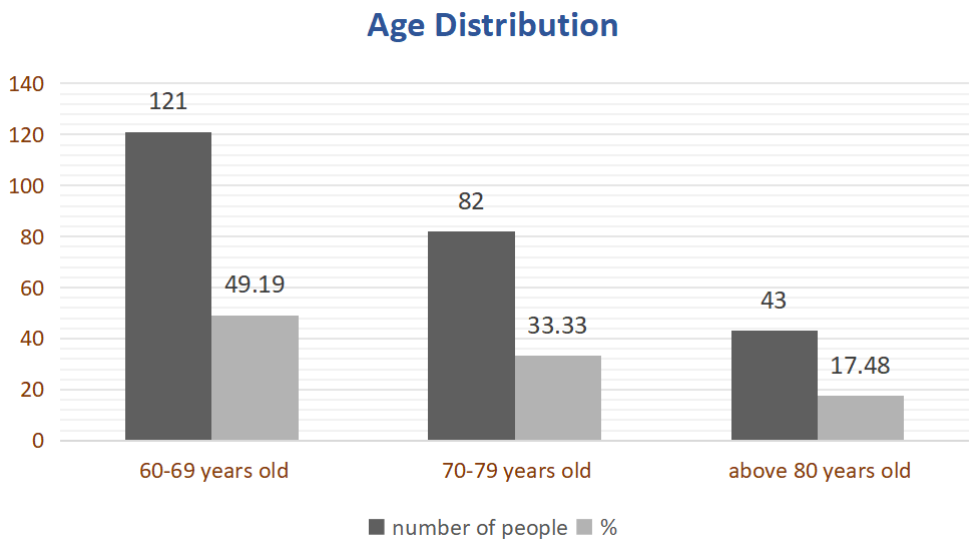


Figure 4.39: Age Distribution of the Elderly in Questionnaire

Age Distribution: Among the 246 participants, 121 elderly were between 60 and 69 years old, accounting for 49.19%, 82 were between 70 and 79 years old, accounting for 32.33%; and 43 were over 80 years old, accounting for 17.48%. This indicated that almost half of the elderly people in Shanghai living at home were under 69, almost three-quarters were under 79, and not many were over 80. Elderly people under 80 years of age constitute the mainstream of those investigated, and these elderly people are in better health condition than those over 80 years of old, suggesting that vigorous elderly (Self-helping Aged People and Device-helping Aged People) constitute the mainstream of ageing people in place and that it is reasonable to take them as research subjects in this study.

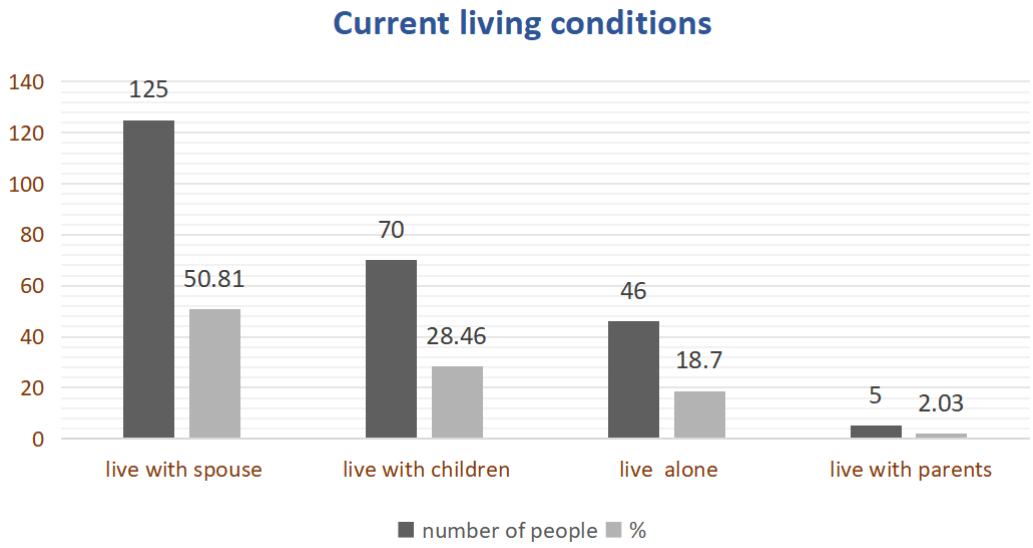


Figure 4.40: Current Living Condition of the Elderly in Questionnaire

Current Living Condition: As shown in Figure4.40, 125 (50.81%) lived with their spouses, followed by those who lived with their children 70 (28.46%), 46 (18.7%) lived alone, and only 5 (2.03%) lived with parents. This adhered to the conventional Chinese attitude towards Ageing, which is to live as much as possible in one's own home with one's own space. Most individuals who resided with their children did so to help look after their grandchildren or were looked after by their children as they aged, which was in line with Chinese tradition.

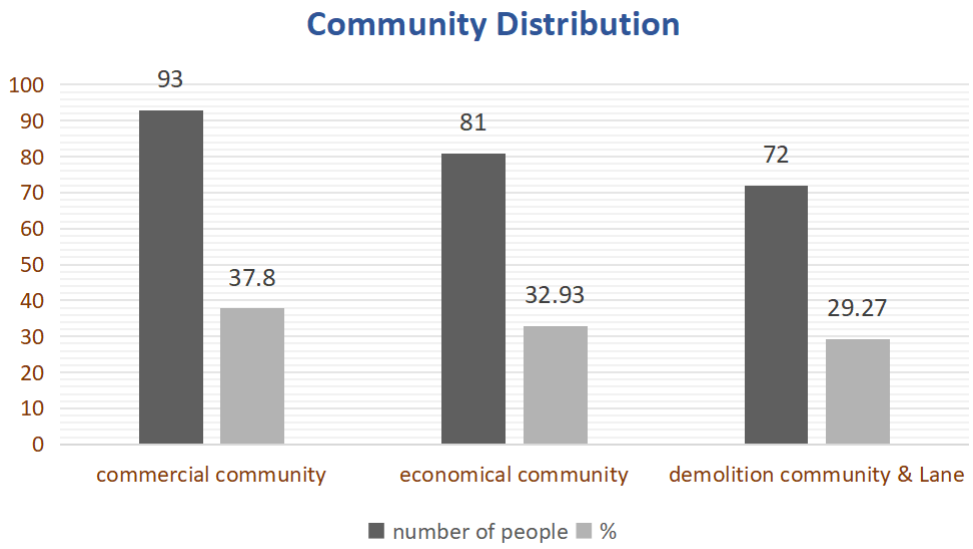


Figure 4.41: Community Distribution of the Elderly in Questionnaire

Community Distribution: 93 people lived in commercial community, 81 lived in economical community and 72 lived in demolition community or Lane. The percentages were approximately similar or even, at 37.8%, 32.93%, and 29.27% respectively. The data confirmed that these three types of communities were very representative in Shanghai. Therefore, this study selected 50 participants from each of the three community types to conduct a questionnaire survey, which is in line with the current living situation of the elderly in Shanghai, and the research object is representative and realistic value.

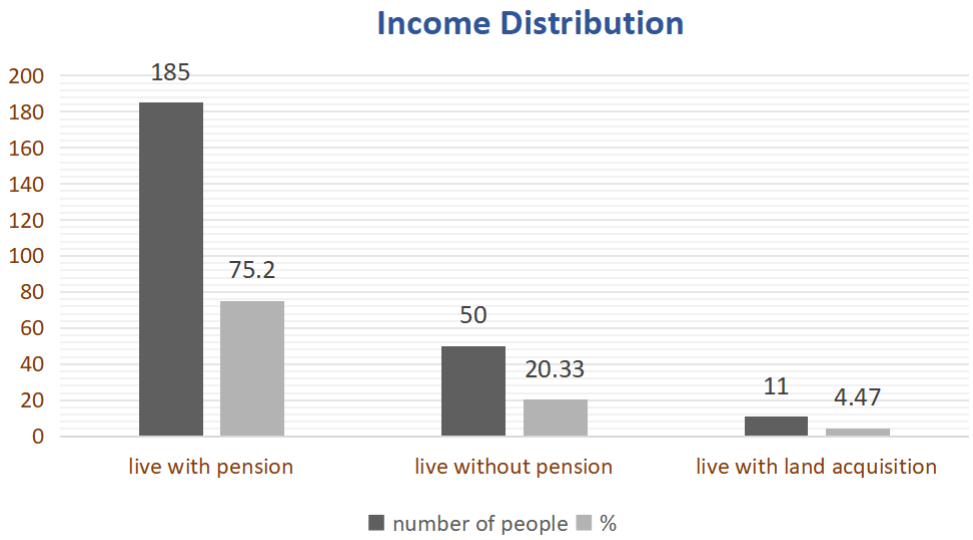


Figure 4.42 : Income Distribution of the Elderly in Questionnaire

The distribution of personal income: 185 of the respondents (75.2%) had pensions, 50 elderly (20.33%) had no pension and relied on other means for living, and 11 elderly (4.47%) lived with land acquisition, which might be local peasants. The dominant form of income remained reliance on pensions, which accounted for three-quarters of elderly people. It is indicated that the majority of elderly individuals possess a pension. The average pension for elderly in Shanghai is 5,000RMB, which is sufficient to meet their daily needs. Improved financial status enables the elderly to pursue a higher quality of life. This data is consistent with the results in Figure 4.31, which found that quality, rather than price, was the most important factor for the elderly when purchasing furniture.

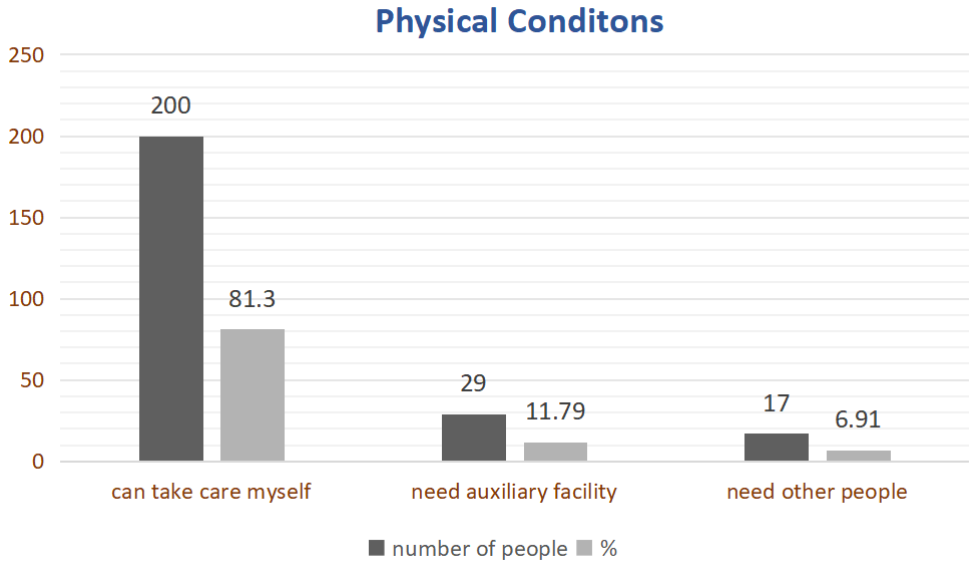


Figure 4.43: Physical Condition Distribution of the Elderly in Questionnaire

Physical condition Distribution: The data showed that out of the 246 respondents, 200 were considerable healthy and able to take care of themselves, were Self-helping Aged People, accounting for 81.3% of the respondents. This was higher than the number of Device-helping Aged People and Under-Nursing Aged People, which were only 29 and 17 elderly, accounting for 11.79% and 6.91% respectively. This significant difference indicated that the community in Shanghai was dominated by Self-helping Aged People. Once again, it has been validated that selecting Self-helping Aged People and Device-helping Aged People as the target population of this study is reasonable.

4.4.2 General Requirement Collection of the Elderly for Furniture

Before commencing this part of the survey, a preliminary question to find out how satisfied the elderly were with their current furniture was asked.

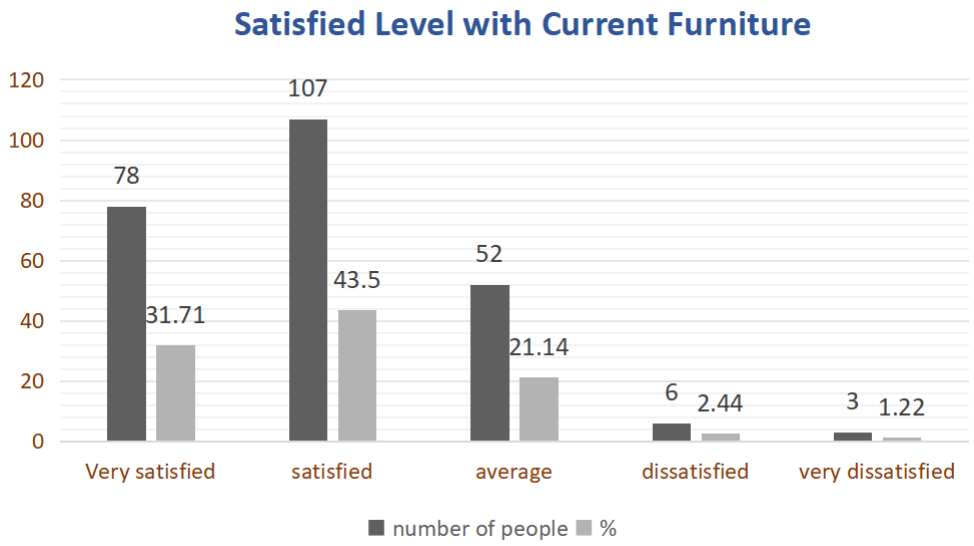


Figure 4.44: Satisfied Level of the Elderly with Current Furniture in Questionnaire

The findings showed that generally, the elderly were satisfied with their current furniture. Among the 246 respondents, 31.71% were satisfied and 45 % were very satisfied with their current furniture while only 2.44% were dissatisfied and 1.22% were very dissatisfied. 21.14% of the respondents' feelings were average. The number of satisfied elderly people was significantly higher than the number of dissatisfied elderly people. It was interesting results, because the follow-up survey also showed a high demand for retrofitting as well. This situation was contradictory, indicating that the elderly did not have a clear understanding of elderly-friendly furniture when starting the questionnaire. However, as they delved further into the questionnaire, they became aware of the various issues related to the current furniture, which deepened their understanding of elderly-friendly furniture and stimulated the demand for retrofitting.

In this part, data on the current furniture of the elderly was first collected. The questionnaire results indicated that the most commonly owned furniture by the elderly

consisted of bed, besides table, wardrobe, kitchen cabinet, dining table/chair, TV cabinet, coffee table and sofa, with more than 200 of the 246 respondents having them at home indicating that this furniture was very popular and were closely associated with the daily life of the elderly. Therefore, the selection of kitchen cabinets as the target of research was universal. This was followed by tables and bookcases, which were owned by 172 and 162 respondents respectively, indicating that reading was not a necessary activity for the elderly. 104 elderly had rocking chairs, due to its leisure function, whereas walking chairs, toilets and massage chairs were owned by a small minority of the respondents, with less than 100 elderly, indicating that these pieces of furniture belonged to the category of life improvement or auxiliary function which were not common for daily life. Therefore, this study began with the selection one of the most necessary furniture for the elderly, which was the kitchen cabinet as the research target, to be explored in terms of the design approach, and expanded to other categories when appropriate opportunities arise, which was practical way.

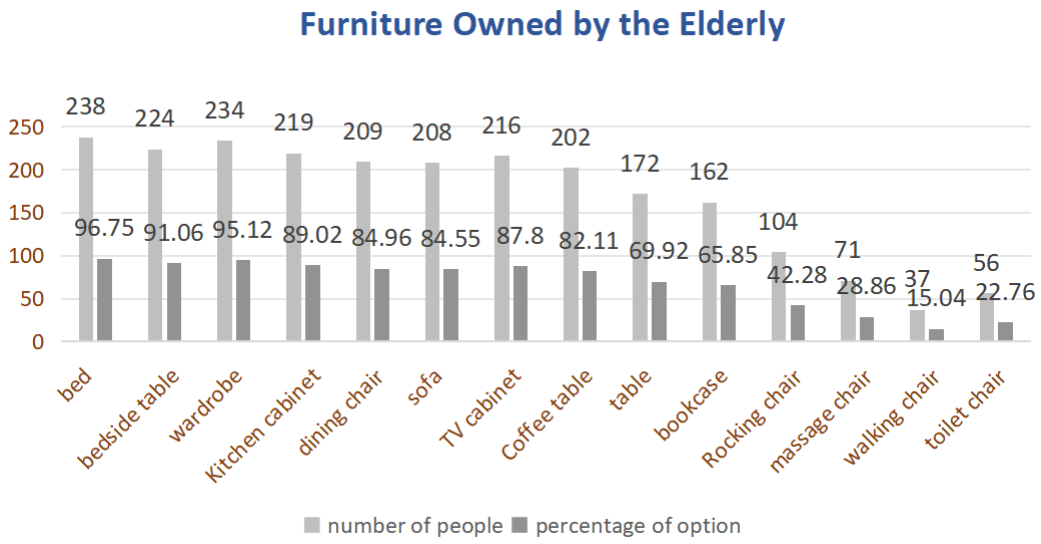


Figure 4.45: Furniture Owned by the Elderly in Questionnaire

Analysis of furniture use frequency could further explain the necessity of the furniture. The data revealed that the top five most commonly used pieces of furniture, in descending order, were beds, bedside tables, wardrobes, sofas and dining tables and chairs, chosen by 238, 185, 161, 124 and 129 respondents respectively. These furnishings provided the necessary support for sleeping, eating, dressing, and resting. Kitchen cabinets were selected by 119 respondents, ranking sixth in terms of use, and were used relatively frequent, showing that the choice of kitchen cabinets as the subject of the study was representative. Furthermore, the frequency of the remaining furniture's use significantly decreased, with 80,69,35 and 13 individuals selecting coffee tables, TV stands, tables and bookcases respectively. Massage chairs and rocking chairs were chosen by 29 and 25 people respectively, while walking chairs and toilet chairs were the least frequently used, selected by only 12 and 11 people respectively. Once again, it was verified that the elderly's behaviours at home were mainly essential activities such as eating, sleeping, and dressing, and therefore the choice of the kitchen cabinet as research target was representative.

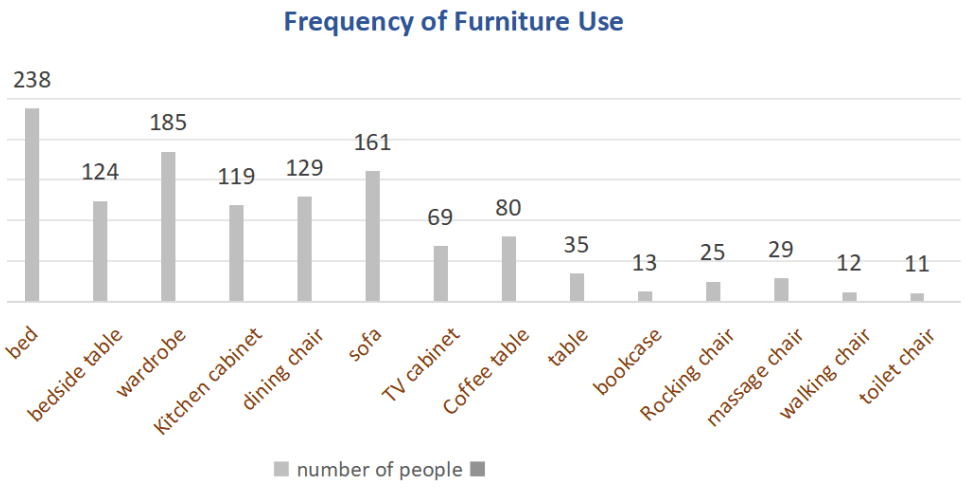


Figure 4.46: Frequency of Furniture Use by the Elderly in Questionnaire

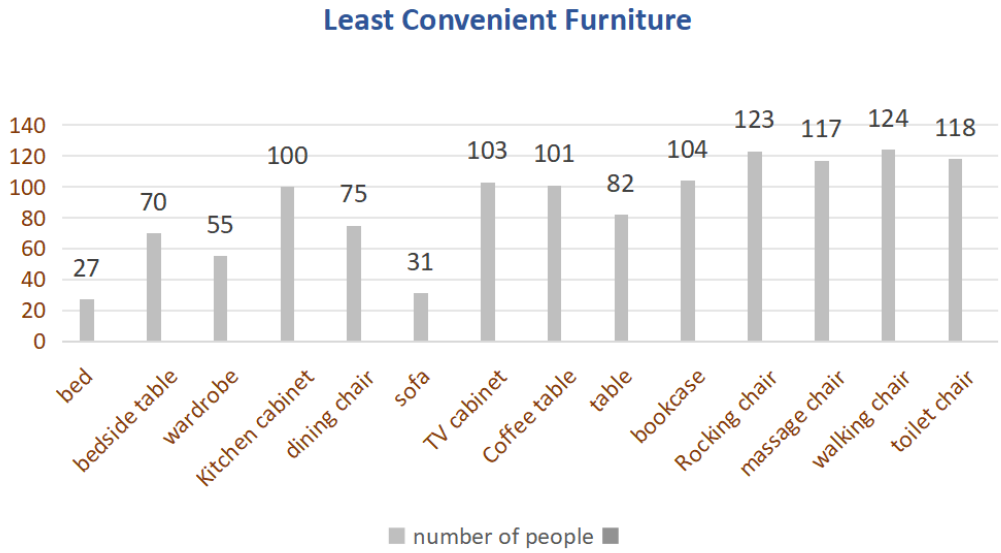


Figure 4.47: Least Convenient Furniture Chosen by the Elderly in Questionnaire

Furniture perceived as inconvenient by the elderly should be analysed to design furniture that caters to their needs. Therefore, it was crucial to identify the problematic furniture to achieve effective design. The questionnaire results revealed that furniture that was rarely used, specifically rocking chairs, walking chairs, massage chairs, and toilet chairs, were the most inconvenient for the elderly. These pieces of furniture were chosen by 124, 123, 118, and 117 seniors, respectively. Following this, bookcases, TV cabinets, and coffee tables were the next most inconvenient furniture, chosen by 104, 103, and 101 seniors, respectively. This phenomenon indicated that a factor contributing to infrequent furniture use, in addition to its unsuitability for essential activities in place, was its inconvenience.

The top five most frequently used furniture items - beds, bedside tables, wardrobes, sofas and dining tables and chairs - were chosen by 27, 70, 55, 31 and 75 respondents respectively, showing that the eldelry were still satisfied with them. Out of the frequently used furniture, only kitchen cabinet was considered inconvenient to be used by the elderly,

chosen by 100 elderly people, and had the highest dissatisfaction level among the frequently used furniture, therefore, there was an necessity to choose kitchen cabinet as the target of the research, this is in line with what the researcher found in literature review.

Materials are essential for furniture design and production, and functions have to be achieved through materials. The furniture materials possessed by the elderly and the materials expected by the elderly would be an important reference for the furniture design. For detailed data and analysis, see Figure 4.48 and 4.49.

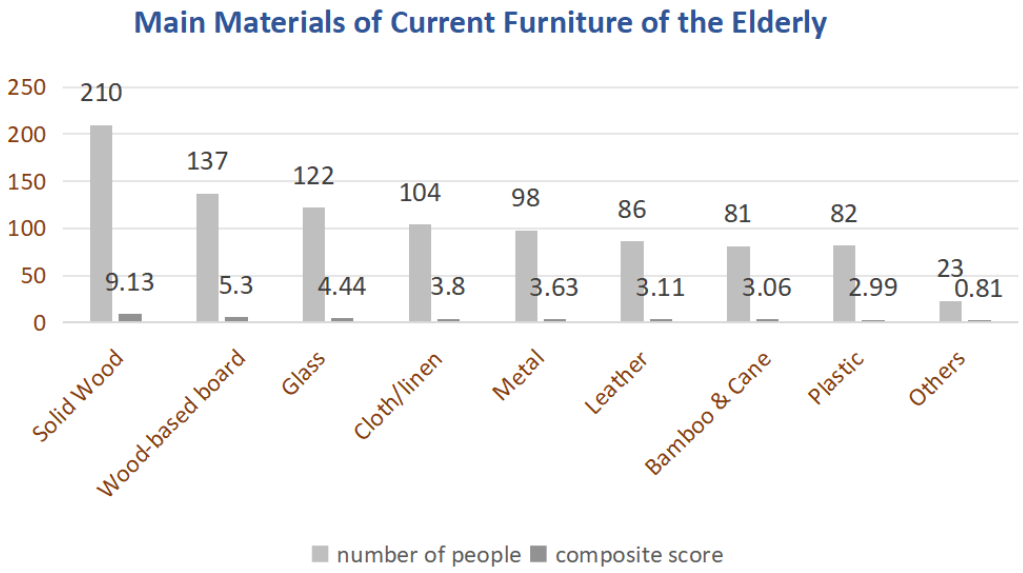


Figure 4.48: Materials Possessed by the Elderly in Questionnaire

The survey regarding the current furniture materials of the elderly required respondents to select four types of furniture in order of number owned, and the data showed that of the total 246 participants, 210 elderly people owned furniture made of solid wood materials, which was significantly higher than the second most popular material, which was board material furniture. Next, 137 seniors possessed wood-based board furniture and 122

seniors possessed glass furniture, as these materials were commonly used in the modern industry. Cloth and metal furniture were owned by about the same number of seniors, 104 and 98 respectively, as these two materials were also common. Leather, bamboo and rattan, and plastic furniture were owned by approximately 1/3 of the total number of elderly people, which was not significant.

