

Research on Design Strategy of Furniture for the Elderly Based on PSS

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Abstract: China's population is aging, and there is less research on suitable furniture. This paper analyzes the definition and connotation of product service system(PSS), constructs the concept of suitable old product based on PSS, and applies it to the research of furniture design strategy. The study used the methods of interviews and questionnaires to carry out the design front-end analysis of the overall product system of the old furniture, and obtained the effective elements of the old furniture design, and constructed the decision model of the old furniture design strategy. Through the empirical discussion of design, the paper verifies that the design elements are reliable and the strategy model is effective.

1. Introduction

With its unique multiple functions, furniture penetrates through all aspects of social life and is closely related to people's clothing, food, housing and transportation. At present, the marketing models of general furniture products tend to be singular, the matching and specificity of the furniture has a lot of(have great) limitations in the market. The existing furniture products cannot meet the personalized and diversified high-quality demands of contemporary people, furniture design faces great challenges and innovations. The development of the furniture industry has also entered a new normal, and the industry needs to constantly improve in product structure, processing and manufacturing, innovative services and other aspects to adapt to the new stage of development[1]. Product service system(PSS), as an emerging business model, is a system composed of products, services, supporting networks and infrastructure. This system is designed to be competitive, to cater to and meet the preferences and needs of consumers, and to produce lower environmental impact than the traditional business model. The overall service concept put forward by the PSS, and the research of furniture design strategy with the overall product service system is the current trend and trend.

According to investigation and research on relevant data, by the end of 2017, China's elderly population aged 60 years and over has reached 241 million, accounting for 17.3% of the total population. It is estimated that the number of elderly population in China will reach a peak of 487 million by 2050, accounting for 34.9% of the total population. The "aging" trend of China's population continues to rise, which has not only created a series of social problems, but also

broadened the market for the "appropriate products for the elderly" industry, suitable furniture is