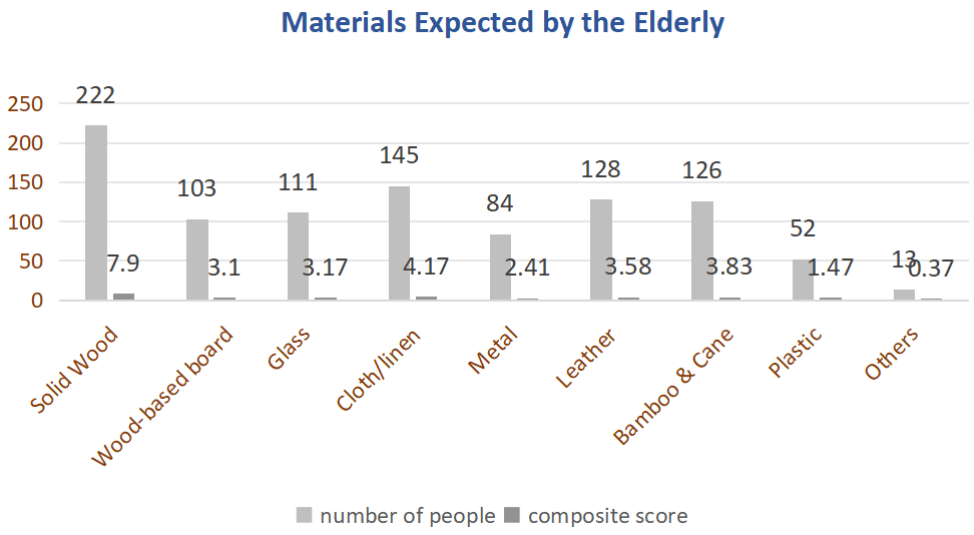


Figure 4.49: Materials Expected by the Elderly in Questionnaire

Among the materials expected by the elderly, they were asked to list the four most expected materials in order of preference. Solid wood emerged as the most favoured material due to its environmental friendliness and natural texture, with 222 out of 246 participants choosing it. Cloth was the second most popular material for the elderly due to its friendly texture and affordability, with 145 older people choosing it. However, the cleaning and replacement of fabric material was a factor to consider when designing, as the elderly would not dry clean it for financial reasons. Leather and bamboo rattan furniture were preferred by 128 and 126 elderly individuals, respectively, comprising approximately half of the total

participants. Leather is soft, durable and displays high-quality, while bamboo rattan has a natural texture that aligns with the psychology of the elderly. Glass and wood-based board were chosen by 111 and 103 elderly, less than half of the total number of people, glass is cold and fragile, but in line with modern design concepts, there is a certain degree of acceptance. Only 84 elderly people chose metal materials, which were not very popular. Only 52 people chose plastic materials, since it is poor in stability, has low quality, and is not in line with the elderly durable consumer psychology. There were 13 elderly individuals who selected other materials, indicating that the above materials basically covered the types of materials expected by the elderly.

4.5 Data Collection and Analysis on Kitchen Cabinet

As a core functional space, the kitchen plays an important role in the daily lives of the elderly. Nevertheless, kitchen designs today are primarily standardized with a focus on young and middle-aged individuals, often neglecting the specific requirements of the elderly when it comes to using the kitchen (Hu,2017).

Modern Chinese cabinets are influenced by Western design concepts. The typical structure comprises a suspended cupboard, a bottom cupboard, and a countertop. All cookware and equipment are combined into an overall arrangement that is unified up and down in two groups. The washing tank, stove, and meal preparation area are typically equipped in the bottom cupboard, the shelf and the top cupboard are typically equipped in the suspended cupboard; the middle wall between the suspended cupboard and the bottom cupboard is usually decorated with ceramic tiles or other waterproof materials. The cabinets consist of the cabinet body, door panel, countertop, hood, hob, sink, tap, other equipment and electrical appliances. Small kitchen appliances, including rice cookers, microwave ovens,

and conventional ovens, are very common. The kitchen cabinets as a whole appear to be the style of indoor furniture (Guide to Beautiful Home, 2022).



Figure 4.50: Modern Chinese Kitchen Cabinet

4.5.1 Kitchen Cabinet Use Habits of the Elderly

In the questionnaire survey, 246 valid questionnaires were collected, and the basic characteristics of the participants were analysed in section 4.4.1. In this section, an analysis of older adults' current kitchen cabinet use habits would be discussed based on questionnaire and interview data.

In addition to the quantitative research carried out through the questionnaires, according to the research methodology design in Chapter 3, qualitative interviews with nine older people from each of the communities A, B and C, were also conducted using a

combination of qualitative and quantitative methods to obtain more accurate information about the difficulties and needs of the elderly in using the cabinet.



Figure 4.51: Group Photos of the Researcher with 9 Interview Participants

The first question for the kitchen cabinet scenario was if there were kitchen cabinet in the elderly people's home. The questionnaire data revealed the following (Figure 4.52).

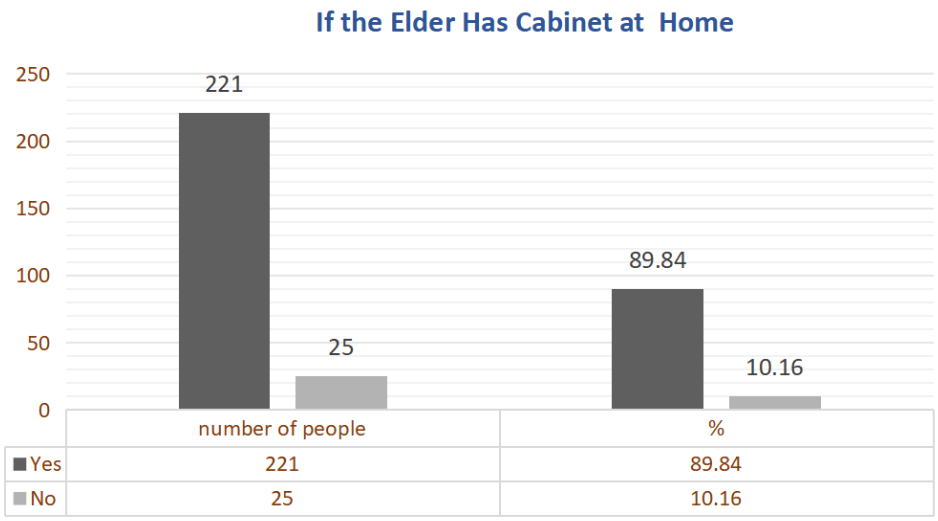


Figure 4.52: Kitchen Cabinet Ownership among the Elderly in Questionnaire

Among the 246 respondents, 221 (89.84%) had kitchen cabinet, and only 25 elderly (10.16%) did not have it, which showed that it was a very common furniture in the home of the elderly nowadays, which was worthwhile for research.

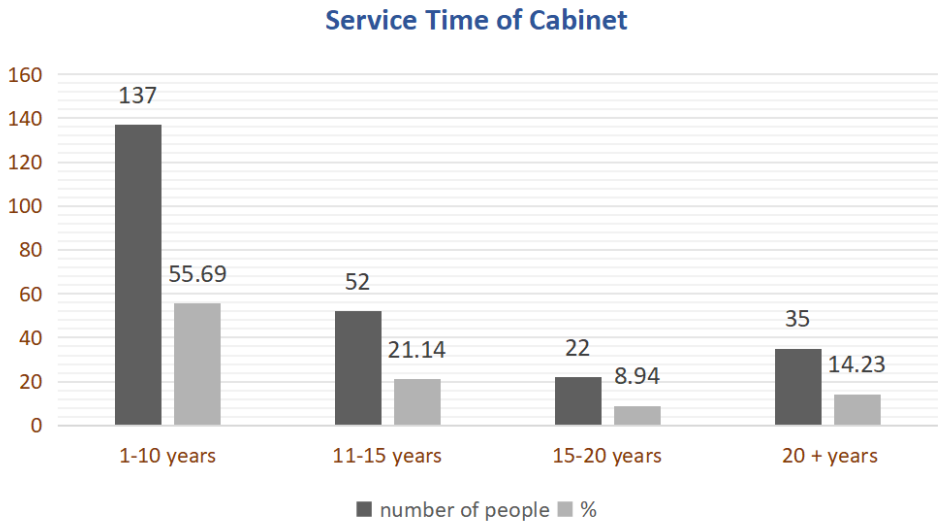


Figure 4.53: Service Time of Kitchen Cabinet

The investigation of the service time of the kitchen cabinet already owned by the elderly showed that a total of 137 elderly people (55.69%), had cabinets that had been in use between 1 and 10 years. The percentage of senior citizens with cabinets that were in use from 11 to 15 years declined drastically to 21.14%, while cabinets that were in use for 15 to 20 years were even less at only 8.94%. Kitchen cabinets that had been in used for more than 20 years accounted for 14.23%. This data showed that about half of the kitchen cabinet in Shanghai's older population were sub-new cabinets that have been in use for less than 10 years, and the other half were old cabinets that have been in use for more than 10 years.

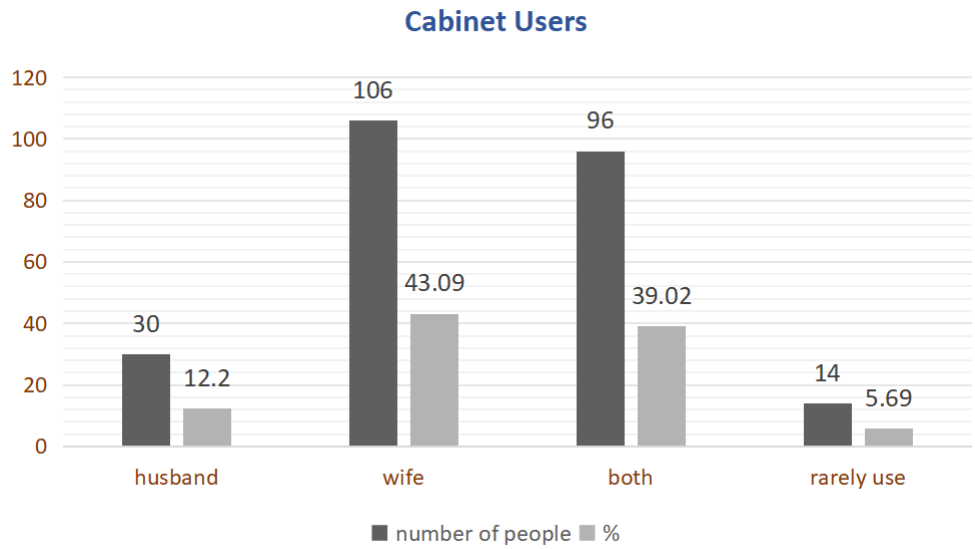


Figure 4.54: Kitchen Cabinet User by the Elderly in Questionnaire

The data regarding kitchen cabinet users were very distinctive, as shown in the Figure 4.54, in older families, the wife used the cabinets the most, 106 the elderly (43.09%), which was close to the number of husbands and wives (both) using the kitchen cabinet together, 96 the elderly (39.02%). The number of husbands who used the cabinet was only 30 (12.2%), which was in line with the real situation of Chinese families, i.e. wives do most of the kitchen

work, and some husbands were involved in cooking, could undertake basic auxiliary tasks like washing dishes and cooking rice, two people shared the kitchen, which was normal, but husband rarely cook alone. In addition, only 14 elderly individuals (5.69%) stated that they rarely use kitchen cabinet, which showed that the majority of elderly people cooked at home, so kitchen cabinet were high-frequency furniture in Chinese elderly families, it is worth to be researched.

Interviews with nine elderly individuals demonstrated that they eat 2-3 meals a day, basically meals were eaten at home, with breakfast consisting of boiled noodles or boiled congee and fried eggs. Lunch cuisine was generally rich, while dinner could range from simple and healthy to rich and sumptuous, depending on the individual's preferences, and here, the cabinet was frequently used. They tend to eat out when they have guests to avoid overworking. Those who lived with their children would cook 1-2 extra dishes after their children came home from work in the evening to show their concern, while it was simpler if they ate alone. Active elderly people wanted to cook independently, while elderly people with behavioural disorders tried to do it independently without disturbing their children.

The interview data indicated that a significant proportion of elderly individuals were involved in looking after their grandchildren, partly because their children were busy at work, and partly because the elderly took the initiative to help their children share their responsibilities.

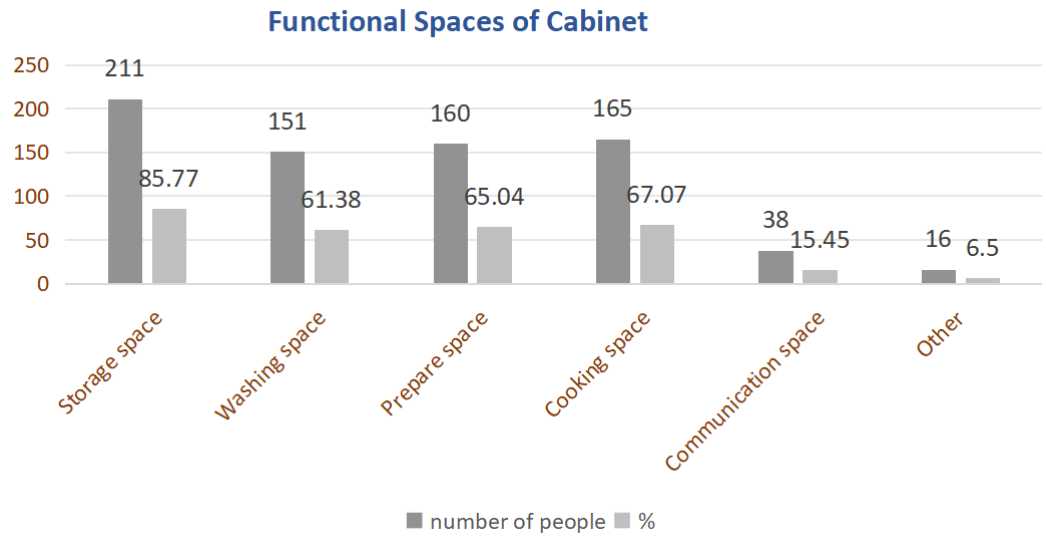


Figure 4.55: Functional Spaces of Kitchen Cabinet in Questionnaire

There are four essential functional spaces in kitchen cabinet: Storage Space, Washing Space, Preparing Space and Cooking Space. The Storage Space in the cabinet is the place to store food and crockery, mainly embodied as the suspended and bottom kitchen cabinet, as well as the refrigerator. The Washing Space is the place to clean food and wash utensils, with the sink as the main equipment for it, while the Preparing Space is the space that occupies most of the elderly's time in the kitchen, whereby it is the area for food processing, and the chopping board as well as various processing utensils are the main equipment for it. Finally, the Cooking Space is the core of the kitchen, where cooking activities can be completed and it is equipped with the stove, ventilation, and smoke exhaust equipment, as well as shelves or hangers for placing seasonings.

The questionnaire data showed that most of the elderly's kitchen cabinet had the basic four functional spaces, with Storage Space (211 people, 85.77%), Washing Space (151 people, 61.38%), Prepare Space (160 people, 65.04%) and Cooking Space (165 people,

67.07%). However, only 38 elderly individuals, accounting for 15.45%, had cabinets with Communication Space, which clearly does not meet the current situation of couples cooking together in the above section and the need for cooking displayed in the following section.

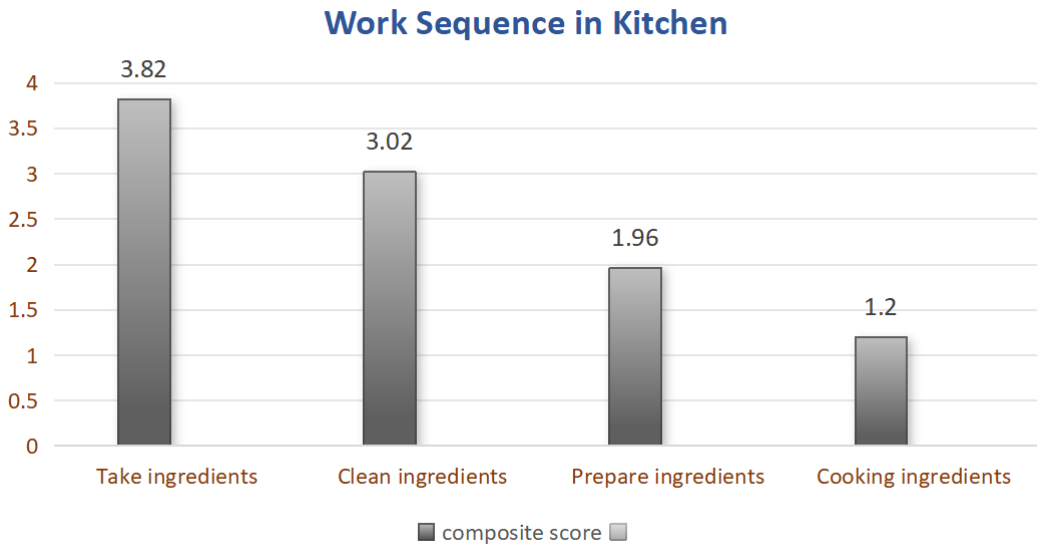


Figure 4.56: Work Sequence of the Elderly in Kitchen

For the investigation of the use sequence of the above four main functional spaces for the elderly, the ranking question was used, and the data showed that the first ranked activity was taking out the ingredients, the second was cleaning the ingredients, the third was preparing the ingredients, and the fourth was cooking the ingredients. This indicated that the kitchen operation sequence of the elderly was "taking out ingredients - cleaning ingredients - preparing ingredients - cooking ingredients," which aligned with the regular operation sequence as shown in the Figure 4.57.

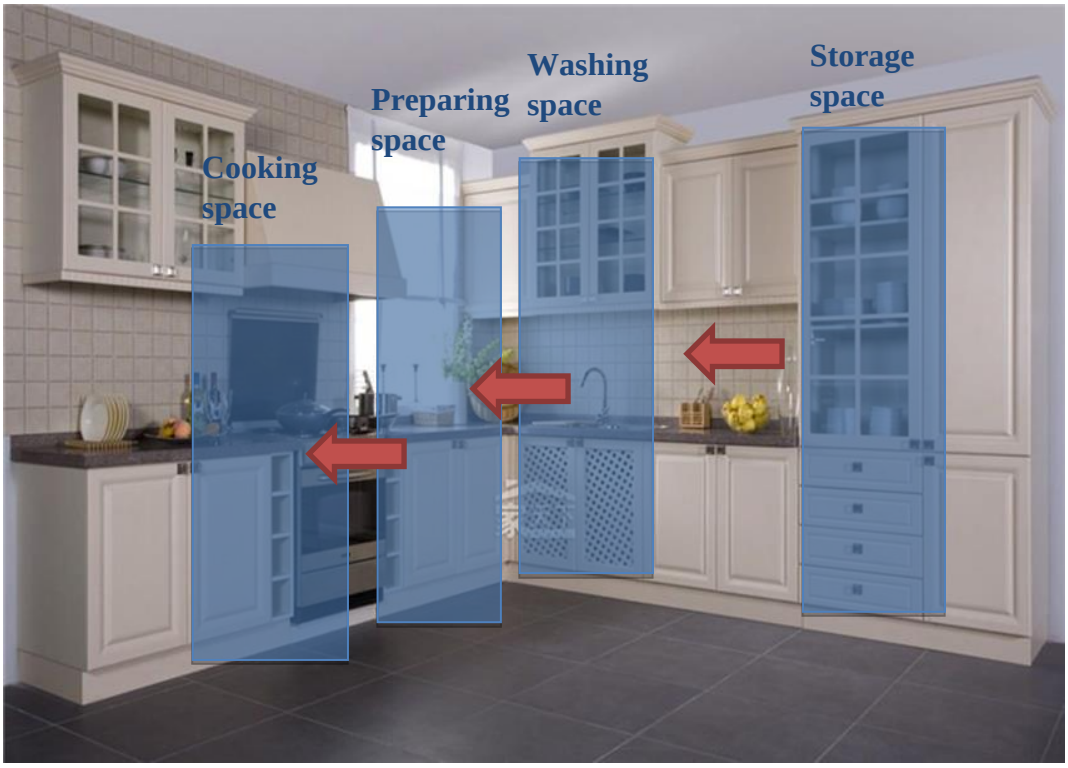


Figure 4.57: Kitchen Cabinet Functional Spaces and Operation Flow

The elderly often use three points in kitchen cabinet operation process: the refrigerator, sink, and cooker, which form the kitchen work triangle (Figure 4.58). To minimize the walking route of the elderly from the layout, the more compact the work triangle, the more concise the walking route of the elderly. The U-shaped and L-shaped layout of the cabinet and the work of the triangle is more compact, and this could effectively reduce the line of action circuitous.

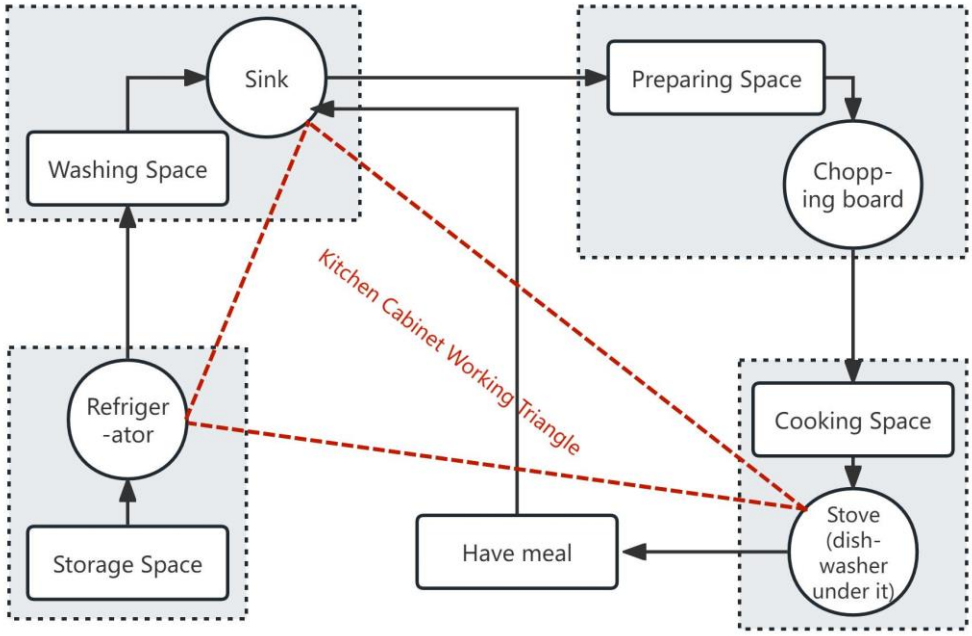


Figure 4.58: Kitchen Cabinet Working Triangle

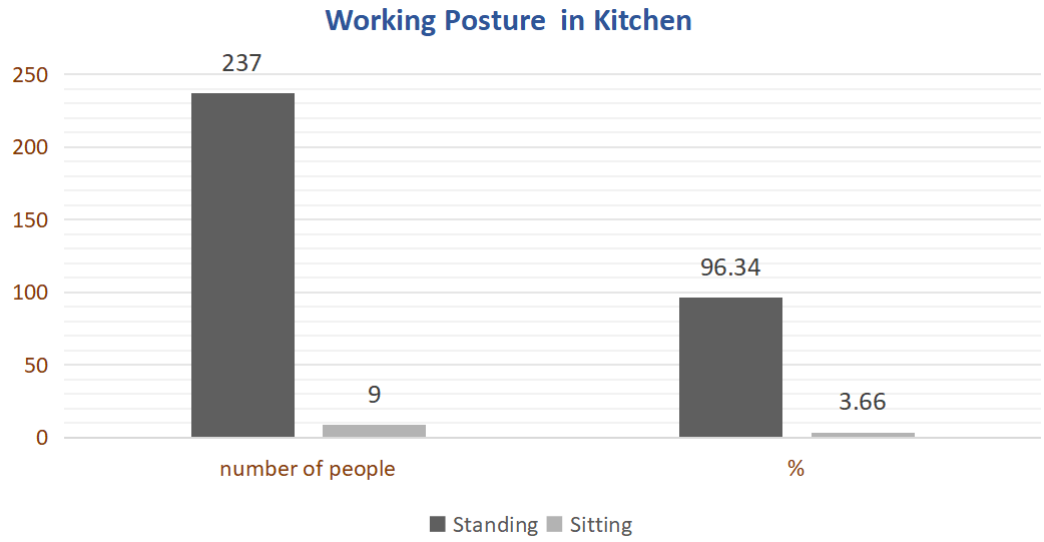


Figure 4.59: Working Posture of the Elderly in Kitchen

The working posture analysis of the questionnaire data showed that out of 246 elderly people, as many as 237 elderly people worked in a standing posture, accounting for 96.34%,

and only 9 elderly people worked in a sitting posture, which may be wheelchair users or Device-helping Elderly People. It is apparent that urban elderly individuals were mostly working in a standing position due to the influence of Western design concept and the limitations of kitchen space, and this was bound to be dominated by the action of the upper limbs, which inevitably increased the pressure on the lower limbs of the elderly.

Kitchen users were mainly Self-care Aged people and a small number of Device-care Aged People who could prepare food themselves while sitting in a wheelchair. It was important, however, to avoid kitchen cabinet that were too low or too high and to provide enough space in the lower cabinets for Device-care Aged People to operate.

The actions of older individuals in the kitchen could be categorised as either continuous or instantaneous behaviour. Instantaneous behaviour could be completed quickly and with little exertion. Continuous behaviour refers to actions that require a significant amount of time to complete while typically taking place in the same or similar locations and demanding considerable physical effort from the elderly. It is important to note that these categories applied to kitchen-related tasks specifically. For instance, actions such as placing items in storage and turning the tap on and off are instantaneous behaviours. Conversely, washing food and cooking within the cooking area are continuous behaviours. This resulted in the elderly moving back and forth in the kitchen area.

The elderly expressed that they would like to be more comfortable when performing continuous behaviours, while immediate movements would be less demanding. For instance, during dishwashing or cooking, seniors often must repeatedly bend and stand for a long time, which posed a significant strain on their lower limbs. Therefore, for behaviours that required

continuous standing, a sitting posture should be considered to allow the elderly to conserve energy and also to relieve the upper limbs of elderly people who use walking aids.

Older individuals enjoy displaying their cooking skills to each other, so the kitchen is also a communication platform for older people. They take pleasure in exchanging cooking tips and engaging in friendly conversation with friends and neighbours in the kitchen, reflecting the leisure and communication functions of the kitchen. Whenever they become a bit tired while cooking, they would sit down to work, or to observe the meal. All of these habits required the kitchen to have a temporary place to sit.

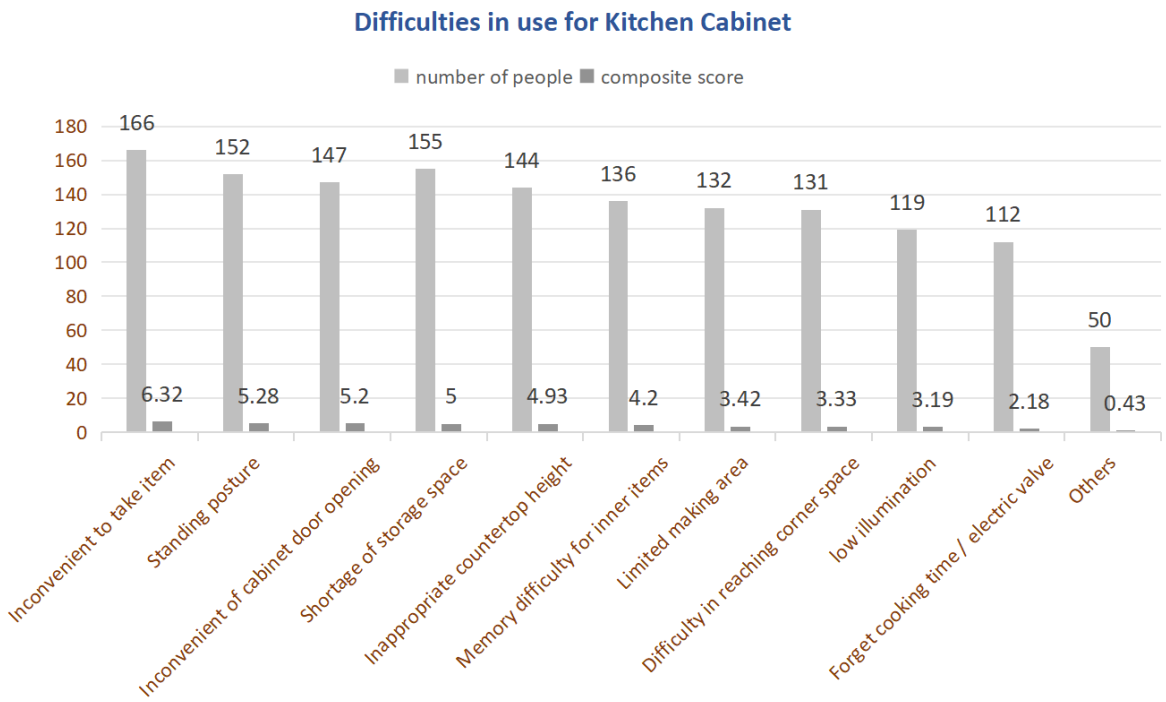


Figure 4.60: Difficulties in Use of the Elderly for Kitchen Cabinet

Finally, ranking questions were used to investigate the difficulties experienced by older people in using kitchen cabinet, and the data is presented in Figure 4.60. The top five

inconveniences perceived by older people were, in descending order, inconvenience to take item, standing posture, inconvenience of cabinet door opening, shortage of storage space and inappropriate countertop height. They were chosen by 166, 152, 147, 155 and 144 seniors, accounting for 67.48%-58.54% of the total surveyed. This was closely followed by memory difficulty for inner items, limited making space and difficulty in reaching corner space, selected by 136, 132 and 131 seniors respectively, placing them in 6th to 8th place in terms of difficulty of use. Low illumination and forgetting cooking time / electric valve and so on were selected by 119 and 112 seniors respectively, nearly half of the older people, which were factors that needed to be considered too. Overall, these data were relatively even, suggesting that the elderly were sensitive to the above difficulties, which provided important data support for subsequent design proposals, namely, that all of the above factors need to be considered in subsequent design proposal.

In Chinese society, most retired elderly people are idle at home. The biggest task is to look after three meals a day, coupled with the characteristics of the elderly thrifty and social activities. To reduce the chances of them eating outside, eating at home has greatly increased, and therefore, the kitchen cabinet is used very frequently.

Thus, the researcher conducted on-site visits to some of the participants and used the observation method to record the difficulties they encountered in using the kitchen cabinet, and found that the results were basically the same as those from the questionnaire survey.

Currently, the Kitchen cabinet is typically designed with closed doors and the elderly must frequently open and close the doors, especially the end of the cabinet space which could not be reached. At the same time, the utilization rate of the hanging cabinet is not high, resulting in inconvenience to take items.



Figure 4.61: Kitchen Cabinet Door Openingand End Space Access Difficulties

Older adults could experience fatigue when they have been standing for extended periods of time, particularly when carrying out tasks such as cooking and cleaning, which could put a strain on the lower back and lower limbs. Hence, for older individuals, sitting down during these activities become the second desire.

Design of the bottom cabinet flat door requires the elderly to stand within a certain turning space and move their lower limbs back, while only using their upper limbs for opening. As for the flat door of the suspended cabinet, the elderly are required to elevate their upper limbs and then pull outward, which both are inconvenient for the elderly.

Most of the elderly were born during a period of material scarcity, which led to the development of habits such as clinging to possessions. Additionally, the kitchen requires many utensils, resulting in a significant amount of kitchen clutter. This clutter could lead to

disorganization and a negative impact on the visual aesthetic of the kitchen as well as hindering free movement for the elderly within the space. In addition, elderly individuals may experience memory loss and have difficulty remembering the contents of closed cabinets or where items are placed. This often results in the need to search for items. To avoid this situation, the elderly tend to put frequently used items on the outside, objectively adding to the messy look and feel.



Figure 4.62: Messy Kitchen and Hanged items

The lower heights of elderly individuals and the standard kitchen cabinet height (80cm) create discomfort during kitchen operations for them. Uniformly high countertops may seem neat and tidy, but they are not suited to the different ways in which older people behave in the kitchen. For cooking purposes, the current countertop height is relatively high, while it is slightly low for cleaning, forcing the elderly to bend down while working. For Device-help Aged people in a wheelchair, the wheelchair could not be close to the cabinets.



Figure 4.63: High Countertop in Cooking Space

Memory difficulties could be experienced by older adults with memory loss due to the opaque door design and diverse storage items, which makes it difficult to remember where items are stored. Moreover, the kitchen includes multiple electrical appliances and facilities, which may be challenging for older people to operate or remember to switch off due to memory decline.

A limited cooking space is also an important factor that affects the efficiency of the kitchen. The cooking space serves as a transition area between the washing space and the cooking space, where food cutting, matching, etc. must be completed. Due to kitchen space limitations, most of the current cabinet countertops between 4-5 metres, deducting the stove and sink (2M) and countertop items, the remaining available space is very limited, affecting the comfort of the elderly use. For some recipes that require more space to cook, such as dumplings, the elderly often finish preparing them at the dining table.



Figure 4.64: Limited Cooking Space

In addition, the elderly with declining eyesight often struggled with poor vision due to low illumination.



Figure 4.65: Low Illumination in Kitchen

Finally, from the three perspectives of behaviours, preferences and barriers, the following table summarised the current situation of cabinet used by older people living in place in Shanghai.

Table 4.11: Kitchen Cabinet Use Situation of the Elderly

Use situation	Contents
Behaviours	Picking items, Washing ingredient, Preparing food, Cooking food, Moving back and forth, Chatting
Preferences	Frequently Used, Hostesses use, Shared use, Display, Brief sitting, Use according to work space and flow
Difficulties	Inconvenient to take item, Standing posture, Frequently door opening, Inappropriate countertop height, Less storage space, Memory difficulty for inner items, Limit preparing space, Low illumination

4.5.2 Kitchen Cabinet Use Demands of the Elderly

After analysing the above contents, it could be seen that the elderly often use the kitchen, therefore the quality of cabinet design directly affects the elderly's life. However, current cabinets are almost designed for fast-paced urban life, with standing operation, which is not suitable for the elderly, and even the standardized height and routine layout may cause difficulties for the elderly (Feng,1999). Therefore, it is necessary to analyse the demands of the elderly for cabinets, and then adopt the appropriate design approach to meet them.

In this section, data on the willingness of older people to own elderly-friendly kitchen cabinet were collected. Subsequently, the design requirements for elderly-friendly kitchen cabinet were collected from four perspectives: dimension optimization, safety, utility and comfort.

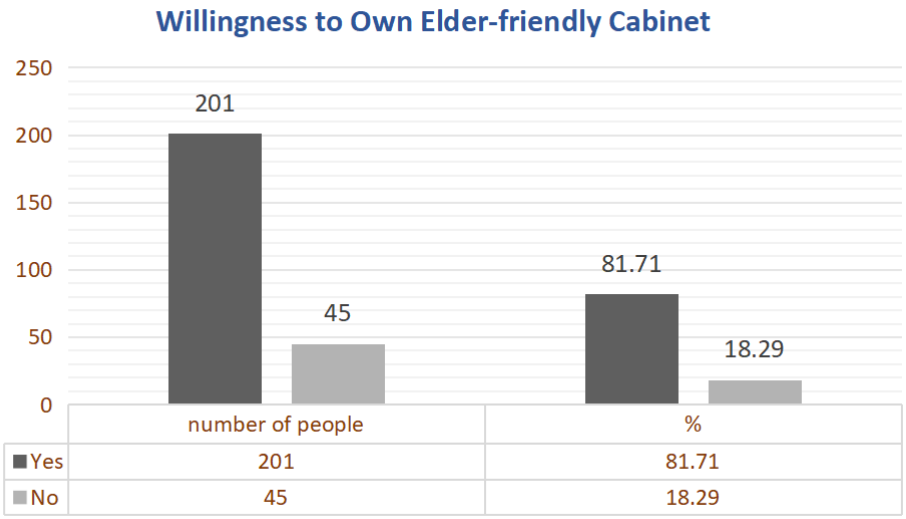


Figure 4.66: Willingness of the Elderly to Own Elderly-friendly Kitchen Cabinet

The questionnaire revealed that out of the 246 respondents, 201 elderly individuals (81.71%) who expressed a willingness to own elderly cabinets. This figure was significantly higher than the number of elderly individuals who did not express a willingness to own elderly kitchen cabinet, 45 elderly individuals (18.29%). These results indicated that a majority of elderly people from the customer perspective supported the elderly-friendly furniture market.

During the interviews with 9 elderly, when asked what aspect of the kitchen cabinet they would most like to improve, the key words in the answers focused on "I wish it was convenient to use" and "visualisation", while other aspects were mentioned less often. Some interview participants stated that they had not seen the retrofitted cabinet and therefore could not offer a specific opinion, while others stated that "it depends on the effect of the retrofitting " and "It is up to the children to decide, they are not involved". This indicates

that although older people are willing to retrofit, they are not very clear about the idea of elder-friendly kitchen cabinet and are still taking a wait-and-see attitude.



Figure 4.67: Improving Demands for the Kitchen Cabinet of the Elderly by Interview

When interviewed about the 'most important factors to consider when purchasing a cabinet', the elderly participants' responses focused on 'practicality', 'simplicity', 'good quality', 'perfect function' and less on style and brand. Interestingly, the elderly did not choose cheap products, but rather hoped that the higher the quality, the better it is, provided that the price was affordable.



Figure 4.68: Factors Considered when Purchasing Kitchen Cabinet of the Elderly by Interview

However, when elderly individuals were offered specific options for improvement and demands in the questionnaire, their choices were slightly different from the interview results, as detailed in Figure 4.69.

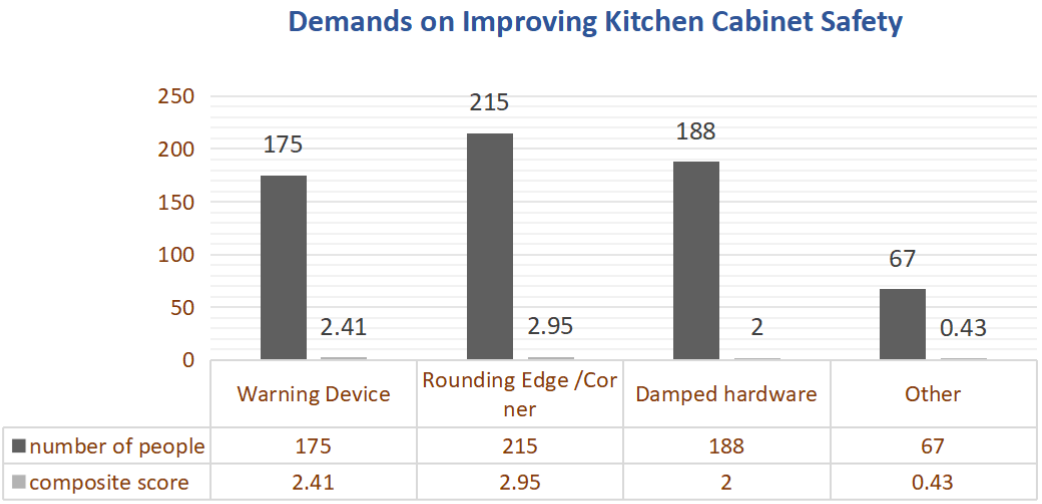


Figure 4.69: Demands of the Elderly on Improving Kitchen Cabinet Safety

Safety demands. The kitchen is a multi-functional space that requires the use of water, electricity, gas and fire. Moreover, the decline in the cognitive and physical abilities of the elderly heightens the potential for hazards. Thus, safety is the primary requirement for the design of the cabinet. In design process, it should be fully considered to meet the actual ability and using habits of the elderly, through reasonable design to eliminate potential hazards, and to ensure the safety of the elderly when using the cabinets. Environmental protection, antibacterial performance, and reliability of the cabinetry itself are also necessary to ensure safety.

This question was set by ranking type, the questionnaire result showed that Rounding Edge /Corner was the main concern of the elderly to improve use safety, among the 246 respondents, 215 elderly people chose this, with a composite score of 2.95, ranked No.1. Following this, the warning device and damped hardware were each selected by 175 and 188 elderly individuals, respectively. These factors were given composite scores of 2.41 and 2, respectively. Only 67 individuals selected the other option, resulting in a composite score of 0.43, significantly lower than the previous three options, indicating that in terms of safety, the first three options are generally more concerned by the elderly, the designer should be focused on. For example, setting smoke, gas warning device can effectively address fire and gas. The regular cabinet corners were right angled, thus it was easy to cause bumps, while rounded-corners cabinet design could effectively avoid bumps and injuries.

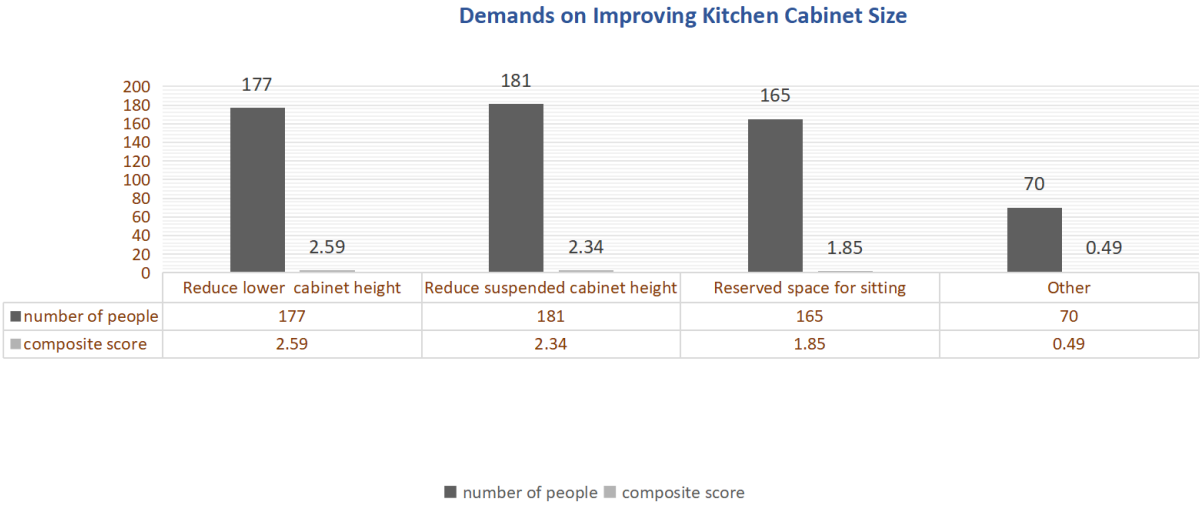


Figure 4.70: Demands of the Elderly on Improving Kitchen Cabinet Size

Size Optimization. To objectively assess the desire of the elderly for size improvement, a ranking question was asked. The results of the questionnaire showed that the elderly's demand for size improvement was to reduce the height of the lower cabinet

countertop, which was the first choice for 177, with a composite score of 2.59, ranking 1rst. 181 seniors wished to reduce the suspended cabinet height, given a composite score of 2.34. The two scores were very close, and as stated earlier, older people are generally shorter than when they were younger, so it made sense that they would choose to reduce cabinet. The 3rd choice was to leave space for a seat or wheelchair under the cabinet. 165 elderly chose this, with a composite score of 1.85, slightly lower than the first two, but the scores of the first three items were significantly higher than the last one, 'Other' (70 people, 0.49), which meant that in terms of dimensional optimization these three items basically meet the needs of older people.

Size optimization requires full consideration of the elderly individuals body measurements, including their height, arm length, and other parameters to determine the appropriate size of kitchen cabinet, countertop. As previously analysed, Chinese kitchens are primarily occupied by female elderly, so the height of elderly women and the possibility of using a wheelchair in the future, should be considered.

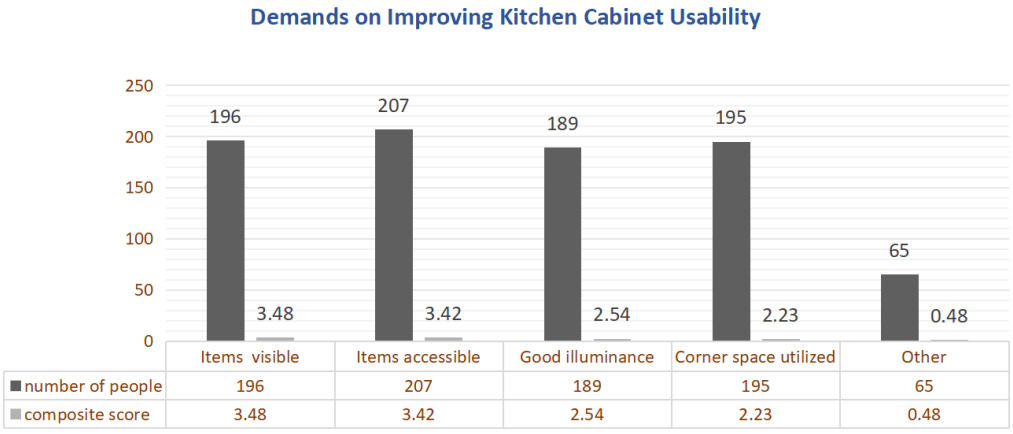


Figure 4.71: Demands of the Elderly on Improving Kitchen Cabinet Usability

Usability demands. Usability is a user-centred design concept, and the focus of usability design is to enable the design of a product to fit the habits and needs of the user. The International Organisation for Standardization (ISO9126-2001) defines it as follows:

Usability is the ability of a product to be understood, learned and used under specified conditions, including ease of understanding, ease of learning, ease of operation, attractiveness and compliance with relevant standards, regulations and conventions.

Cabinets are highly practical furniture items, and usability is a crucial evaluation index for cabinets that depends on the actual needs of users, which is also the starting point for design. The core function of the cabinet is to help the elderly finish cooking easily and smoothly. Designers should have a comprehensive understanding of the needs of the elderly, use this information to guide the design, and continuously improve the product to achieve a win-win situation in terms of social and economic benefits. "Ease of use, including "zero learning" and intuitive operation, is a key requirement for usability, and the design should take into account the cognitive habits and abilities of the elderly, try to reduce the burden of the elderly to learn new things.

For the purposes of cabinet usability, the researcher designed five options: items visible, items accessible, good illuminance, corner space utilized and other, according to the cabinet characteristics. The questionnaire result showed that among the 246 elderly, 196 of them chose items visible with a total score of 3.48, ranking 1st and needing to be satisfied as the primary demand. 207 elderly people chose option within items accessible, with a composite score of 3.42, ranking 2nd, so that frequently used items should be placed in an easily accessible location. The close similarity of these two scores suggested that this was the most important factor for older people to consider and prioritise. Good illuminance and

corner space utilized scored close together, with 189 and 195 older people choosing them respectively, and the composite scores of 2.54 and 2.23 were slightly lower than the previous two options, but there were still many older people who wanted to make improvements.

Out of the 246 elderly participants, only 65 chose the 'other' option, with a composite score of 0.48, much lower than the first four options, which meant that the first four options could basically meet the elderly's needs for cabinet usability.

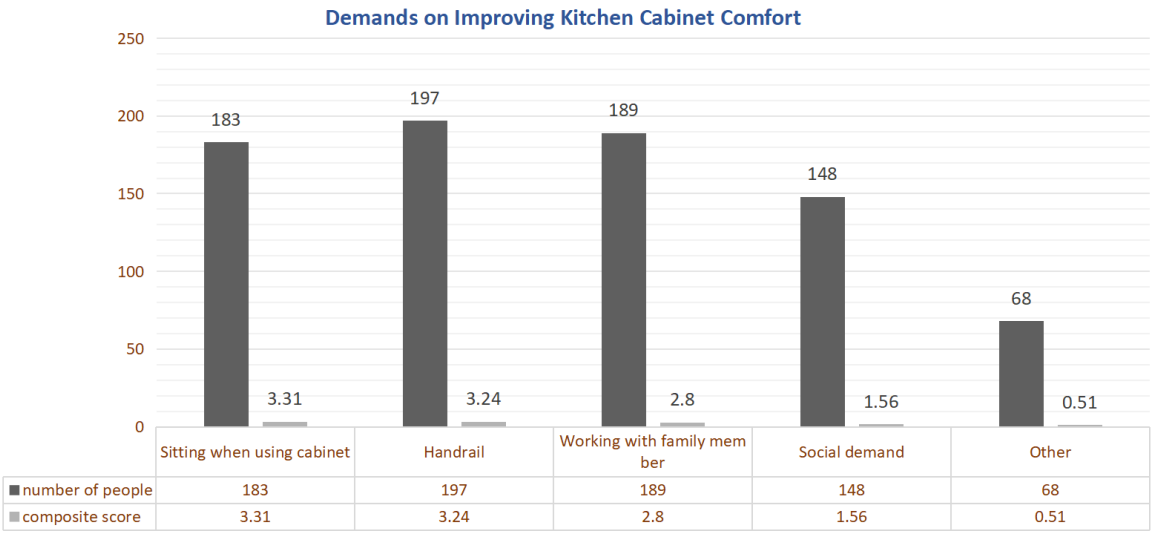


Figure 4.72: Demands of the Elderly on Improving Kitchen Cabinet Comfortableness

Comfort demands. The concept of comfort refers to enabling the elderly to utilize the cabinet effortlessly and comfortably in order to accomplish cooking activities. The physical ability of the elderly is a decreasing trend, so the cabinet design should be reasonable to help the elderly to complete the cooking work happily and comfortably, and to improve the quality of use.

To explore the preferences of older individuals regarding cabinet comfort, a survey using a sorting question was designed to examine the following five options: sitting when using cabinet, handrail, working with family member, social demand and others, according to the characteristics of the cabinet. The questionnaire results indicated that sitting when using cabinet received the highest score, with 183 older people (score of 3.31) choosing it, putting it in 1st place. The next highest scoring option was the working via handrail, which was chosen by 197 older people (score of 3.24), slightly more than the first option, but due to the slightly backward order. Similarly, a significant number of elderly people chose to work with family member (score of 2.8), but due to the slightly backward order, which put it in 3rd place. The social demand ranked 4th, chosen by 148 elderly people (score of 1.56). The small number of respondents who selected the "other" option (merely 68 individuals, score of 0.51) indicated that, with regard to comfort, the first four items met the needs of older people.

Cooking with family member and social demand together, explained the need for communication of the elderly on the use of cabinets. For the elderly, kitchen cooking, on the one hand, could maintain their remaining independent living ability, so that the elderly could find a sense of value, happy mood, especially the elderly women, cooking could be driven away from their sense of loneliness and sense of uselessness. Besides working in the kitchen, they could help their children to look after grandchildren and be respected by the family.

4.6 Chapter Summary

China's elderly-friendly furniture industry has an immature situation of a large market but a low level of development, few categories, and is still at a low level of development. This is not only a dilemma, but also an opportunity for the elder-friendly

furniture industry. Elder-friendly furniture development should be well in the elderly use needs and consumption intentions through investigation and analysis, in order to grasp the wind vane of elder-friendly furniture. It is also necessary to integrate enterprise resources and product data, provide the elderly with the products they really need, improve the quality of life of the elderly, so as to make the elderly-friendly furniture as a new economic growth point in the market.

Chapter 4 completed the first two research objectives of this study by collecting and analysing data, RO1 being the current situation and challenges of the EHF market, and RO2 being the core elements of EHF.

The analysis for RO1 showed that furniture manufacturers perceived the main challenges in developing elder-friendly furniture are less supportive policies, industry standards requirement, intellectual property rights, lack of elderly products, enterprises gathering at B sales channel, high cost of R & D, lack of consumer awareness and insufficient industrialisation level. Despite these challenges, furniture manufacturers are still optimistic about elder-friendly furniture.

At the same time in the market, one could hardly see elder-friendly furniture on sale, and the sales staff had misunderstanding, conservative or wait-and-see attitude, and the main performance was they did not understand what the elderly furniture is, have not heard of it, and assuming that the elderly do not need special furniture. They also assumed that the elderly do not have consumption capacity, as well as misunderstanding that mahogany furniture suits the elderly and was not sure if it was the best seller.

Data on RO2 revealed that the physiology, psychology, and behaviour of the elderly differed from those of other groups, as well as from when they were younger. The main

physiological changes in older adults were perceptual characteristics, such as decreased visual acuity, decreased hearing, dull sense of touch, reduced memory and decreased cognitive. In addition, there were also changes in the movement characteristics, such as reduction in height, reduction in balance and slow movement as well as increased risk of falling. Psychological changes in the elderly were mainly characterised by empty mind, helplessness, strong self-esteem, stubbornness, suspicion, personality change, embracing positive aging and special colour psychology as well as consumed psychology.

The research on RO2 also found that the furniture most frequently used by the elderly were, in frequency order, beds and bedside tables, wardrobes, sofas, dining tables and chairs as well as kitchen cabinet, with the highest level of dissatisfaction with the use of kitchen cabinet. The most preferred furniture materials for the elderly were, in preference, solid wood, linen, bamboo, rattan, and leather. Among them, the special research on kitchen cabinet found that kitchen cabinet users were hostesses and couples together, accounting for the absolute mainstream, the elderly use of the kitchen cabinet procedures were "taking out ingredients - cleaning ingredients - preparing ingredients - cooking ingredients," It was basically a standing operation. The main difficulties in using kitchen cabinet for the elderly, in order, were, inconvenience to take item, standing posture, inconvenience of cabinet door opening, shortage of storage space, inappropriate countertop height, memory difficulty for inner items, limited making space, difficulty in reaching corner space, low illumination and forgetting cooking time / electric valve.

The questionnaire showed that more than 89% of the elderly expressed their willingness to own an elder-friendly kitchen cabinet, and the researcher then made a

collection of elderly people's needs for kitchen cabinet optimization in four aspects, namely safety, size optimization, usability, and comfort.

In summary, Chapter 4 analysed the situation and challenges of the EHF from the perspective of manufacturers and the market, the core elements of EHF from the perspective of the elderly, and answered Research Question 1 and Research Question 2, which would form a guide and important groundwork for the proposed design solutions in Chapter 5. In Chapter 5, the researcher will use this as a foundation for proposing targeted design approach.

CHAPTER 5

RESULT AND DISCUSSION

As discussed in Chapter 4, older people experience many obstacles and pathologies as they get older, and their cognitive and psychological situations differ significantly from that of younger people. It is clear that general purpose furniture cannot meet the furniture needs of the elderly. However, furniture manufacturers and markets face a number of challenges when entering the elderly furniture market. In addition, in researching on furniture for the elderly, it was noted in the literature reviews in Chapter 2 that the research gaps in this subject matter include (1) less comprehensive solutions, (2) less practical research and (3) less research related to Active Ageing. This resulted in a dilemma of "strong demand, insufficient market supply and insufficient research support".

Ageing has become an inevitable fact, and China is one of the countries where ageing is serious. Responding to ageing is an issue that the whole world needs to address. As early as 2002, the United Nations has proposed that the core of Active Ageing lies in promoting the health, participation, and security of the elderly. Based on this framework, a conceptual model of EHF in the field of elderly furniture was proposed in Chapter 2. In 2020, the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China proposed that active response to population ageing is an important consideration in maintaining national demographic security, social harmony and stability, as well as to elevate active response to ageing to a national strategy. This reflected the necessity and urgency of Active Ageing.

Based on the above situation and background, in Chapter 5, design approach for Elder-friendly Home Furniture was proposed from the perspective of Active Ageing, using elder-friendly kitchen cabinet as an example, which should not only meet the demands of elderly users, but also satisfy the concerns of furniture manufacturers, while trying to fill the research gap, which would complete Research Objective 3: To recommend developing design approach for EHF. Finally, the design-based method would be used to create a kitchen cabinet model in order to verify the validity of the design approach, so as to complete Research Objective 4: To evaluate consumer perception for proposed design approach.

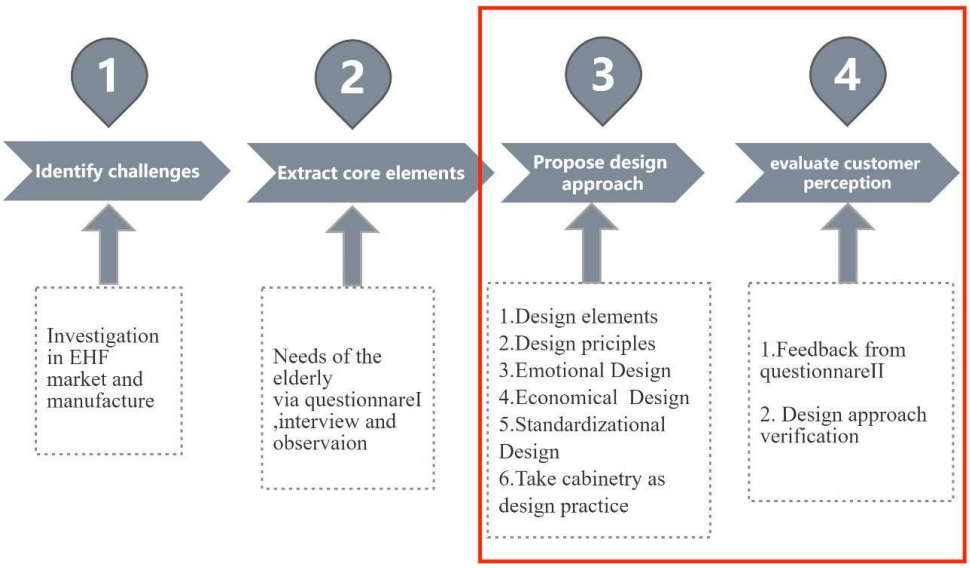


Figure 5.1: Research Objectives 3 and 4

5.1 Design Principles

Elder-friendly Home Furniture, in addition to the general function of furniture, should also consider the care of auxiliary functions, while distinguishing them from medical and nursing home furniture, as well as highlighting the home atmosphere. The design principles should take the following factors into account.

i. Healthy

It is challenging to modify the long-term lifestyle of the elderly. Therefore, it is advisable to ensure that the furniture aligns with their daily operating habits. The furniture should provide intermediate assistive functions to enable the elderly to cope with home life.

ii. Participation

It is crucial to acknowledge the value of self-care for the elderly at home and support their participations in community activities and neighbourhood exchanges to maintain their independence, sense of inclusion and dignity. Therefore, it is advisable to avoid furnishings that reinforce the idea of elderly individuals as being distinct from others in their age group.

iii. Security

First of all, in terms of hazard prevention and management, accidents that the elderly may encounter should be foreseen in advance. Secondly, in the event of an emergency, the elderly could be treated in time to avoid serious consequences. Furthermore, it is important to provide protection and care for older individuals who are unable to maintain and protect themselves.

iv. Variability

Furniture belongs to durable goods, from self-care to intermediate care stage, and the needs of the elderly for furniture are constantly changing. Ageing is a gradual process, and together with variable design, modular design concepts, such as scalable design and modular design need to be considered. Therefore, the structure and function of furniture must be designed according to the stage of ageing and adaptive adjustments need to consider to adapt to the different stages of ageing, to extend the life of the product.

v. Standardization

It is important to unify the design and production standards of EHF, so that a good job can be done with the general furniture and interchangeable articulation. This would reflect the universality of furniture, unify the market of EHF on one hand, eliminate the resource barriers between enterprises and save social resources as well.

vi. Economy

The consumption concepts of the elderly are more conservative, meaning they are more sensitive to functionality and price factors. Therefore, EHF should be under the premise of meeting the elderly's function, and to achieve cost-effective optimization, so that the elderly can afford to buy, thus to activate the elderly furniture market.

vii. Emotional

The design of furniture for elderly individuals is influenced by emotional activities and seeks to incorporate the experiential and emotional needs of this population, designing product forms and human-computer interaction with a human touch, so that the elderly can gain psychological recognition and experience emotion (Norman, 2004). If the objects have personal relevance and can bring a happy and comfortable mood, people would be attached to them. During this time what people are attached to is not the object itself, but the meaning and emotion that the object represents.

viii. Universal Design

Universal Design (UD) involves designing products and environments in a way that caters to all, without the need for specialized design (Leibrock T, 1999). UD considers a wide range of physical conditions that may arise during a person's life, allowing for the use of products by a broader range of individuals. Despite the fact that the elderly share certain

common characteristics, the conditions that may arise during an individual's ageing process should be considered in a comprehensive manner. Furthermore, cabinets specifically designed for the elderly can be used by their children or caregivers as well as by the elderly. UD allows elder-friendly cabinets to be used by seniors as well as family members or caregivers.

5.2 Design Approach for Elder-Friendly Kitchen Cabinet

As stated in Chapter 2, the Active Ageing strategy advocated by the WHO aims to improve the quality of life of the elderly through the implementation of policies in three main areas: health, participation and security. Thus, a policy framework consisting of three primary support systems for promoting active ageing can be established.

Health is defined as a life-cycle perspective that emphasizes on maintaining an individual's independence, well-being, and dignity. The government is dedicated to promoting health and provision of appropriate services. By adopting healthier lifestyles, individuals could reduce the incidence of disease.

Participation entails society offering appropriate and equivalent work opportunities to the elderly, reducing and eliminating discrimination against them. At the same time, society as a whole should recognize the unpaid contribution of older people at home and the value of their self-care. Older adults ought to be viewed as active contributors to society and given the necessary support to participate in appropriate activities. The elderly may continue to make meaningful contributions to their families, communities, and societies, while realizing their sense of self-worth based on their abilities and wishes.

Security refers to the provision by society of basic social security and services, crisis relief, consumer protection and social justice in old age to ensure protection, dignity as well as care in the event that the resident is unable to care for and protect himself or herself.

Specifically in the field of elder-friendly furniture, the practice of "health, participation and security" can start from the following aspects and propose corresponding reactions (Figure 5.2).

In Figure 5.2, the graphic in red represented the core requirements of an Active Ageing Society, and the graphic in green represented the design approach that could be adopted to meet an Active Ageing Society. The yellow graphic represented (1) the challenges facing by elderly furniture market, (2) the physical and psychological characteristics of the elderly, (3) the kitchen cabinet use habits and demands of the elderly.

This logical relationship figure started with the core requirements of an Active Ageing Society, which determine the direction of the design. The design approach was crucial as it not only meet the requirements of an Active Ageing Society but also addressed the challenges of the elderly furniture market and the characteristics and demands of the elderly, playing an important bridging role. The purpose of the design was to address the challenges of the market and the demands of older people. The direction of the arrow can reflect this logical relationship.

This logical relationship figure integrated the results of previous research and analyses and specified the follow-up design approach.

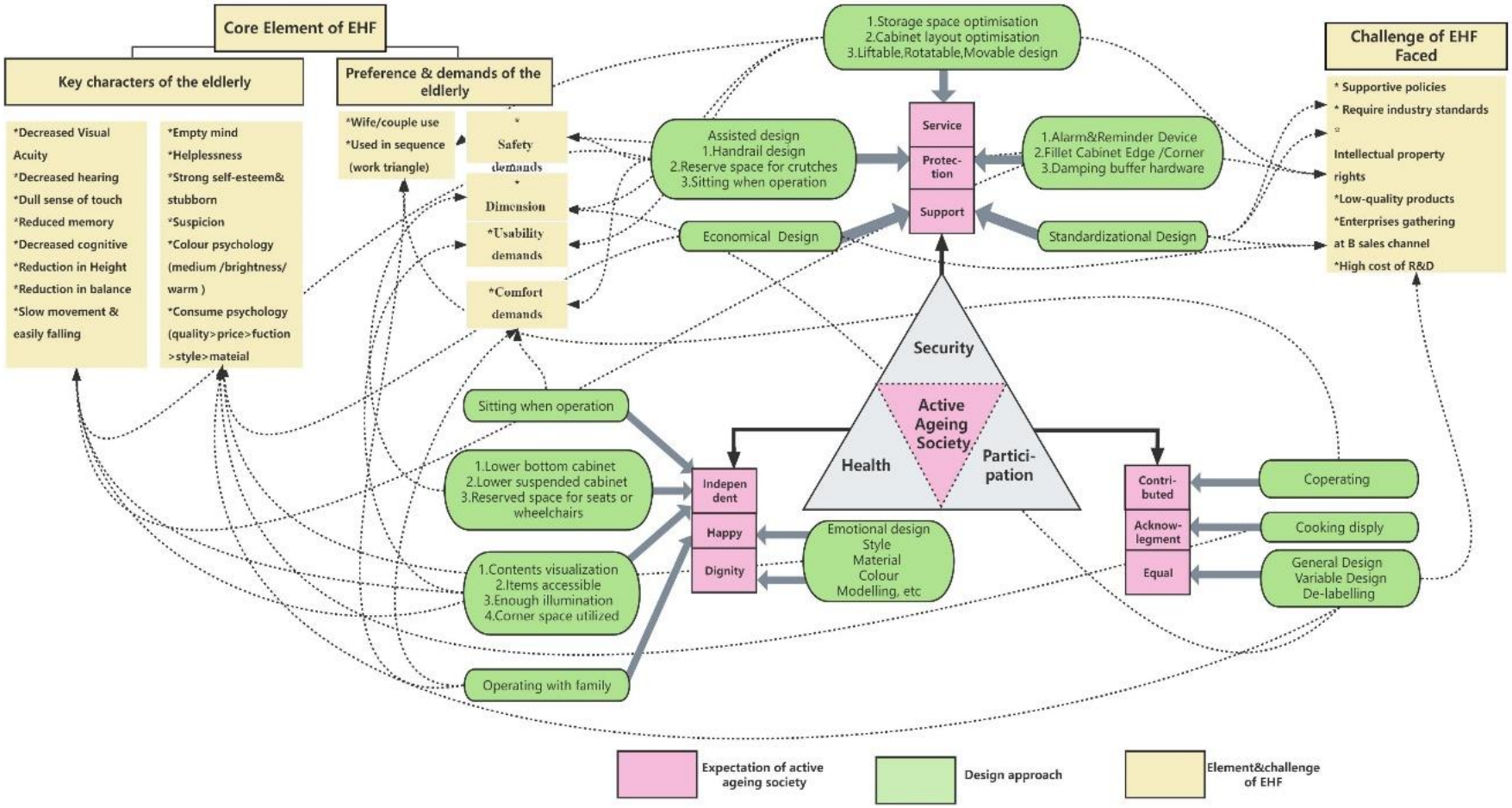


Figure 5.2: Research Flow Chart of Design Approach

5.2.1 Dimension optimization

i. Height of bottom Kitchen cabinet

The universal height for a bottom cabinet is 780-800mm, and the height of the elderly is reduced compared to when they were younger, resulting in the elderly feeling laborious and uncomfortable in using these cabinets. Thus, the cabinets need to be redesigned according to the height of the elderly. Several indicators can be used as a reference.

Item 4.6.4 of the Code for Elderly Architectural Design (JGJL22-99,1999) specifies that the height of the bottom cabinet should not be less than 0.75 ~ 0.80 m.

Item 4.10.2 of the Design Standard for Residential Buildings for the Elderly (GB/T 50340-2003,2003) outlines guidelines for wheelchair users: the height of the bottom cabinet for wheelchair users should not be more than 0.75m, and the net height under the cabinet surface should not be less than 0.70m.

Based on research conducted by British scholars, Holms and Goldsmith (2002), a working surface at a height of 700mm from the ground is more comfortable to use. However, compared to a table at 800mm from the ground which could be more accessible by wheelchair, the former is more comfortable, although it makes reaching for the wheelchair user more limited.

Considering the above regulations, and the height of the elderly is generally 2.25-3% lower than that of the young (see Chapter 4), the height of the bottom cabinet should be reduced from 800mm to 750mm as the height of the preparing area.

Furthermore, relevant data from the Association of German Kitchen (AGK) showed that the behaviour of the elderly in cooking and washing is different, thus differences in the comfort height. Taking the height of the preparing area as a reference, to provide comfort

to the elderly, the height of the cooking area should be appropriately lowered by 40-80mm, the washing should be appropriately raised by 30-80mm, (Ma, 2016). Therefore, for the elderly, the appropriate height for their cooking area should be 700mm and the washing area 800mm. Considering that the height is a dynamic range and to fully accommodate elderly individuals, the first step involves setting the height of the bottom cabinet according to different operation areas, and the second step involves installing a lifting device to adjust the bottom cabinet, so that elderly individuals could flexibly adjust it themselves, while also solving the problem for wheelchair operation.

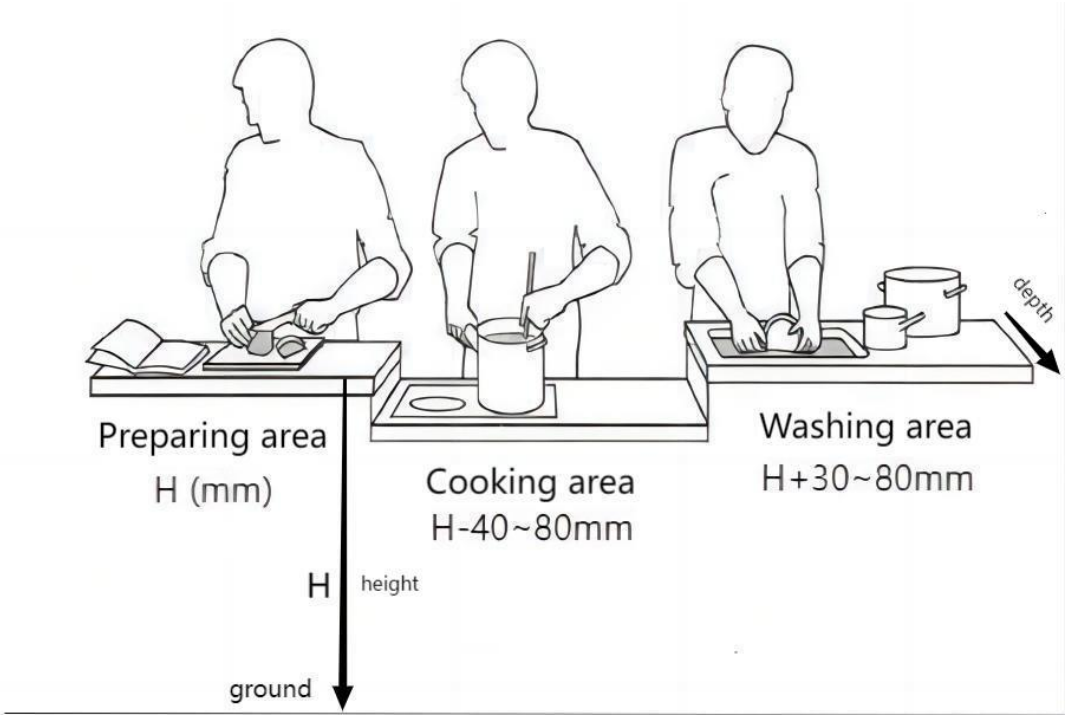


Figure 5.3: Height of Bottom Kitchen Cabinet According to Working Areas

ii. Depth of bottom kitchen cabinet

Item 4.6.4 of the JGJL22-99 Code for Elderly Architectural Design states that the bottom cabinet depth should not be less than 500 mm.

The depth of the bottom cabinet suitable for the elderly is recommended to be 600 mm, the same as the general cabinet, to provide more bench space. When the head is lowered, it tends to lean forward, and a deeper countertop can also decrease the possibility of bumping into the suspended cabinet.

iii. Leg clearance under the bottom kitchen cabinet

The furniture should also consider the need for the elderly to operate in a sitting position, and the wheelchair users need to accommodate leg space to be close to the worktop. Article 4.10.2 of the Elderly Residential Building Design Standards GB/T 50340-2003 which stated that "The leg clearance should not be less than 0.25m" should be referred. The 4.6.4 article of the elderly building design code JGJl22-99 also stated that "the clearance under the counter, the depth should not be less than 0.25 m. Therefore, the sitting spots required by the elderly in kitchen, such as washing area and cooking area where the elderly would work for a long time, is the recommended height should be 250~300mm, that is, around half the depth of the kitchen cabinet.

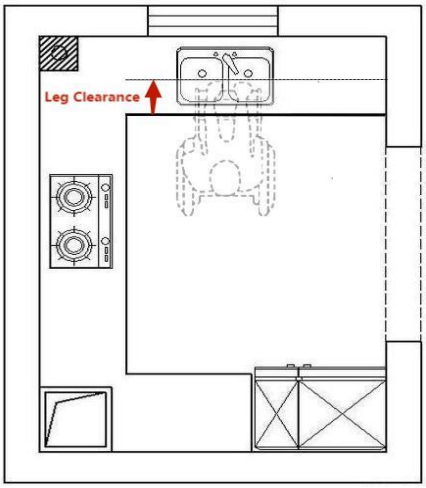


Figure 5.4: Leg Clearance under the Bottom Kitchen Cabinet

iv. Dimension of suspended kitchen cabinet

An appropriate suspended kitchen cabinet can be determined by measuring the height of the elderly person's hand. As discuss in Table 5.1, the touch height within the reach of the elderly is 1700mm. Item 4.6.5 of the Code of Architectural Design for the Elderly (JGJL22-99) indicates that the bottom height of the suspended cabinet should be at least 1200mm from the floor, to match to the touch height of wheelchair-user, so from1200 to 1700mm, which is the appropriate dimension of lower edge for suspended kitchen cabinet. The depth of the suspended cabinet is consistent with the depth of conventional cabinets, 350mm, which is 250mm less than the depth of the bottom cabinet of 600mm, leaving room for the upper limbs and head to move when standing.

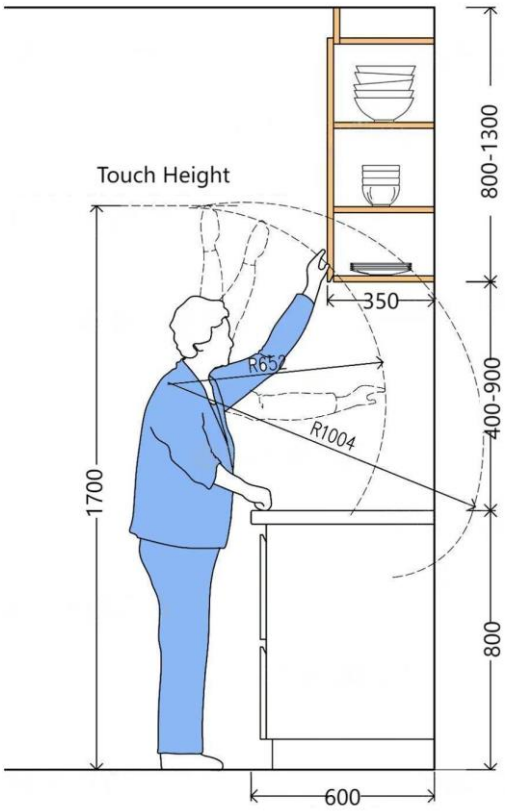


Figure 5.5: Touch Height of the Elderly

5.2.2 Kitchen Cabinet layout optimization

Optimization should be based on the operation habits of the elderly in the kitchen. Based on the results of the interview in Chapter 3, the common operation processes of the elderly in the kitchen are: (1) storing items, (2) washing ingredient, (3) preparing food, (4) cooking food. To save space, the working line should be compact and smooth, and the ideal mode is to shape "Washing - Preparing - Cooking" working triangle to avoid roundabout.

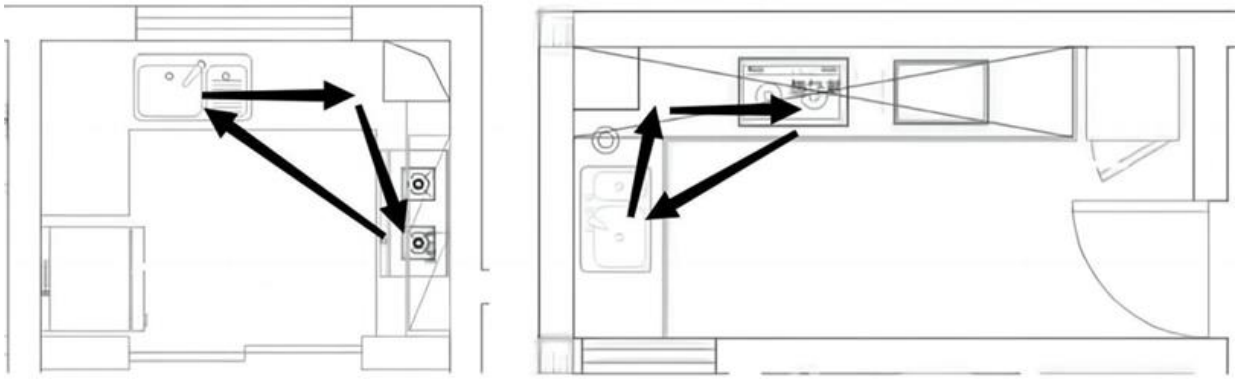


Figure 5.6: Working Triangle of Kitchen Cabinet

No less than 1500mm of circulation zone should be provided in front of the bottom cabinet to facilitate wheelchair users. U-shape, and L-shape are more suitable for the elderly, while "---"-type and parallel type are inferior. If the kitchen space allows it, a wall can be reserved to install a 700-750mm high low operating counter to make it easier for the elderly to operate and to compensate for the narrow preparing area.

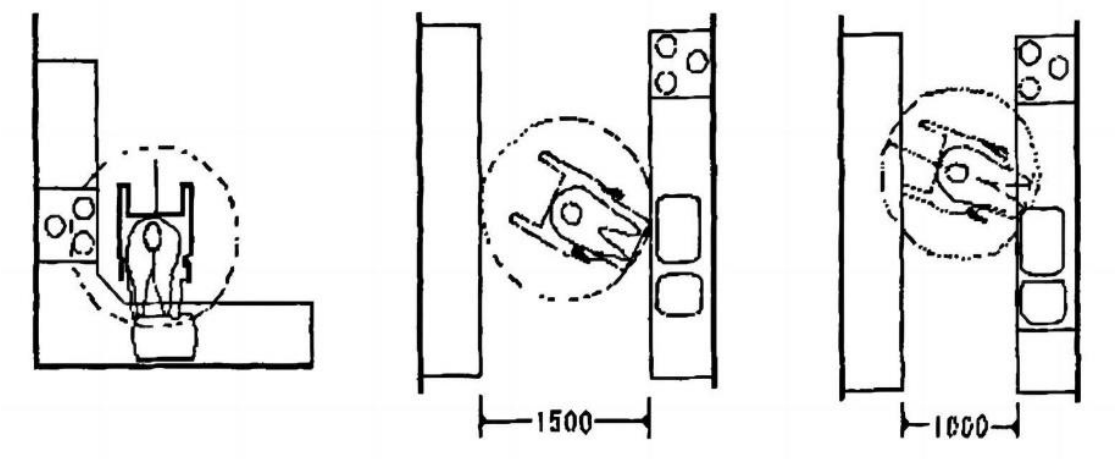


Figure 5.7: L-shaped and Parallel Kitchen Cabinet Layout with Suitable Circulation Zone (Resources: Architectural Design Collection 1 (2nd Edition), Beijing: China Architecture Industry Press, P142)

A practical layout could minimize the elderly's need to traverse the kitchen back and forth, thereby promoting a streamlined and effective work line, which reduces unnecessary walking routes and lowers physical exertion. In addition, the washing area ought to be positioned in front of the window and lighting arrangements should be considered to compensate for the deterioration of the elderly's visual acuity.

5.2.3 Storage space optimization

Although kitchen space is limited, various items such as cutlery, kitchenware, condiments, appliances, and cleaning supplies need to be stored in an orderly manner to ensure easy access and recall. This is crucial for elderly individuals. The primary storage space in the kitchen is usually the cabinets, which should be arranged to match the working triangle for ease of use by elderly users. Secondly, the elderly's observational ability is reduced, so the storage space should be more intuitive and convenient for the elderly to use. Finally, it is important to classify and diversify the storage space. For example, lighter items

can be stored in the suspended cupboard, heavier items can be stored in the bottom cupboard, and the space in the cupboard can be divided according to the characteristics of the items.

One reason for the elderly feeling that there is a lack of storage space is that they cannot make full use of the suspended cupboard due to height limitations, and the corner of the bottom cupboard is difficult to reach due to squatting difficulties. Correspondingly, several design solutions could be applied:

i. Items accessible

Avoid storing frequently used items in high places. The middle and lower sections of the cabinet, which are 700 to 1500mm high, provide a comfortable zone for the elderly and can be used as a frequent use area. The best option is a pull-out storage type. For suspended cabinet, lifting function hardware can be selected to ensure convenience and safety.

The touching height for elderly individuals is 1700mm, and they must bend down when the furniture is below 650mm in height. As a result, based on the physical parameters of the elderly, storage furniture can be divided into three parts: upper, middle, and lower.

Table 5.1: Height Partition of Storage Furniture

Section	Height(mm)	Using behaviours	Ease degree of use
Upper section	>1700	Need to climb to reach it	Most difficult
Middle section	650-1700	Easy to reach it when standing up	Easy
Low section	<650	Bend forward or squat to reach it	Difficult

To access the low sections, the part below 650mm in height of storage furniture, the elderly need to squat when taking the item, which is not very convenient, therefore, heavier or less frequently used items and miscellaneous items can be placed. Considering the use situation of elderly people in wheelchairs, this section can be processed flexibly, and the combination design concept could be adopted. For Self-helping Aged People, they can squat to take items, while for the elderly who use wheelchairs, this space can be reserved for easy access to the wheelchair, and the upper space can be used instead.

The middle section is the best storage area. They are not only convenient for picking up items, but also the most visible area, which can be used as a frequently used space.

For spaces higher or the upper section which could be reached, it is advisable to install a lifting hanger with the centre of gravity of the hanging area set as low as possible to aid daily use. Additionally, when considering height, it is important to place any drawers in the middle section of the closet where possible.



Figure 5.8: Liftable Function Shelf for Suspended Kitchen Cabinet (Resources: www.baidu.com)

ii. Corner space utilized

Pull-out basket hardware can be utilised to fully maximise the end space of the bottom cabinet to meet the storage needs of the elderly.



Figure 5.9: Pull-out Basket for Bottom Kitchen Cabinet (Resources: www.baidu.com)

iii. Items visible

Open or semi-open storage spaces, such as shelves or glass doors, could enhance the accessibility and visibility of the storage area. This is particularly beneficial for the elderly who can easily locate their items. Considering the weakening memory of the elderly, elder-friendly furniture should be kept open and flat as much as possible. This facilitates the elderly in finding items they need easily. For the areas that require a door panel, the purpose of visualisation can be achieved in various methods. For instance, using colours to distinguish function, whereby different colours represent different types of items, since using a variety of colours could help memory. Doorknobs and other important fixtures could utilise high-contrast colours or employ designs that compensate for sensory deficiencies. They could also try using different materials such as metal for electrical appliances and ordinary panels for tableware. Additionally, transparent, or translucent materials like PE or acrylic are utilised for cabinet doors and open-style cabinet in order to facilitate memory.

iv. Develop various types of storage spaces

Such as the multi-functional pull-out table, it can serve as an auxiliary cooking table, as an auxiliary counter or as a breakfast table.



Figure 5.10: Multi-functional Pull-out Table and Slide Used (Resources: www.baidu.com)

5.2.4 Design for safety and usability

Warning Device. Due to memory decline, the elderly often forget the cooking time or forget to turn off the gas valve. In particular, there are more and more elderly people living alone, therefore colour, lighting, and intelligent systems can serve as reminder alarms for kitchen appliances, water and electrical valves, as well as other equipment. Additionally, automatic leak detection systems must be installed.

Good illuminance. The inner space of the deep cupboard is too dark, which creates certain obstacles for the elderly, and it is recommended to add inductive LED lights in the cupboards to make it easier for the elderly to find the items they need.

Therefore, cabinet lighting should not be overlooked. As the depth of the bottom kitchen cabinet is typically around 580-600cm, natural light from outside is insufficient and coupled with age-related vision decline, it becomes particularly inconvenient to access the items. It is recommended to install an induction light in the cabinet, which gradually lights up when the door is opened, providing moderate light to help the elderly find items, ensuring that the light in the cabinet is soft and not dazzling, and the lighting is convenient to switch.

Rounding Edge /Corner. To prevent falls and bumps, the edges of cabinet counters should be rounded or covered with flexible materials. This would provide protection for the elderly and also enhance the aesthetic appeal of the piece of furniture. The physiological and psychological needs of the elderly should be considered during the design process.



Figure 5.11: Rounding Kitchen Cabinet Edge /Corner

Damped hardware. Labour-saving and safety are important to the elderly, and soft-closing technology is applied to hinges and drawers to make kitchen cabinet opening and closing smooth as well as easy and quiet. Research has shown that over 60% of older adults struggle with cabinet hardware issues, which can be effectively addressed through the use of damping technology in hardware.

Suitable Handle. The cabinet handle is a very important piece of hardware that should be effortless to use. The convex pull handle, which has a large U or C shape, is particularly comfortable to use. Handles with no heads at their ends can prevent snagging. However, small point-like handles require delicate operation, and the built-in handle is not easy to grasp, therefore is not suitable for the elderly. The handle on the lower cabinet door can function as a horizontal handle that is ideal for hanging towels. This feature provides an additional practical use for the cabinet.



Figure 5.12: Ergonomics Handle for the Elderly

Reserved place for crutches. Device-helping Elderly People use crutches frequently, even in kitchen operation and they need to have a temporary place to put their crutches. Therefore, proper place should be reserved for crutches in cabinet.

Elevatable range hood. To ensure that elderly individuals can enjoy their time in the kitchen without facing any issues, it is essential to prioritize kitchen hygiene. The range hood has been deemed a potential inconvenience, however, elevating it could alleviate this issue by making cleaning easier.

5.2.5 Design for comfort

The comfort of elder-friendly furniture can be categorised into two types, physiological comfort and psychological comfort. The former acts as the foundation and the latter as the sublimation, with both influencing each other.

Physiological Comfort. The concept of physiological comfort involves evaluating products solely based on the physiological characteristics of the elderly, rather than relying on subjective factors. Its aim is to offer furniture that delivers an enjoyable experience and meets the comfort needs of the elderly. To attain physiological comfort, it is necessary to

consider the functional properties of the product. This can be accomplished through the following means.

i. Material comfort

Material comfort comprises support materials and contact materials on furniture. Comfort criteria for contact materials in cabinets, including countertops, door panels and handles, usually include tactility, ease of cleaning and durability of the material. Generally, a material that is tactile, easy to clean and durable is appropriate for use as a contact material in cabinets for the elderly. The supporting materials of cabinets encompass their structural and hardware materials, the premise of these materials to meet the comfort is safety, and the usual evaluation indices include strength, stability, and sense of quantity, etc. Evaluation criteria commonly used are strength, stability, and functionality. The use of resilient materials that exhibit high strength, great stability and a moderate sense of quantity is advisable as it supports and enhances the safety and comfort of the cabinets.

ii. Structural comfort

Structural comfort refers to the structural integrity of the cabinet, including appropriate top and bottom cabinets, equipment and supports, as well as the location of parts of the structure in relation to each other, the volume, and the user. It is crucial for a properly structured cabinet to have a comprehensive system, with rational placement and proportion among its constituents, catering to the elderly individual's bodily dimensions.

iii. Dimensional comfort

Dimensional comfort refers to the relationship between the scale of the cabinet and the dimensions of the human body. It also refers to the dimensional relationship with other furniture in the environment in which it is used. Several dimensions, such as the height,

depth, width of the top and bottom cabinets, etc., determine whether the dimensions of the cabinet are comfortable or not. As discussed in Sections 5.2.1 and 5.2.2, cabinet design must be based on the ergonomics of older people and the dimensions must be reasonably designed to help older people move smoothly between different activities in the kitchen.

iv. Auxiliary functions and usability

Auxiliary functions refer to the cabinet's ability to perform beyond the basic cooking functions, including rotating, lifting, moving, intelligent reminder and so on. These additional functions improve the comfort and usability of the cabinet, simplifying operating procedures and interfaces, can also improve the use of comfort.

Psychological comfort is an essential consideration when using cabinets. In addition to their physical function, cabinets should accommodate personal preferences and cultural demands. These specifically include:

i. Aesthetic comfort

Refers to the user's satisfaction with the appearance of the cabinet modelling and emotional indicators, including style, modelling, material, colour and co-ordination with the appearance of other furniture in the environment. Determinants usually comprise personal preferences, cultural background, and interior.

ii. Colour comfort

The user's satisfaction index with the colour and colour arrangement of the cabinet, including the colour of the material, the colour of the surface finish and the colour co-ordination with other furniture. For an elder-friendly cabinet, a balanced and coordinated colour scheme is recommended to produce a comfortable, calm, and soft atmosphere, rather than employing a palette with overly active colours that might create a strong contrast.

Orderly arrangement of various hues, brightness levels, and purities of a colour allows for gradual colour transition. This effect can be enhanced through the application of contrast, balance, coordination, and unity in formatting, thereby resulting in a visually balanced colour. Using pure colours in large areas should be avoided, while smaller areas should be kept coordinated with increased purity.

Low Purity and Brightness Principle. After middle age, people tend to develop a peaceful and calm character, leading them to prefer elegant colours and matching in elder-friendly furniture design. To achieve this, designers should aim for reduced purity and brightness of colours and consider harmonious combinations with black, white, and grey, resulting in a quiet and elegant atmosphere. ach.

Natural Colour Principle. Natural scenery holds a magical quality; even after prolonged admiration, individuals do not tire of it. The elderly are more prone to free, casual, primitive pastoral life，being close to nature, far from the past work setting，can make the elderly feel more peaceful and cheerful. In design practice, it is possible to fully maintain natural characteristics, like the colour and texture of materials such as rattan and wood, so that the elderly can merge with the original, simple nature.

iii. Environmental-friendly

To better serve the elderly population, furniture designers should try to reduce the gap between elderly and general furniture. This includes avoiding labels that stigmatize the elderly and promoting environmentally friendly production with greater harmony, avoiding the idea of "disadvantaged" groups.

Table 5.2: Psychological Comfort Design Index

Design index	Design elements	Design methods
Aesthetic comfort	Styles	Simple, practical, with cultural connotations and a blend of ancient and modern designs, coordinates effortlessly with other furniture.
	Materials	Wood, rattan, bamboo and other natural materials possess beautiful textures and offer ease of access.
	Moulding/forms	Simple, smooth, stretch, in line with the aesthetic of the elderly, in line with traditional Chinese philosophy, adopt traditional patterns.
Colour comfort	Hue	Natural colour principle.
	Hue	Colour transition method, formal beauty principle.
	Brightness and purity	Low purity, low brightness principle.
Environmental-friendly	Avoid "labelling"	Minimize appearance differences with general furniture, avoid "be medicalized", and do not affect other functions of furniture.

iv. Sitting when working in kitchen

Although kitchen housework primarily engages the upper limbs, standing for extended of time induces significant strain on an elderly's legs. This continuous action which concentrates on the three points of washing the sink, making counter and stove, should be designed or reserved for sitting operating positions, and retractable seating could be set up by adjusting the depth of the leg space in the bottom cabinet. For wheelchair users, it is

essential to position themselves appropriately to ensure that they are as close as possible to the counter.

The kitchen seating is intended for short periods of use and should have a simple and compact design, with variability to allow the elderly to use it from different angles and directions. An adjustable back or seat surface design could facilitate standing up and reaching in various directions for the elderly. The implementation of a rotated seat surface design may reduce unsafe and cumbersome auxiliary movements, reducing associated risk factors. Such universal design is not only appropriate for elderly individuals, but also useful in settings where dragging a chair is unwanted.

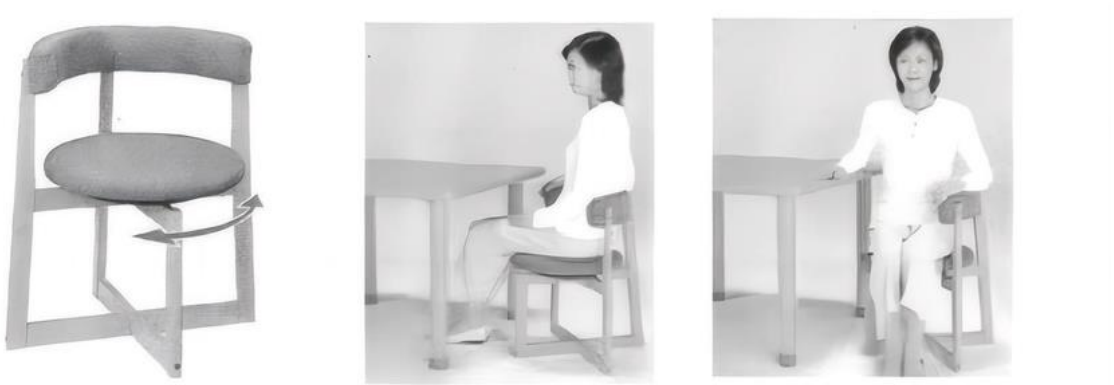


Figure 5.13: Swivel Seat (Resources: www.baidu.com)

v. Invisible handrail design

The limited muscle strength of the lower limbs of elderly individuals can cause difficulties when maintaining standing positions for extended periods, particularly in places where the elderly need to stand for a long time, such as at the sink and stove. Handrails or hidden handrails can be set up as support points for the elderly when they stand or move. This can be achieved through the widening design of the cabinet edge and groove because

this design can help the elderly to stand, or as a temporary resting point to lean, while the groove can facilitate the elderly to find a grasping point.



Figure 5.14: Kitchen Cabinet Edge Widening and Groove

Invisible handrails enhance functionality and effectively avoid labelled designs, thereby avoiding psychological discomfort for the elderly.

5.3 Emotional Design for Elder-Friendly Home Furniture

The primary idea of emotional design is to guide users to generate cognitive pleasure and positive emotional experience through product optimization design (Fu&Zhang,2019). Emotion and design have an internal interactive relationship, with the latter being a recreative process that brings out the recognised emotion. Essentially, design is an extension of emotion and a materialization of the spirit.

As discussed in Chapter 4, changes in the economic status and social role of the elderly, as well as increased solitary time, could lead to psychological issues such as self-isolation, emotional distress, suspicion, and anxiety. Therefore, in addition to functional design, furniture design should also focus on the extension of emotions to enable effective

emotional communication and interaction between the elderly and their environment (Liang & Ren, 2017).

China's furniture industry is currently facing intense competition with category boundaries being reshaped. Regardless of whether the furniture is sold in physical stores or online, they suffer from homogeneity and lack of design, which manifests in the design style, moulding design, function configuration, decoration, and other aspects. The supposedly "personalized design" only involves changes to the colour of panels, veneer patterns, and dimensions, but still have the same sense of view.

Furniture is an essential companion for the elderly day and night, and the design of elderly-friendly furniture should follow the law of aesthetic appropriateness and use appropriate arcs, curves, and other modelling languages to convey visual semantics such as "welcome", "warmth" and "care". Colours, patterns, and seasonal variations in furniture coverings could project the image of lively, independent, and energetic furniture, adding visual interest and dispelling a dull, cold, and mechanical impression. The best balance between visual and tactile elements can showcase the identity and quality of life of elderly users (Cui, Wan & Song, 2020), which can start with the following aspects.

i. Function

User-friendly products can evoke positive emotions and stimulate feelings of warmth and humanistic care. To establish an emotional connection with the user, primarily based on the product's functionality, and the design of elder-friendly furniture, if there are shortcomings in performance, such as furniture dimensions is unreasonable, not in line with the size of the body of the elderly, this would certainly make the elderly feel uncomfortable,

or if the use of the furniture is too complex, it would burden the elderly, and its function of the emotional will not be conveyed.

ii. Colour

Colour is a powerful medium for emotional communication, with a greater impact on mood than shape, and can play a major role in emotional communication with the elderly. When selecting colours for Elder-friendly Furniture, there is no need to limit oneself to traditional grey-brown schemes. As long as the chosen colours are in line with the psychology of the elderly, they can be used to create a warm and comfortable environment. It is important to consider factors such as the elderly themselves, the function of the furniture and the indoor environment to make a reasonable choice.

The elderly have unique colour requirements due to differing physiological and psychological aspects compared to other groups (Zhong & Shen2018). Chapter 4 stated that due to physiological and psychological reasons, elderly people are more likely to distinguish between red and yellow and prefer medium-bright colours, especially warm colours such as red and orange. Therefore, medium-bright warm tones could be used as the preferred colours. The elderly also have an appreciation for patterns with natural textures or colours, such as wood or rattan, which are in tune with their psychology.

Colour schemes for elder-friendly furniture should be compatible with their functions. The use of complementary, contrasting, and gradient techniques can be applied to highlight the purpose of the furniture.

The colour scheme of elder-friendly furniture should be consistent with the interior environment, with some variations based on unity.

iii. Material

The proper material can convey certain thoughts and feelings through its own unique "expression" and bring different experiences to the users. This principle also applies to designing elderly furniture (Zhao & Zong, 2012). For instance, matte materials could prevent eye irritation in older adults. Materials with consistent patterns and colours could help minimize disruptions caused by the decline of physiological functions and slow reaction time in the elderly. When choosing appropriate furniture materials for this demographic, factors such as furniture function, artistic impact and eco-friendly should be prioritized.

The furniture's function should be the first consideration, with skin-friendly materials used for human-body furniture, durable materials for storage furniture, and waterproof, non-slip materials for kitchen and bathroom furniture. Furthermore, the chosen materials usually possess a specific artistic effect, showcasing their own unique expression. For instance, wooden materials evoke warmth, while fabric materials highlight delicacy, and glass materials emphasize modernity. It is important to consider the artistic charm of the texture of each material. To cater to the elderly consumers' heightened sensitivity towards harmful material components, it is essential that furniture materials possess environmental attributes. Therefore, more natural and harmless materials such as wood, bamboo and so on should be used.

iv. Modelling

Furniture modelling brings different visual and psychological feelings. At present, in the market, old-style furniture is often equivalent to and related to elderly furniture, and this cannot highlight the personality of the elderly group. On the other hand, modern furniture is too fashionable and flashy, and the acceptance of the elderly group towards the furniture is

low. Furniture with novel modelling and in line with the aesthetics of the elderly is very important.

In general, elder-friendly furniture should have sturdy, simple designs. It is advisable to use symmetry, and balanced shapes, together with the elements of beauty to create a sense of identity for the furniture. It is advisable to steer away from furniture with unusual designs, which can cause discomfort. Since older Chinese people prefer Chinese-style furniture, it is worth to consider incorporating Chinese elements into the design.

Besides that, the furniture design should avoid the use of hard, stiff vertical lines and adopt more gentle curves, so that the elderly can feel psychologically calm and soft， as well as to avoid the pursuit of novelty and complexity.

Finally, it is advisable to avoid the design of medical-style furniture and labelling. Survey results showed that the elderly are hesitant to purchase products labelled "elderly furniture" as they prefer not to be singled out as different from others. Neutral language should be used to express concern for the elderly, avoiding labels for furniture intended for this demographic. Styling can be enhanced with elements such as points, lines, surfaces, and bodies to improve the aesthetic quality of elder-friendly furniture. Universal design should also be applied throughout the furniture's lifespan, making it suitable for both young and old, thereby increasing acceptance among the elderly.

v. Nostalgia emotion

Nostalgia is a significant means of artistic reconstruction and aesthetic development in elder-friendly furniture through emotional experience (Li et al, 2013). Nostalgia often serves as the fundamental theme for numerous products designed for the elderly, which is a

kind of complex of unique memories of people's past lives in the process of continuous evolution.

In contemporary times, the elderly population expresses nostalgia in many aspects, such as nostalgia for a simple and natural way of life, abandonment of the intense entertainment life, the pursuit of a leisure life of simplicity. Nostalgia is a widely experienced emotional trait amongst the elderly with human memory serving as a sentimental link between the furniture possessor and their possessions. EHF should focus on the cultural characteristics and related information of the elderly group to evoke their memories of the past and traditions.

Nostalgia often makes the elderly yearn for a simpler, freer, and more relaxed life, and being in close proximity to nature can evoke memories of past experiences. Natural materials such as wood, bamboo, and rattan are often preferred by the elderly due to their original, simple, and tactile qualities, which convey a sense of free and rustic longing, and are an effective means of nostalgic design. Moreover, utilizing traditional elements and low-purity, warm colours can also satisfy the nostalgic psychology of the elderly.

High-level emotional design can offer optimistic support and motivation for the elderly, give comfort to the soul, improve the quality of life of the elderly, and at the same time enable the elderly to gain a sense of belonging to the culture and identity, and enhance their self-confidence in life (Sun & Zhang,2014). Due to the physiological and psychological changes experienced by elderly individuals, the functionality of furniture necessitates an elevated standard of requirements. These requirements extend beyond mere aesthetic and practical considerations, to encompass the need for innovative design and structural refinement. The furniture's operation must be uncomplicated, enabling the elderly to take

control and master the use. This, in turn, would boost their quality of life, self-confidence, and hope for the future.

Table 5.3: Emotional Design of Elder-friendly Furniture

Emotional characteristics of the elderly	**Emotional Design Countermeasures**	
Nostalgia	Colour	Low lightness, low purity, warm tones, natural colours, harmony colour
	Materials	Natural and simple materials
	Design elements	Traditional elements
Lonely and insecure	Modelling	Steady and pleasing modelling
		Avoid medical furniture forms
	Design approach	Increase interactivity
Want to be recognised	Design approach	Conveying of cultural connotations via geographic, humanistic and era, Using elements of harmony
Resistance to new things, stress	Design approach	Reduce high-tech design
		Avoid design need to be memorised
		Pleasant and convenient operation interface
Not wanting to be labelled	Design approach	Universal design language

5.4 Economical Design for Elder-Friendly Home Furniture

Designing elder-friendly furniture need not be expensive. A simple and moderate design is sufficient. The survey results presented in Chapter 4 showed that most of the

elderly 's consumption is still affordable, and the price of the product is their main concern when purchasing furniture.

Japan's elderly care industry started and developed earlier, and there are different categories of elderly products in the product system, except for the new luxury private elderly care facilities, the furniture used are not luxury or expensive, but simple and moderate furniture that meet the function of the elderly (Chen & Zhou, 2015). The furniture in the asset-light operated nursing home shown in the Figure 5.15, is simple in shape and similar to the common furniture in the market, but it is as age-appropriate as possible in terms of scale, colour, and material selection. Notably, the furniture is not labelled as "for the elderly", which can offer potential care for them both physically and psychologically (Zhou & Qin, 2015).



Figure 5.15: Elder- friendly Chair in Japanese Nursing Home

The economical design of furniture for the elderly refers to the premise of meeting the function of the elderly, the form of furniture as much as possible is to simplify, or through a multi-purpose, to abandon unnecessary design, to reduce the material and labour costs, to

achieve the purpose of reducing production costs. In particular, through the control of raw materials and processes, variable design and other ways to reduce costs, it is recommended that the price of elder-friendly furniture be maintained between the middle or low level of the market to reduce the threshold of entry this segment market, and activate the mainstream users.

i. Design optimization

Firstly, energy efficiency and reduced consumption can be attained by enhancing the design and minimising the usage of materials and production processes.

Simplifying the structure of furniture and reducing the amount of furniture components and materials are direct and effective means of reducing costs.

Multi-functional Design. The aim of designing furniture for the elderly is to meet their diverse needs and enhance the economical performance of an important means. For instance, Italian designer Lanzavecchia-Wai drew inspiration from his grandmother when designing the Together Canes (Wei, 2012). This product, designed for the elderly who have mobility issues, serves as a multi-functional coffee table and storage unit equipped with pulleys of various shapes and functions. It helps elderly individuals with tasks such as storage, stabilizing and balancing their bodies while assisting with walking.



Figure 5.16: Together Canes by Lanzavecchia-Wai (Resources: www.baidu.com)

The furniture's functionality is optimized with the walking stick's versatility, which can take on three different forms. Firstly, it has a tray for holding cups and chopsticks. Secondly, it has a stand for electronic devices, and lastly, it has a bucket for books, newspapers and magazines. Furthermore, the cane is equipped with pulleys to aid the elderly with mobility.

Variable design. Employing interchangeable design based on the human life cycle can be an efficient means of achieving cost-effectiveness. As human aging progresses, the elderly traverse three stages: independent living, assisted living and nursing care. The design of elder-friendly furniture should be variable, easy to dismantle, a combination of structural components, through different collocation, the furniture to do deformation, replacement and other modular management, to meet the needs of the elderly at different stages, to extend the life cycle of furniture. Additionally, any auxiliary functions that are non-essential to the furniture may be reserved in the interface and subsequently added or replaced over time. Simultaneously, disassembled and replaced components should be conveniently recycled to achieve component recycling and ultimately reduce the structural cost of furniture and improve its economical performance.

ii. Economy of material

Material is a crucial element that affects the cost of furniture, especially for elder-friendly furniture. To minimize costs, materials should be eco-friendly and cost-effective. The following factors can be considered to control the overall cost of elderly furniture.

Natural materials such as wood, bamboo, and rattan are preferred in furniture making. Solid wood, which has been used since ancient times, remains one of the most widely used materials. However, excessive logging will cause significant damage to the ecosystem,

particularly for high-quality wood species such as red pear and rosewood. These woods are valuable and take a long time to grow. If their use is not restricted, they will cease to exist on Earth, making it crucial to prioritize preservation efforts. To enhance the quality of wood, particularly the utilization of high-value wood, scientific and technological methods involve slicing precious wood into 0.1mm - 0.4mm thin sheets. These thin sheets can be attached to ordinary or fast-growing timber to create a base. This process maintains the natural wood quality while expanding furniture quality. Additionally, it creates a stronger connection between people, materials, and nature.

Secondly, it is recommended to explore alternative materials to wood furniture. Bamboo and rattan are suitable alternatives that can complement traditional wooden furniture. Bamboo and rattan are natural, eco-friendly materials with short growth cycles, rapid growth, high yield, and renewable properties that do not negatively impact the environment. Bamboo has a smooth and delicate texture with a natural appearance, making it a fresh and elegant addition to any furniture piece. Rattan has a comfortable and natural attribute with a warm and peaceful presence. Bamboo and rattan furniture is durable, fresh, and natural which is aligned with the nostalgic emotion of elders who seek solace in nature's simplicity.

Thirdly, recycling furniture materials involves recovering and reusing waste materials. Agricultural and industrial production, as well as everyday life, generate significant amounts of waste materials which can be effectively reused to conserve raw materials through technical means. For instance, long fibres can be extracted from agricultural straw via deep processing and then pressed into sheets using bio-adhesives, thereby broadening the raw material base for furniture production. Waste furniture can be

recycled by disassembling and reusing some parts after simple processing. This means that old objects with sentimental value can be given new life, reflecting a humanistic approach to caring for the elderly and reducing costs.

iii. Economy of manufacturing process

In general, companies prioritize accelerating new product development and shortening product cycles, often at the expense of environmental impact. The manufacturing process demands significant resource consumption, while disregarding the environmental burden. Thus, integrating recycling practices during the production stage can considerably enhance the recycling efficiency of discarded products.

Currently, China's furniture manufacturing process technology level is relatively low. The most effective approach to reducing costs and improving the environment is through technological innovation and material recycling. This can be achieved by optimizing the manufacturing process and developing a new eco-process system. Transforming and regenerating materials should also be within the scope of the optimization process. The focus lies on minimizing energy consumption and reducing the environmental impact through controlling dust pollution and hazardous substance emissions.

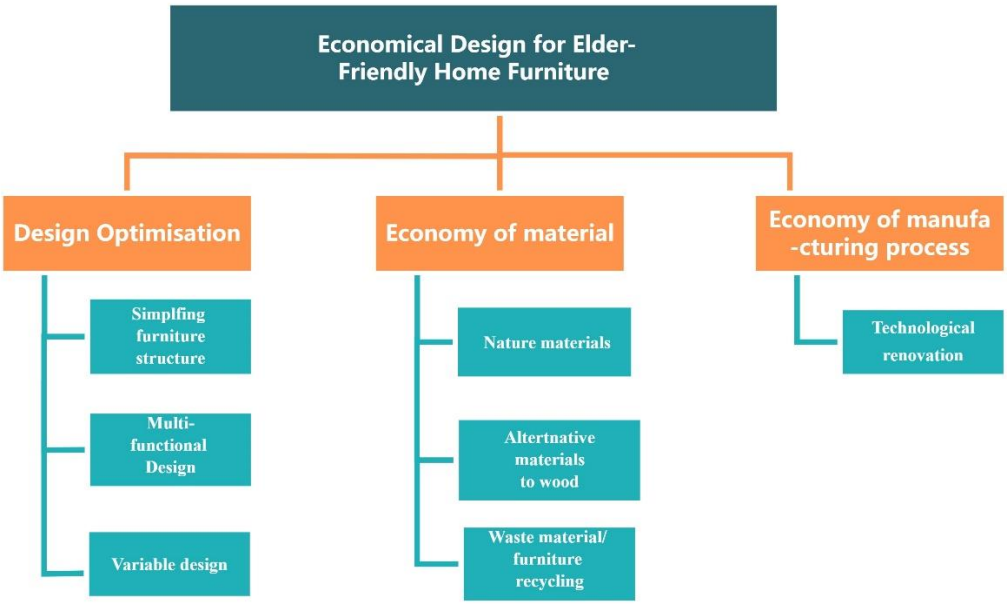


Figure 5.17: Economical Design for Elder-Friendly Home Furniture

5.5 Standardized Design for Elder-Friendly Home Furniture

Standardized design refers to release and implementation of standards for repetitive things and concepts to achieve uniformity in design practice to improve productivity and reduce costs. Standardization is an effective approach to enhance design quality, reduce operating costs, improve management capabilities, and achieve sustainable, healthy development of elderly-friendly furniture.

The aim of standardized design is to generate standard products with distinctive features using numerous standard components and a small number of non-standard components, as well as to adapt them to automatic high-volume production (Andreas Heinzmann, 2005).

Currently, there is no national standard in China for elderly furniture design. It is necessary to introduce design standards, from the perspectives of ergonomics, mechanical properties, safety performance and etc, accompanied with the corresponding manufacturing standards so that the authorities have a law as reference, the enterprises have a law to abide, the elderly have a law to sue, and to guide the industry to develop in a healthy way.

The formulation of standards should reflect cooperation. A number of industry leaders have already acquired more advanced production techniques, and facing the serious aging situation, these enterprises should take on the social responsibility of providing technical support and guidance in the formulation of standards. Furthermore, the study of ageing populations in the West has developed a well-established model. At the beginning of development, we can draw on the theory of Western countries to promote the Standardization process of elderly-friendly furniture.

An integral Standardization system includes design, manufacturing and quality control, etc. Hence, ensuring Standardization of elderly-friendly furniture requires raw materials, production process, graphic documents, furniture dimensions, components, mechanical properties, physical and chemical properties, limits of hazardous substances, flame-resistant and so on. The researcher has collected Chinese national standards and norms that could be used as references, some of which needs to be modified according to the characteristics of the elderly.

5.5.1 Standardization of Materials

The cost of materials typically constitutes around 50% of furniture costs. Material Standardization is beneficial to the reasonable compression of material varieties, simplify management, and saves raw materials.

Common materials used in elderly-friendly furniture include wood, fabric, leather, metal, and plastic etc.

For wood usage for material, one can refer to the current standard "General Technical Conditions for Wooden Furniture" (GB/T3324-2008).

While for fabric usage for material, one can refer to the current standard "National textile products basic safety technical specifications" (GB 18401-2010).

Materials using leather one may refer to the current standard "Leather and fur harmful substances limit" (GB 20400-2006).

Mattresses may refer to the requirements of "Soft Furniture Spring Mattress" (QB/T 1952.2-2011) and the padding material of sofas, mattresses and other upholstered furniture may refer to the requirements of the current standard "Upholstered Furniture Sofa" (QB/T 1952.1-2012).

In view of the behavioural and physiological characteristics of the elderly, the standard of elderly furniture materials, on the basis of the above requirements can also be considered to the add:

i. Anti-corrosion and anti-mould treatment of materials.
ii. Chamfering and bevelling treatment of exposed edges of furniture.
iii. Hardness index of upholstered furniture such as mattresses and sofas.
iv. Mattresses and sofas have anti-mite properties
v. The use of toughened glass for glass components.
vi. Non-slip surface of the bottom surface of furniture components.
vii. Exposed metal components are protected by rubber and other soft materials

viii. Anti-aging property of plastic parts.

5.5.2 Standardization of Manufacturing Processes

Manufacturing process standardization involves the unification and simplification of furniture manufacturing processes, elements, and instructions. This approach promotes the use of standard processes to achieve the requirements of furniture making with the least amount of process. Including the Standardization of manufacturing specifications, methods, process documents, symbols, and etc.

5.5.3 Standardization of Drawings and Technical Documents

Furniture drawings and documents provide a universal language for technical communication. They are a common element of furniture design standardization. Standardized drawing techniques, symbols, line patterns, annotations, and so forth form a unified technical language to ensure effective and accurate communication and are an important element of furniture design Standardization.

5.5.4 Standardization of Furniture Dimension

The General Technical Conditions for Wooden Furniture (GB/T3324- 2008）(referred to as "conditions" henceforth) covers general furniture dimensions while factoring in physiological changes of the elderly. Corresponding adjustments can be made to this part of the content, based on the original standard and the study of Chapter 4.

Table Furniture: The conditions mandate a tabletop height of 680mm to 760mm, a minimum centre clear space height of 580mm, a minimum centre clear space width of 520mm, and a height difference between the chair and table of at least 300mm. As discussed in Chapter 4, elderly individuals on average have a height 3cm lower than younger people.

Therefore, after ergonomic measurements, the average sitting height of elderly individuals has been lowered from 450mm to 430mm. Hence, considering future intervention possibilities, the tabletop's height needs to be lowered while creating more space beneath it. It is advisable that tables for elderly individuals should be set at a height of between 660 mm and 740 mm, the height of the free space under the table should be more than 650 mm and the width of the free space under the table should be more than 580 mm.

Cabinet Furniture: In accordance with the Conditions, the height from the upper edge of the hanging rod to the floor must not exceed 1500mm. Based on the analysis in Section 5.2.3, the comfortable height for the elderly for standing up and picking up objects is between 650mm and 1700mm, and the movement range of the elderly's upper limbs should not exceed 1700mm, and for the elderly in a wheelchair, the maximum height should not exceed 1500mm.

Bed furniture: Based on the Conditions, the width of the bedding should not be less than 1000mm, the length of the bedding 2000mm, the height of the bedding (including mattresses) 420 ~ 450mm, special purposes (such as wheelchair users) can choose 500mm. Considering the decreased height of elderly individuals and the potential need for wheelchair use in the future, it is recommended that the height of bedding for elderly furniture be set at 450mm--matching the height of a wheelchair--to assist with both standing up and transferring from the wheelchair to the bed. This suggestion is based on ergonomic dimensions. It is recommended that the length and width of the bed should be a large size to meet the requirements of elderly people with large figures. In addition, the bed should be compatible with common bedding sizes. For a single bed, it is suggested to choose 1200mm × 2050mm; for a double bed, it is suggested to use 1800mm × 2050mm.

Sitting furniture: According to the standard for upholstered furniture sofa (QB/T1952.1-2012), the seat height range should be 340mm to 440mm. Considering the decline in lower limb and waist strength among the elderly, the seat height should not be too low. Through calculations, it has been determined that a reasonable sitting height is 430mm, with a seat depth of 450mm and a sitting width of 430mm (which can be expanded in the case of sofa).

5.5.5 Standardization of Connecting Parts and Components

Furniture standardization can be categorised into three types: unibody Standardization, component Standardization, and connecting part standardization. Component and connecting part Standardization are the basis for the realization of unibody standardization, and the characteristics of furniture components and connecting parts are reflected in their contour dimensions, shape, cross-sectional shape, and connecting parts.

Firstly, simplifying furniture structure, reducing component specifications, and enhancing their universality and interchangeability, thus simplifying the manufacturing process, is the first choice for the Standardization of connecting parts and components.

Secondly, by standardising components and connecting parts, their universality and interchangeability are improved, and repetitive work is reduced. Component Standardization optimises the thickness and section of furniture. First, the components can be archived to the commonly used specification thickness, and second, the components with the same function can adopt the same thickness as far as possible, and for the same components with more parameter changes, a modular design can be adopted.

Connecting parts Standardization means to use the similarity principle of grouping technology to sort out the dimensions of connecting parts and find the commonalities, then categorise them into groups to make them Standardized and normalised.

Standardization of connecting parts can be achieved through Standardization and parametric design. Typically, this is achieved through the size-driven method where functional equations are used to establish a constraint relationship between dimensions. This ensures that when the driving size changes, the slave size also changes, generating a part model that meets specifications (Chen & Wang， 2017). The hardware accessories are standardized with the current Chinese "32mm system" as a technical guarantee.

Finally, a standardized components database can be created. After establishing the parts model and storing the code in the database, each component can be matched with its respective information card. Designers can access the furniture design model from the database, and manufacturing enterprises can use the shared database to view and organize production parameters. Collaboration between enterprises and designers, as well as professional collaboration between enterprises, can also be facilitated through the shared database.

5.5.6 Mechanical Performance

The current standards for testing the mechanical performance of furniture are GB/T10357.1 ~ GB/T10357.7, the elderly-friendly furniture encountered more unusual use, in addition to the overall strength of the test, some furniture components such as the top of the back of the chair, the cabinet corners and the top edge of the cabinet, cabinet doors, drawers, shelves, hanging rods, locking devices, etc., need to test the strength, stability and impact resistance.

The stability, strength, and durability of tables, chairs, and stools, as well as cabinets and beds used in elder-friendly furniture, ought to comply with the relevant standards outlined in GB/T 3324-2008, which covers the "General Technical Conditions for Wooden Furniture".

The sofa seat, backrest, and armrest need to comply with Upholstered Furniture Sofa for durability (QB/T 1952.1-2012).

The mattresses should meet the requirements of Spring mattresses for soft furniture (QB/T 1952.2-2011).

5.5.7 Physical and Chemical Properties

The physical and chemical properties of wooden elder-friendly furniture should meet the relevant requirements of General Technical Conditions for Wooden Furniture (GB/T 3324-2008).

Meanwhile, the physical and chemical properties of metal elder-friendly furniture should meet the requirements of General Technical Conditions for Metal Furniture (GB/T 3325-2008).

Glass components should meet the requirements of Safety Glass for Building Use Part 2 Tempered Glass (GB 15763.2) in terms of impact resistance, fragmentation, impact performance and thermal impact performance.

Additionally, the physical and chemical properties of artificial board components should meet the requirements of Test Methods for Physical and Chemical Properties of Artificial Boards and Veneer Boards (GB/T 17657-2013).

5.5.8 Hazardous Substance Limit

The limit for hazardous substances in elder-friendly furniture should be stricter, because the elderly have weak resistance, stay indoors for a long time and are more vulnerable to harm.

The heavy metal content and formaldehyde emission limits in wooden furniture should conform to the requirements specified in Indoor Decorating Materials Limit of Harmful Substances in Wooden Furniture (GB18584-2001).

Formaldehyde emissions from artificial boards should meet the requirements of Formaldehyde Emission Limits of Indoor Decoration Materials - Artificial Boards and Their Products E1(GB 18580-2001).

Additionally, plastic components or elder-friendly furniture should meet the requirements of Hazardous Substance Limits in Plastic Furniture (GB 28481-2012).

Leather and fur must comply with the Leather and Fur Hazardous Substances Limit (GB20400-2006).

The emission of formaldehyde from mattresses should meet the standards set by Soft Furniture Spring Soft Mattress (QB/T 1952.2-2011).

Flame retardant furniture containing PBB and PBDE must not exceed 1000mg/kg.

5.5.9 Flame Resistance

Flame resistance should be in line with the requirements of General Technical Conditions for Wooden Furniture (GB/T3324-2008).

Furniture utilised in nursing homes and other concentrated living areas for the elderly should also meet the requirements of Flame-Retardant Products and Components in Public Places - Burning Performance Requirements and Labelling (GB 20286-2006).

The flame resistance of upholstered furniture sofas, mattresses and upholstered furniture components should meet the requirements of Evaluation of the anti-ignition characteristics of upholstered furniture mattresses and sofas - Part 2: Simulation of match flames (GB 17927.2-2011).

All standards mentioned above are national standard (GB) and industry standard (QB) from China.

Table 5.4: Standardized Design for Elder-friendly Home Furniture

Standardized terms	**Contents/ Norms referenced**
Standardization of Materials	Wood (GB/T3324-2008) Fabric (GB 18401-2010) Leather (GB 20400-2006) Mattresses (QB/T 1952.2-2011) Padding material of sofas, mattresses and other upholstered furniture (QB/T 1952.1-2012)
Standardization of Manufacturing Processes	Including the Standardization of manufacturing specifications, methods, process documents, symbols, and etc
Standardization of Drawings and Technical Documents	Drawing techniques, symbols, line patterns, annotations, and so forth
Standardization of Furniture Dimension	Table Furniture Cabinet Furniture Bed furniture Sitting furniture

Table 5.4 continued

Standardization of Connecting Parts and Components	Simplifying furniture structure Standardising components and connecting parts Standardized components database
Mechanical Performance	GB/T10357.1 ~ GB/T10357.7 GB/T 3324-2008 QB/T 1952.1-2012 QB/T 1952.2-2011
Physical and Chemical Properties	Wooden EHF (GB/T 3324-2008) Metal EHF (GB/T 3325-2008) Glass components (GB 15763.2) Artificial board components (GB/T 17657-2013)
Hazardous Substance Limit	Metal content and formaldehyde emission limits in wooden EHF (GB18584-2001) Formaldehyde emissions from artificial boards E1(GB 18580-2001) Hazardous Substance Limits in Plastic Furniture (GB 28481-2012) Leather and fur (GB20400-2006) Formaldehyde from mattresses (QB/T 1952.2-2011)
Flame Resistance	(GB/T3324-2008) (GB 20286-2006) (GB 17927.2-2011)

Note: GB is referring to China national standard, QB is referring to China industry standard.

5.6 Validation and Discussion

5.6.1 Design-Based Validation

According to the research design in Figure 3.5 in Chapter 3, the Design-based Verification Method aims to address the design gap by comparing the elder-friendly kitchen cabinet currently available in the market with those that meet the expectations of the elderly. Additionally, the method combines the habits and demands of the elderly while considering the context of Active Aging Society. This involves conceptualising sketches based on the aforementioned factors and presenting them using 3DMAX and VR software for intuitive verification to the elderly.

After conducting the research in Chapter 4 on the current furniture market in Shanghai, it was discovered that the elder-friendly kitchen cabinet was not available, so there was no EHF on the market.

The collection of EHF expected by the elderly was based on two research methods, which are questionnaires, and interviews. While the two methods diverged slightly in the data they collected, the information as the core elements for drafting the conceptual design was identified. The convergent keywords are visualisation, items accessible, corner space utilized, sitting, handrail, dimension modification, rounding cabinet edge /corner, practicality, simplicity, good quality and function, work triangle.

The framework of Active Ageing was analysed in Chapter 2 and its specific manifestation in the field of elder-friendly cabinetry was refined in Chapter 5 with the keywords:

Health: independent, happy, dignity. Participation: contributed, acknowledgement, equal. Security: service, protection, support

Therefore, the Design Gap that guided the sketch conception was logically deduced as shown in Figure 5.18:

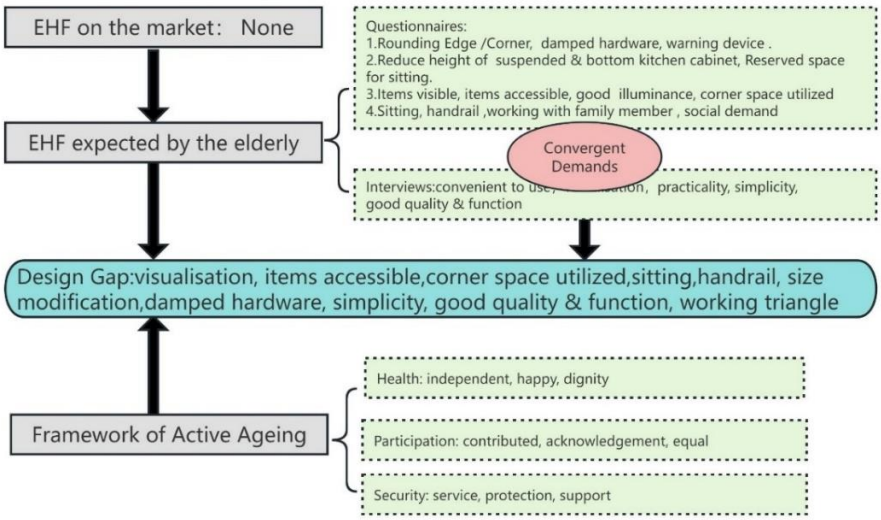


Figure 5.18: Design Gap Found for Elder-Friendly Kitchen Cabinet Sketch Conception

Based on above identified design gap, a common kitchen layout in Shanghai apartment buildings was selected and the following sketch was designed:

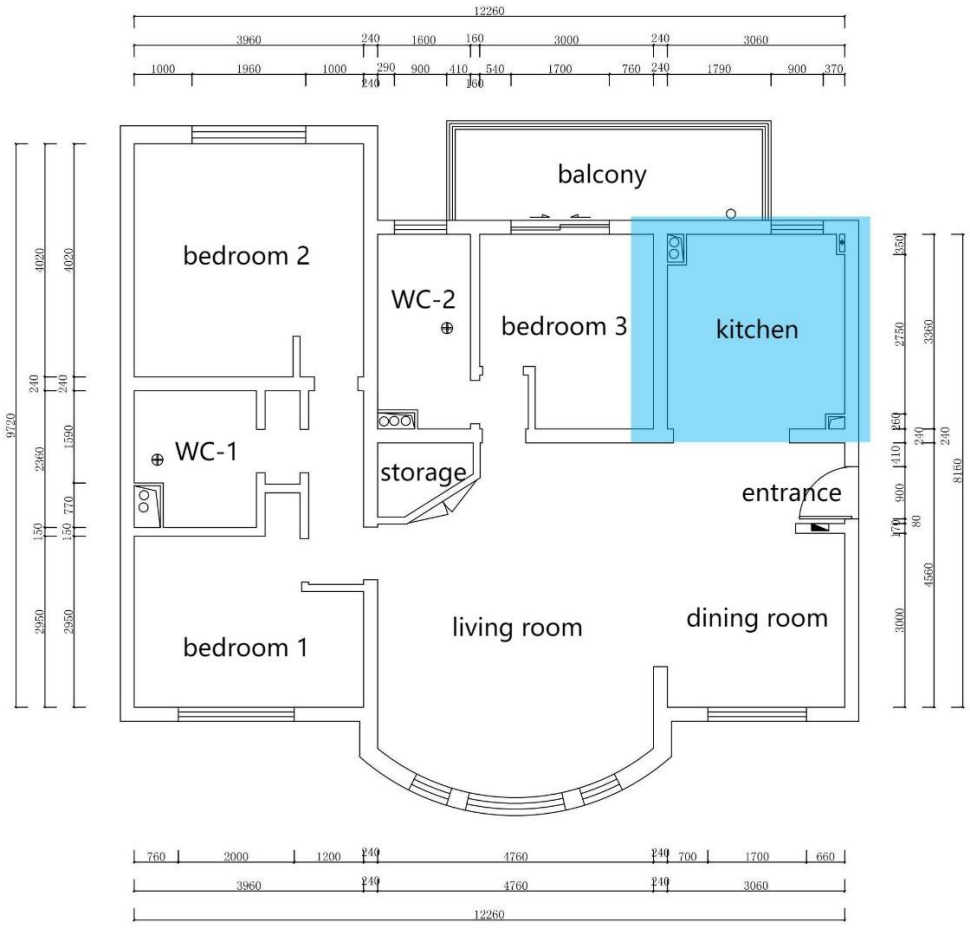


Figure 5.19: Original Apartment Layout and Kitchen Area

Design statement. A typical three-bedroom, two-bathroom apartment in Shanghai was selected for this design to ensure the representativeness. The kitchen measures 3m by 3.3 m, with a total area of 9.9 m2, an L-shaped kitchen cabinet layout, and a large sliding kitchen door to allow easy access for elderly people and wheelchair users, as well as space for wheelchair circulation zone.

The kitchen cabinet door panels are in wood colours favoured by the elderly , inlaid with glass and partially open shelves are designed to make it easier to identify and access items，which is particularly helpful for the elderly.

A reversible countertop was designed to provide additional workspace. The bottom cabinet beneath the reversible countertop can be moved under the sink, instantly transforming into a universal kitchen cabinet, and when the bottom cabinet is pulled out, the reserved space can be used for the Device-help Elderly as leg clearance in the future.

The kitchen cabinet length is modular at 900mm to facilitate high-volume production. Both the bottom and suspended cabinets are equipped with pull-out hardware. The height of the bottom cabinet is designed in a high-low style, 800 mm for the washing area and 700 mm for the cooking area. The bottom of the suspended cabinet is 1500mm from the floor, and the top of the suspended cabinet is 2500mm from the floor. The depth of the bottom cabinet is 600mm, and the depth of the suspended cabinet is 350mm.

The bottom countertop features with rounding corner, with the countertop edges turned up, one as a waterproof edge and the other as a hidden handrail. The corner space of the bottom cabinet has built-in rotatable hardware, and the door panels all have large handle and a crutch holder at the sink.

Spot lighting has been added at the sink and strip lighting at the open shelves in addition to the overall ceiling lighting for the kitchen.

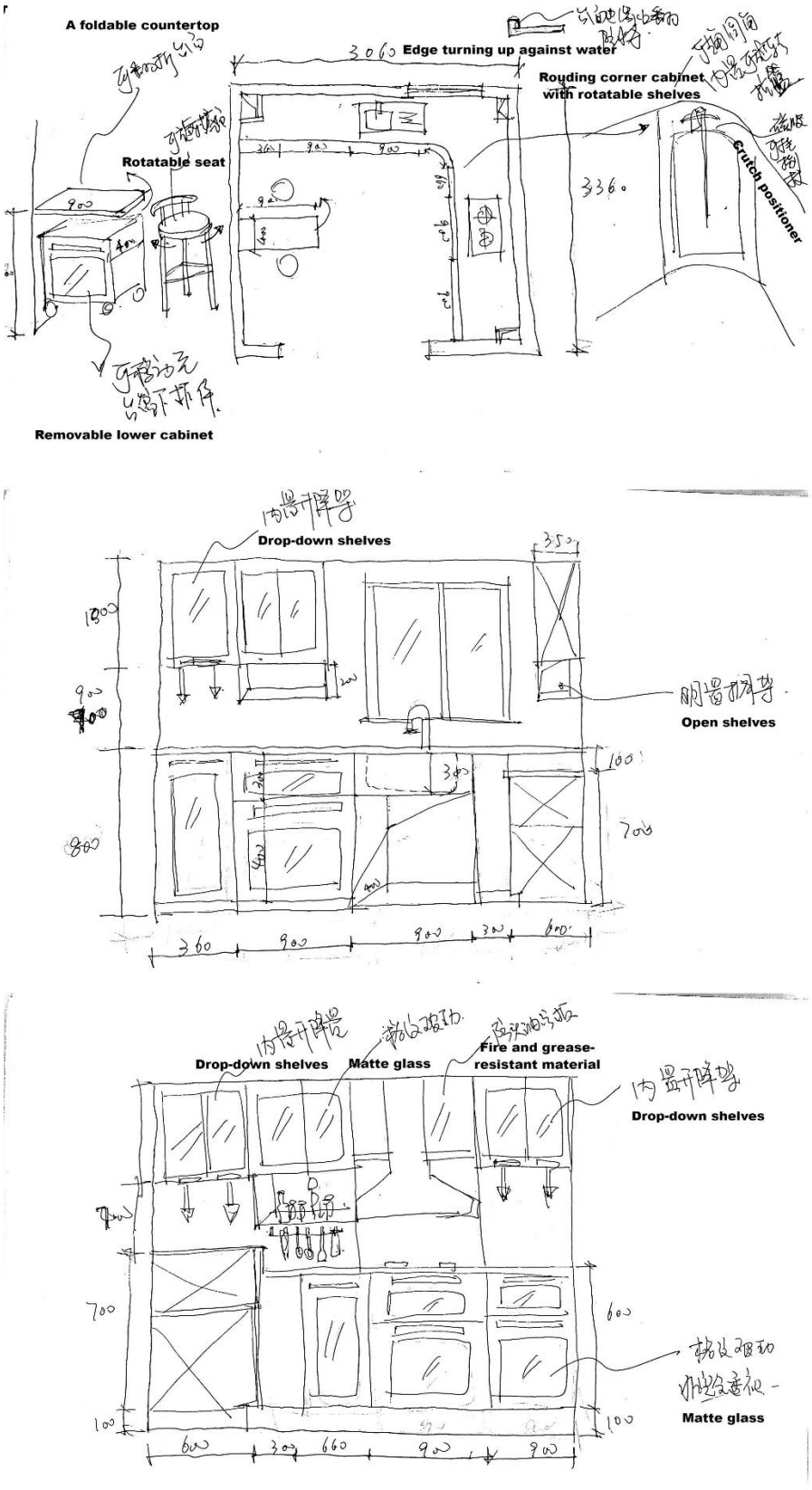


Figure 5.20: Kitchen Cabinet Sketch Programming by Researcher



Figure 5.21: Elder-friendly Kitchen Cabinet Design by Researcher (Perspectives 1)



Figure 5.22: Elder-friendly Kitchen Cabinet Design by Researcher (Details)

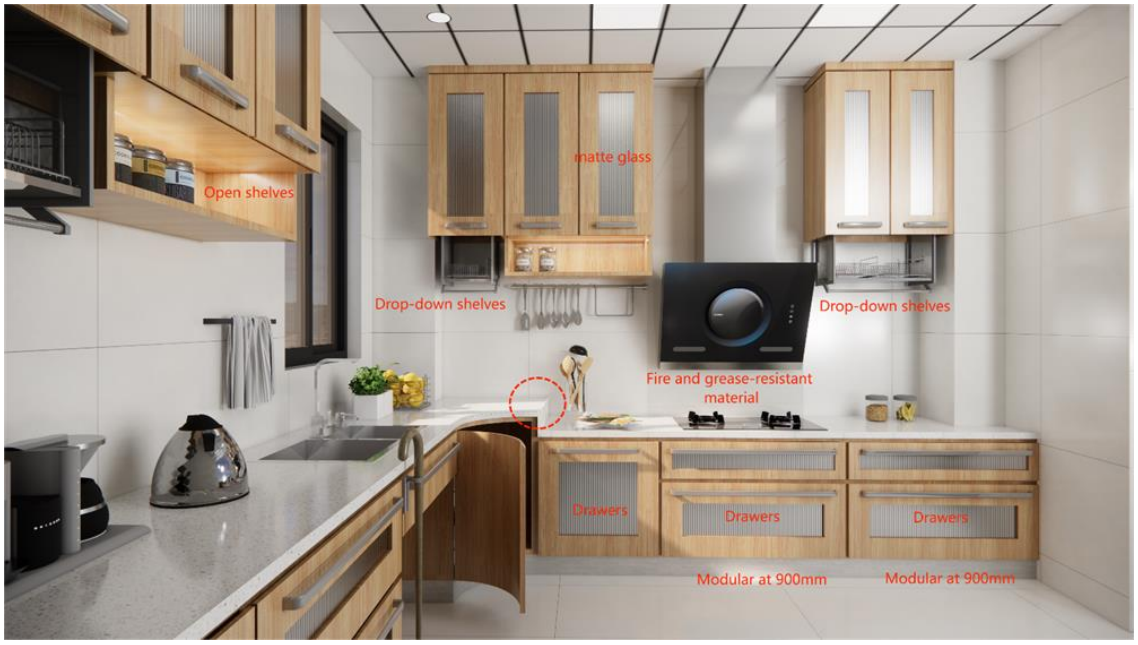


Figure 5.23: Elder-friendly Kitchen Cabinet Design by Researcher (Perspectives 2)



Figure 5.24: Elder-friendly Kitchen Cabinet Design by Researcher (Perspectives 3)

In addition to the 3D rendering, a VR reality map to represent the information visually and vividly during in-depth interviews with elderly participants was created. The

VR reality map can be accessed by scanning the code with WeChat APP (Figure 5.25) or input via the website: https://www.720yun.com/t/3fakn7rlgf9?scene_id=116203684.

Figure 5.25: Access Code for VR Reality Map



Figure 5.26: Screenshot of VR Reality Map

The main highlights of this design are as follows:

i. L-shaped layout kitchen cabinet, the washing area, preparing area, cooking area and form a working triangle, resulting in a simple and smooth workflow.

ii. Based on the previous analysis, the washing and cooking areas utilize cabinets of varying heights to accommodate the different elderly operations required. The bottom of the suspended cabinet is 1700 mm from the floor to accommodate the elderly's touch height.

iii. Kitchen cabinet length is modular at 900mm, enhancing versatility and compatibility.

iv. Bottom kitchen cabinets are converted from partitions to drawers, with corner swivel hardware in the transfer area, and suspended kitchen cabinets with drop-down shelves inside, complemented by a small number of open shelves to increase the usability and storage capacity of the cabinets.

v. The kitchen cabinet door panels are made from woodgrain panels inlaid with matte glass to enhance the visibility of the inner items.

vi. The kitchen cabinet doors are outfitted with broad, horizontal handles for easy grasping while hanging items. Additionally, invisible grab handles and crutch positioners are available in the washing area to further enhance the cabinet's assistance features.

vii. A foldable countertop is available in the kitchen to provide temporary sitting for the elderly and can also be used as a breakfast counter. The seats that match have a rotatable seat surface, which is convenient for the elderly to monitor the cooking process, and the seat surface material is artificial leather, which is economical and easy to clean.

viii. The cleaning area is reserved for wheelchair users. For Self-care Elderly people, the removable bottom kitchen cabinet can be moved to this area and can be removed as additional bottom cabinets if required in the future, and the variable design improves the usability and lifecycle of the cabinets.

ix. The countertop's edge is turned up, acting as a barrier against water.

x. In addition to the general illumination of the kitchen, point illumination is provided in the washing area and light strips are added to the open shelves, combining point, line and surface lighting to provide sufficient illumination and enrich the lighting level of the space.

xi. The hood wall is finished in fire and grease-resistant material for easy cleaning.

During the design validation stage, the initial plan was to design a second set of questionnaires to be distributed to the communities ABC to validate the design using quantitative methods. However, after consulting with my supervisor, it was suggested to change the method into in-depth interview, considering the 3D rendering plus VR virtual presentation in this design.

First, through detailed explanation and demonstration of the design, the interviewee was able to see the design effect more vividly and intuitively, and truly understood the intention and effect of the design.

Secondly, the elderly's reactions can be observed directly, and even infer feelings that the elderly could not express from their body language and facial expressions, to get more accurate feedback on the design.

Therefore, changing the method of design validation from questionnaire validation into in-depth interview validation was chosen. The researcher designed an interview outline2 (see Appendix 3 for details). The aim of the interviews was to verify:

i. Whether the design aligns with the use habits and needs of older people.
ii. Whether the design meets the requirements of an Actively Ageing Society.
iii. What is the willingness of older people to buy the kitchen cabinet if the design is produced and marketed.

Validation Steps. The 3D effect drawing was printed, and the VR drawing was saved in the IPAD. From the community ABC, 9 elderly who were participating for the first time were selected to be interviewed and recorded while demonstrating and verifying. These elderly had prior interview experience and knowledge of the interview's objectives and requirements, making them more likely to provide genuine feedback.

The results of the deep interviews were as follows (refer to figure 5.27, 5.28 and 5.29 for graphical description)

Results regarding to whether the design aligns with their use habits and needs.

i. There are no elderly kitchen cabinets on the market, no concept at all. I did not expect that the cabinet could be designed in such a way, in line with my operating procedures, quite smoothly. Kitchen cabinets are used a lot and it would be nice to be able to introduce them earlier.
ii. The suspended cupboards are difficult to access and basically unused, so the use of drop-down hardware has increased the efficiency of use. The bottom kitchen cabinets are outfitted with drawers that facilitate effortless accessibility and can be organised

for efficient storage. Open shelves can put cooking and cleaning items commonly used, feel comfortable, smooth.

iii. The design of bottom kitchen cabinet height differences looks convenient, but whether it is good or not, need to use to determine.

iv. The door panel features a visible design, so the contents can be seen and not forgotten. The use of translucent glass achieves a nice visual effect.

v. Functional and practical, with a simple and generous design and colour that is easy to match with other furniture. The product also features movable bottom cabinets, drawer tracks, pull-out baskets, drop-down frames, and other hardware that hopefully ensure excellent quality.

vi. There are reserved handrails, crutches, wheelchairs, and seats included in the design. The functionality surpasses that of the current kitchen cabinet, and as you get older, it can be easily operated by yourself if your mobility is limited.

vii. It is also easier to rest in the gap when cooking and more comfortable to use than the current kitchen cabinet.



Figure 5.27 : In-depth Interview Results-1 (Whether the Design Aligns with Use Habits and Needs of the Elderly)

Results regarding to whether the design meets the requirements of an Actively Ageing Society.

i. Improve independent operation skills and embrace it with happiness.

ii. It was not immediately apparent that the kitchen cabinets were designed for the elderly, it felt more universal and could be used by all ages.

iii. With this kitchen cabinet, cooking for the family will be easier and time in the kitchen will be more enjoyable.

iv. The care and concern of the designers can be felt, and at the same time it is different from traditional medical and rehabilitation furniture, with a strong sense of homeliness.



Figure 5.28: In-depth Interview Results -2 (Whether the Design Meets the Requirements of an Actively Ageing Society)

Results regarding to what is your willingness to purchase the kitchen cabinets if this kitchen cabinet designed is produced and on sale.

i. Would consider purchasing but would like to know if it would be expensive. Would consider purchasing or replacing current kitchen cabinets as long as it is affordable within income, but would need to discuss this with children.

ii. Concerns about the potential difficulties of the refurbishment and whether I can do it by myself.



Figure 5.29 : In-depth Interview Results -3 (Willingness of the Elderly for purchasing cabinets designed)

5.6.2 Discussion for Validation Results

The above design verification results demonstrated that:

Elderly individuals do not possess a scientific understanding of elderly-friendly furniture**.** In-depth interviews revealed that almost no elderly people know what elder-friendly home furniture was, let alone understood what an elder-friendly kitchen cabinet was. The lack of understanding made it hard to stimulate the demand for elder-friendly furniture, and even the elderly subconsciously believed that transforming the elder-friendly kitchen cabinet was "very tedious", "the current kitchen cabinet could be used, there was no need to replace it", and directly transferred the right of transformation to their children. However, upon viewing the design effect and the actual scene, they were surprised and showed great interest. The aforementioned once again confirmed what was stated in the literature review in Chapter 2, which was current research on elder-friendly furniture was still dominated by

theoretical studies, a certain type of elder-friendly furniture or a certain characteristic of elder-friendly furniture. A lack of systematic research on home scenarios, the combination of theory and practice. In the era of aging, theoretical research should take the social responsibility of guiding and stimulating the market of elder-friendly furniture.

Physical objects and sample rooms should be included in the validation methodology. The in-depth interviews showed that older people could immediately confirm what could be visualised in the design. Nevertheless, they adopted a wait-and-see attitude regarding the aspects that required experience such as dimensions and quality; they would like to test it themselves to ascertain its suitability. Therefore, to promote elder-friendly furniture, it could be complemented with a kitchen showroom, elderly furniture, and other more intuitive methods aside from design and VR demonstrations to enhance the elderly's experience.

Elderly individuals tend to have a negative perception of labelled designs. Instead, they were more open to universal, nature-inspired designs. The verified kitchen cabinet design for older adults featured minimal labelling, thus increasing its appeal across all age groups, extending its product life cycle. The universality of design confirmed that the "health, participation and security" concept in an Active Ageing Society was applicable to the design of elder-friendly furniture.

Elderly individuals do not unilaterally seek low prices, but instead prioritize higher quality products that are affordable. Although the average pension of elderly individuals in Shanghai was approximately 5K RMB, which was sufficient to meet their daily requirements, in the interviews, elderly individuals still expressed their concern about the price, and their wish that as long as the price was affordable, they would be willing to pay for products with better quality to increase the safety and convenience of the products. Therefore, designers of

elder-friendly furniture should still consider reducing manufacturing costs through standardized design, economical design, variable design and other methods.

Stereotypes persist among the elderly regarding cabinet replacement and upgrading. They assumed that the replacement of kitchen cabinets would be very cumbersome, the elderly worry that it was difficult to complete independently, to avoid the trouble, preferred to keep the original, which also objectively affected the popularity of elder-friendly furniture. The promotion of elder-friendly furniture should not just stay in theory, the need for design, manufacturing, installation, maintenance of the whole process of integrated should be taken in consideration. The current absence of integrated solutions in the field of elderly furniture confirmed the finding of chapter 2, the literature review that there was a lack of systematic research on elder-friendly furniture. Hopefully, the design approach, emotional design, economical design and standardized design proposed in this study could provide a reference and basis for subsequent studies to eliminate the concerns of the elderly.

5.7 Chapter Summary

Based on the data collection and analysis conducted in Chapter 4, Chapter 5 proposed design approach for elder-friendly furniture from the perspective of an Active Ageing Society, using elder-friendly kitchen cabinet as a starting point, and validated the above design approach using the design-based validation method.

The researcher suggested that unlike universal furniture, the principles of elder-friendly furniture design should take the following factors into account, which are healthy, participation, security, variability, standardization, emotional anduniversal design (UD), the first three of which, are in line with the concept of an Active Ageing Society.

Starting from the expectation of an Active Aging Society, the researcher proposed that the design approach of elder-friendly furniture should be based on the following aspects and analysed and demonstrated accordingly, which were size optimization, kitchen cabinet layout optimization, storage space optimization, safety and usability design, design for comfort.

Emotion and elder-friendly furniture design have an internal interactive relationship, the researcher recommended several ways to enhance the emotional design of elder-friendly furniture, including exploring the functions, colours, materials, and modelling techniques that evoke nostalgia and emotion.

The researcher highlighted that the design of elder-friendly furniture does not mean increasing costs but should be based on simplicity and moderation. Economic, practicality can be reached in three ways, which were design optimization, economy of material and economy of manufacturing process.

Standardization is an effective approach to enhance design quality, reduce operating costs, improve management capabilities, so as to achieve sustainable development of elderly-friendly furniture. This study proposed a standardization framework for the design and manufacture of elderly furniture based on the following aspects, and provided existing national standards and norms that can be used as a reference, which were standardization of materials, standardization of manufacturing processes, standardization of drawings and technical documents, standardization of furniture dimension, standardization of connecting Parts and components, mechanical performance, physical and chemical properties, hazardous substance limit and flame resistance

Based on the proposed design approach for the elderly kitchen cabinet, the 3D design drawings and VR real-life demonstration drawings were produced using the design-based verification method. Verification was conducted using the in-depth interview method and the results indicated that the feedback was relatively positive, which basically responded to the expectation of an Active Aging Society and has the value for further research and promotion.

During the design verification process, it was discovered that the elderly lacked a scientific cognition of elder-friendly furniture, which hindered the promotion of elder-friendly furniture. In addition to the 3D effect drawing and VR real-life map verification method, sample room and physical objects can be used to express factors that the elderly could be difficult to intuitively feel, such as dimensions, quality, craftsmanship. Elderly individuals tend to prefer universal and natural designs over those that are labelled or overly branded. With improved living standards, the elderly tend not to unilaterally pursue low prices, but within the acceptable range of prices, choose better quality products, and should practice simple and moderate and economical design and control the cost of furniture. Furniture, as a large-scale product in the home environment, the elderly were more concerned about the convenience of upgrading or replacement, the use of standardized design and strengthening the whole chain management about “design - manufacturing - installation – maintenance” is one of the options to be considered.

CHAPTER 6

CONCLUSION

This study focused on the design strategies of Elder-friendly Home Furniture (EHF) in the perspective of Active Ageing Society, and the main research objectives were (1) to investigate the current situation and challenges of EHF, (2) to analyse core elements of EHF design based on the above investigation, questionnaire for the elderly, (3) to recommend developing design approach for EHF, (4) to evaluate consumers' perception on the proposed design approach. This chapter summarizes the study and synthesize the key findings of the study.

6.1 Summary of the Research

This study was conducted with a comprehensive research method, combining qualitative and quantitative research, complemented by a design-based method. This comprehensive research method was relatively rare in similar studies and included the specific research methods listed: documentary research method, field investigation method, questionnaire survey method, interview method、observation method and design-based method. The appropriate research methods for different research subjects were selected to achieve the research objectives at different stages.

Chapter 1 provided the research background, presented the research objectives and research questions, limited the scope of the research, explained the significance of the research and presented the research framework, which provided direction and guidance for the subsequent research.

Chapter 2 discussed the literature review on elderly furniture. It introduced the history of design development, summarized the segmentation of elderly furniture in China from design and market perspectives, introduced the concept of EHF, and classified the research findings in this field. It was found that there were less home-based comprehensive solution, practical research and research related to an active ageing society, which was the gap of this study. The concept of active ageing society proposed by the World Health Organisation (WHO), its role in today's ageing society and the expectation of active ageing society were described, and then the expectation of elder-friendly home furniture for active ageing society was proposed. These literature reviews provided the theoretical basis for subsequent research.

Chapter 3 designed the research methodology of this study, including the setting of the research participants, the choice of research location, and the reasons for choosing cabinets as the entry point of the study. The subsequent sections describe each in detail.

To achieve RO1 (To investigate current situation and challenges of EHF), The investigation method and documentary research were conducted to obtain first-hand and second-hand information respectively.

To achieve RO2（To Analyse core elements of EHF design according to above investigation, questionnaire for the elderly, questionnaires, interviews and observation and documentary research methods were adopted to obtain the necessary information.

To solve RO3（To recommend developing design approach for EHF）, a design-based method was adopted.

To address RO4 (To evaluate the elderly perception about proposed design approach), the research which was originally designed to use a questionnaire survey method, was later changed to an in-depth interview method for validation after discussion with the supervisor, taking into account the characteristics of the results of the design-based method.

These provided the methodological support for the follow-up study.

Chapter 4 discussed the data collection and analysis based of this research, so as to achieve RO1(the challenges of EHF market) and RO2 (the core elements of EHF).

In section 4.2, the data collection and analysis for the manufacturer and market research for EHF, challenges faced by the EHF were identified. Here RO1 was completed.

In sections 4.3 to 4.5, through the data collection and analysis of the physiological, psychological and behavioural characteristics of the elderly, the general demand for EHF, and the use habits and demands for kitchen cabinet, which were the three aspects of data collection and analysis of the core elements of EHF, RO2 was achieved so far.

These laid the foundation for the proposed design approach for EHF in follow-up research.

Chapter 5 proposed design approach for elder-friendly furniture from the perspective of an Active Ageing Society, using elder-friendly kitchen cabinet as a starting point, and validated the above design approach using the design-based validation method, so as to solve RO3（To recommend developing design approach for EHF）and RO4（To evaluate the elderly perception about proposed design approach）.

In Section 5.2， starting from the expectation of an Active Aging Society, the researcher proposed that the design approach of elder-friendly furniture should be based on the aspects of size optimization, kitchen cabinet layout optimization, storage space optimization, safety and usability design, design for comfort.

In Sections 5.3 to 5.5， emotional Design, economical design and standardized design approach for EHF were proposed. So far, RO3 was achieved.

In Section 5.6, on the basis of the design approach proposed, 3D rendering and live view VR of the elder-friendly kitchen cabinet were designed and the design results were verified through the in-depth interview method to determine the validity of this research. The results indicated that the feedback was relatively positive, so far, RO 4 was achieved.

Chapter 6 provided an overall summary of the research and synthesis of key findings of the study.

6.2 Synthesis of Key Findings

6.2.1 Findings in Research Phase 1 to achieve RO1

In Research Phase 1 of the realisation of RO1, through research and analysis of manufacturers of furniture for the elderly, it was found that Elder-friendly cabinets were almost non-existent, and it was meaningful to choose it as an entry point for the research.

Through the elderly furniture market investigation, it was evident that not only foreign enterprises but also Chinese manufactures, which currently caters to the elderly furniture, primarily focused on designing and developing specific types of furniture, with a preference for functional equipment, such as electric nursing beds, electric sofas, whereas

no cabinet. The range of elderly-friendly furniture was limited, indicating a need for further clarification and positioning of elder-friendly furniture in China.

For the elderly, the kitchen cabinet is a very frequent daily used furniture, it is representative. On the other hand, for the study, the kitchen cabinet integrated multiple functions, so choosing it as the research object could fill the gap of elderly furniture in the market, and could also facilitates the extension of the research methodology to other categories of furniture.

In the market, it was rare see the elder-friendly furniture on sale, and the sales staff with a misunderstanding, conservative or wait-and-see attitude, the main performance was they did not understand what the elderly furniture is, have not heard of it, assumed that the elderly do not need special furniture, assumed that the elderly did not have consumption capacity, had misconception that only mahogany furniture suited the elderly and was not sure if it was best seller. This also verified the findings of the literature review, that was, the existing research on elderly furniture laced the design of home scenarios, practical research, and a more systematic study on elderly furniture, this study proposed a comprehensive renovation programme for elderly home furniture from a combination of theoretical and practical methods, with the hope of achieving the effect of throwing bricks to draw jade.

Furniture manufacturers perceived the main challenges in developing elder-friendly furniture to be less supportive policies, requiring industry standards, intellectual property rights, lack of elderly products, enterprises gathering at B sales channel, high cost of R & D, lack of consumer awareness and insufficient industrialisation level. Despite these challenges, furniture manufacturers were still optimistic about elder-friendly furniture.

6.2.2 Findings in Research Phase 2 to achieve RO2

The main physiological changes in older adults are perceptual characteristics, such as decreased visual acuity, decreased hearing, dull sense of touch, reduced memory and decreased cognitive. In addition, the movement characteristics, such as reduction in height, reduction in balance and slow movement and increased risk of falling. Psychological changes in the elderly are mainly characterised by empty mind, helplessness, strong self-esteem and stubborn, suspicion, personality change, embracing positive aging and special colour psychology and consume psychology.

The furniture most frequently used by older people were, in frequency order, beds and bedside tables, wardrobes, sofas, dining tables and chairs and kitchen cabinets, with the highest level of dissatisfaction with the use of cabinets. The most preferred furniture materials for older people were, in preference, solid wood, linen, bamboo and rattan, and leather. Among them, the special research on cabinets found that cabinet users are hostesses and couples together, accounting for the absolute mainstream, the elderly use of the cabinet procedures are "taking out ingredients - washing ingredients - preparing ingredients - cooking ingredients," It is basically a standing operation. The main difficulties in using kitchen cabinets for the elderly, in order, are, inconvenience to take item, standing posture, inconvenience of kitchen cabinet door opening, shortage of storage space, inappropriate countertop height, memory difficulty for inner items, limited preparing space, difficulty in reaching corner space, low illumination and forgetting cooking time / electric valve.

6.2.3 Findings in Research Phase 3 to achieve RO3

Starting from the expectation of an Active Aging Society, the researcher proposed that the design approach of elder-friendly furniture should be based on the following aspects,

which were size optimization, kitchen cabinet layout optimization, storage space optimization, safety and usability design, design for comfort. Among them, size optimization can be realised via setting suitable height of bottom and suspended kitchen cabinet, leg clearance, U-shape and L-shape are more suitable for the elderly, storage space optimization can be realised via utilizing middle section of kitchen cabinet, liftable and rotatable hardware and visible design, safety and usability design can be achieved via warning device, good lighting, rounding edge or corner, damper hinge, ergonomics handle and so on, in addition design for comfort can be realised via physiological comfort, psychological comfort and short sitting when working in kitchen.

Emotion and elder-friendly furniture design have an internal interactive relationship, the researcher recommended several ways to enhance the emotional design of elder-friendly furniture, including exploring the functions, colours, materials, and modelling techniques that evoke nostalgia and emotion.

The researcher highlighted that the design of elder-friendly furniture does not mean increasing costs but should be based on simplicity and moderation. Economic, practicality could be reached in three ways, which were design optimization, economy of material and economy of manufacturing process.

Standardization is an effective approach to enhance design quality, reduce operating costs, improve management capabilities, so as to achieve sustainable development of elderly-friendly furniture. This study proposed a standardization framework for the design and manufacture of elderly furniture based on the following aspects, and provided existing national standards and norms that can be used as a reference, which were standardization of materials, standardization of manufacturing processes, standardization of drawings and

technical documents, standardization of furniture dimension, standardization of connecting parts and components, mechanical performance, physical and chemical properties, hazardous substance limit and flame resistance.

6.2.4 Findings in Research Phase 4 to achieve RO4

It was discovered that the elderly lacked a scientific cognition of elder-friendly furniture, which hindered the promotion of elder-friendly furniture. This once again confirmed what was stated in the literature review in Chapter 2, which is lacking systematic research on home scenarios, the combination of theory and practice.

In addition to the 3D effect drawing and VR real-life map verification method, sample room and physical objects could be used to express factors that the elderly could be difficult to intuitively feel, such as dimensions, quality, craftsmanship.

Elderly individuals tend to prefer universal, simple, practical, and natural designs over those that are labelled or overly branded. Elderly individuals tend to have a negative perception of labelled designs. Thus, increasing its appeal across all age groups, extending its product life cycle. The universality of design confirmed that the "health, participation and security" concept in an Active Ageing Society is applicable to the design of elder-friendly furniture.

With improved living standards, elderly individuals do not unilaterally seek low prices, but instead prioritize higher quality products that are affordable. But they still expressed their concern about the price, therefore, designers of elder-friendly furniture should still consider reducing manufacturing costs through standardized design, economical design, variable design and other methods to control the cost of furniture.

Stereotypes persisted among the elderly regarding cabinet replacement and upgrading. As furniture were a large-scale product in the home environment, the elderly were more concerned about the convenience of upgrading or replacement, the use of standardized design and strengthening the whole chain management about “design - manufacturing - installation – maintenance” was one of the options to be considered. The current absence of integrated solutions in the field of elderly furniture confirms the finding of Chapter 2, the literature review that there is a lack of systematic research on elder-friendly furniture. Hopefully, the design approach, emotional design, economical design and standardized design proposed in this study could provide a reference and basis for subsequent studies to eliminate the concerns of the elderly.

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APPENDICES

Appendix A: Journal Publications

1. **Junli Zhang.,** & Musdi bin Hj. Shanat. (2023) Research on Design and Development of Elder-Friendly Furniture in Chinese Residential Situation., *Art and Society，2*(3), 32–37.
2. **Zhang Junli.,** Musdi bin Hj. Shanat., Ma Xiaoyuan. & Khong Heng Yen. (2023). The Theory and Practice of Ageing Housing Transformation in China and Abroad: A Review. *International Journal of Service Management and Sustainability*, *8*(1), 113–128.
3. **Junli Zhang.,** & Musdi bin Hj. Shanat. (2024). Virtual Reality-based Accessibility Design of Elder-friendly Spaces and Furniture. *Journal of Advanced Research in Applied Sciences and Engineering Technology, submit and accepted via 15th International UNIMAS Engineering Conference 2024*, EnCon2024: 047-039.

Appendix B: Questionnaire I for the Elderly Preferences and Demands on Elder-friendly Furniture

Participant Information

Zhang Junli is taking her PhD studies at the Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak. Her PhD research entitled: The Design Development of Elder-friendly Home Furniture for an Active Aging Society

Objectives of Research

i. To investigate current situation and challenges of Elder-friendly Furniture (EHF).

ii. To Analyse core elements of EHF design according to above investigation, questionnaire for the elderly.

iii. To recommend developing design approach for EHF.

iv. To evaluate consumer perception for proposed design approach.

The purpose of this survey is to understand elder's condition of furniture use, the elder's demands for furniture.

What Your Participation will be Involved in This Study

It will take you approximately 15 to 20 minutes to complete the questionnaire and please remember to complete all the questions. Please return the questionnaire to the researcher once it has been completed. Once you have completed the questionnaire please click on close and the system will automatically receive the questionnaire.

Notice to Participants

The survey is conducted on an anonymous basis and the responses are not right or wrong. We also declare that the data collected in this survey will be used for academic research purposes only, and will only be handled by professional researchers related to this topic for overall statistical analysis, and will not involve any specific individuals or units. Your privacy will be protected, please fill it out truthfully.

For Further Details

If you are interested in this research topic and would like to know more about it, you can contact us with email: 20010093@siswa.unimas.my

If you have any complaint about this study or the results, please do not hesitate to contact the CGS office at Universiti Malaysia Sarawak,94300 Kota Samarahan, Sarawak,

Malaysia.082-582409/2436/2441.

Thank you very and we sincerely appreciate your enthusiastic participation.

Part 1: Basic Information

1 Your gender
A Male B female

2 Your age
A 60-69 years old B 70-79 years old C above 80 years old

3 Your current residential conditions
A live with spouse B live with children C live alone D live with parents

4 Where do you live?
A commercial community B economical community C demolition community
D Lane

5 What is your income?
A live with pension B live without pension C Land acquisition income

6 What is your physical condition?
A can take care of yourself, not depend on others B need Auxiliary Facility in daily life
C need other people to look after

7 Do you have any of the following physical problems? (Multiple options)
A Vision impairment B Hearing impairment C upper limb impairment
D lower limb impairment E Waist pain F neck pain H Other problems

8 How satisfied you are with current furniture?
A Very satisfied B satisfied C not care D dissatisfied E very dissatisfied

9 What do you care most when choosing furniture? (Choose 4 items in descending order)
A Price B Quality C Brand D Appearance E Style F Function G Material
H Leisure function I healthy function J Collectible value K others

Part 2: Use Habits on Furniture

10 what kinds of furniture do you have currently? (Multiple options)
A Bed B Bedside Table C Wardrobe D Cabinetry E Dining Table /chair
F Sofa
G TV cabinet H Tea table I bookcase J Rocking chair K Massage chair
L Walking chair M Toilet chair

11 The furniture you use most frequently (please choose 5 kinds in descending order)
A Bed B Bedside Table C Wardrobe D Cabinetry E Dining Table /chair
F Sofa G TV cabinet H Tea table I bookcase J Rocking chair K Massage chair L Walking chair M Toilet chair

12 The most inconvenient furniture you supposed (please choose 5 items in descending order)
A Bed B Bedside Table C Wardrobe D Cabinetry E Dining Table /chair F Sofa
G TV cabinet H Tea table I bookcase J Rocking chair K Massage chair
L Walking chair M Toilet chair

13 Select the appropriate answer from the following items:
A Solid Wood B Wood-based board C Bamboo and Cane D Metal E Plastic
F Glass G Cloth/linen H Leather I Others

The main material of your current furniture? (Choose 4 items in descending order)

What are your favorite materials for future furniture? (Multiple choices. Please list 4 in descending order of preference

<u>Scenario-based questions – Kitchen Cabinet</u>

14 Do you have cabinetry at home? (If not, please skip to next part)
A Yes B No

15 Length of use of your cabinets.
A 1-10 years B 11-15 years C 15-20 years D 20 + years

16 Who usually use cabinetry at home?
A husband B wife C both D rarely use

17 what kinds of functional spaces in your kitchen cabinet (multiple options)
A Storage space B Washing space C Preparing space D Cooking space
E Communication zone F Other

18 Fill out your work sequence in kitchen. (Ranking question, please select them in order)
A Take ingredients B Clean ingredients C Prepare ingredients
D Cooking ingredients

19 Your posture when operating in kitchen.
A Standing B Sitting

20 Your difficulties when using kitchen cabinet (Ranking question, please select in descending order of difficulty)

A Inconvenient to take item
B Inconvenient of cabinet door opening
C Inappropriate countertop height
D Standing posture
E Memory difficulty for inner items
F Shortage of storage space
G low illumination
H Limited making area
I Difficulty in reaching corner space
J Forget cooking time / electric valve and so on
K Others

Scenario-based questions-- sitting furniture and bed

21 The average time you use sofa/chair per day.
A Less than 1 hour B 1-2 hours C 2-3 hours D 3-4 hours E more than 4 hours

22 What is your usual behavior on chair? (Multiple options)
A Watch TV/newspaper B Play chess C chat D nap/ daze
E lie for sleeping F Others

23 What is the most uncomfortable position of your body when you use sitting furniture? (Ranking question, please select in descending order)
A Waist B Neck C Shoulders D Legs E Other

24 Your difficulties when using sitting furniture. (Ranking question, please select in descending order of difficulty)
A Transfer difficulty between standing and sitting B uncomfortable handrail
C difficult to move D difficult to clean E lacking head support E inappropriate size

25 How many times you get up overnight.
A None B 1-2 times C 2-3 times D 3-4 times D more than 4 times

26 Do you read before going to sleep?
A Yes B no

27 Do you use bedside table usually?
A Yes B No

28 What is the most uncomfortable part of your body when using bed (Ranking question, please select in order of discomfort)
A Waist B Neck C Shoulders D Legs E Head F Other

29 Your difficulties when using bed (Ranking question, please select items in descending order of difficulty)
A Difficulty in sitting up B difficulty in turning over C lacking handrail
D inappropriate angle of bed head E inconvenient when getting up over night
F nowhere to put crutches
G too soft/too hard mattress H others

Scenario-based questions - wardrobe

30 The main items in your wardrobe? (Ranking question, please in descending order of amount)

A Clothing B shoes and socks C quilts D sheets E tools
F valuables G luggage H accessories I Other

31 How do you store items in your wardrobe?
A Stack store B hang store

32 Your difficulties when using of the wardrobe. (Ranking question, please select in descending order of difficulty)
A too high B difficulty in reaching corner space C low illumination
D Inconvenient in door opening E inconvenient in bending over to take item
F Poor organization G Poor visualization

Part 3: Elderly' Use Demands on furniture

Scenario-based questions – Kitchen Cabinet

33 Would you like elderly-friendly kitchen cabinet?
A Yes B No

34 Your demands on improvement of kitchen cabinet size. (Ranking question, please choose in descending order. _____
A Reduce lower cabinet height B Reduce suspended cabinet height C Reserved space for sitting D Other

35 Your demands on improving safety of kitchen cabinet. (Ranking question, please choose in descending order. _____
A Warning Device B Rounding Edge /Corner
C Damped hardware D Other

36 Your demands on improving utility of kitchen cabinet? (Ranking question, pleas choose in descending order_____
A Items visible B Items accessible C Good illuminance
D corner space utilized E Other

37 Your demands on improving using comfortableness of kitchen cabinet? (Ranking question, please choose in descending order. _____
A Sitting when using cabinet B Handrail C Working with family member
D Social demand E Other

Scenario-based questions -- sitting furniture and bed

38 Would you like an elderly-friendly chair or sofa?
A Yes B No

39 Your focus attention on sitting furniture? (Please select 3 most important item in descending order) _____
A Price B Economy C Comfort D service life E brand F style
multi-function

40 Your demands on comfort of sitting furniture? (Ranking question, please select in descending order) _____
A Easy to move B easy to sit C back adjustment D height adjustment
E easy to clean F crutch placement G Other

41 Your demands on leisure of sitting furniture? (Ranking question，please select in descending order) _____
A Massage B Heating C audio/visual function D recline E sitting adjustment

42 Your preference about sitting furniture material? (Ranking question, please select in descending order)

_____
A Solid wood B rattan C fabric D metal E polymer F leather

43 Your preference about sitting furniture color? (Ranking question，Please select in descending order) _____
A Red B Yellow C Black D wood brown E light gray F blue

44 Your demands on improving bed design? (Ranking question, please select in descending order) _____
A adjustable bedhead B adjustable bed board C night lighting D crutch placement
E guardrail F storage space G SOS device H Other

Scenario-based questions - Wardrobe

45 Would you like an elderly-friendly wardrobe?
A Yes B No

46 Your demands on improving wardrobe design? (Multiple options, please select in descending order) _____
A Adjustable division board B easy access to item C increase storage space
D internal lighting E use of corner space F reasonable function zone
G item visualization H other

--THANK YOU--

Appendix C: Interview Outline for the Elderly Use Habits and Demands in Shanghai community A, B and C

Interviewee		
Age		
Place of interview		
Date of interview		
Family structures		

Characteristics of the Elderly

1. What is your physical condition at present? Have your senses (e.g. sight, hearing, smell, touch, etc.) and mobility changed since you were young?

2.What is your current mindset/Psychological condition compared with the time you were young?

3.What are your basic daily activities, arranged chronologically?

Kitchen Cabinet Use Habits

4. How often do you cook? How do you usually organize breakfast, lunch and dinner?

5.Do your kids and grandchildren often visit and dine with you, and if so, do you prepare elaborate meals for them?

6.Do you often have friends over for dinner because you feel lonely and isolated?

7. Do you want to cooperate with others when cooking?

8. Please describe your main difficulties when using kitchen cabinet.

Kitchen Cabinet Use Demands

9. If cabinetry can be improved, which parts would you like to improve first? Why?

10.What are your primary considerations when purchasing cabinet (e.g. price, quality, brand, service, style, function)?

--THANK YOU—

Appendix D: Design-based Validation Interview Outline for the Elderly in Shanghai community A, B and C

Interviewee		
Age		
Place of interview		
Date of interview		
Family structures		

Whether the design aligns with your use habits and needs.

Note: The evaluation of the suitability of the elderly's using habits is assessed in terms of functional division, using flow, dimensions and scale, visualization, accessibility, operation and storage space.

Practicality, simplicity, quality, function, price, cabinet safety, kitchen cabinet dimensions, kitchen cabinet usability, and user comfort will be considered when interviewing the users regarding their usage demands.

Whether the design meets the requirements of an Actively Ageing Society.

Note: The evaluation of whether the expectations of an Active Ageing Society are met will be assessed in terms of health (independence, happiness, dignity), participation (contribution, acknowledgement, equal rights) and security (service, protection, support).

What is your willingness to purchase the kitchen cabinet if this kitchen cabinet designed is produced and on sale?

--THANK YOU--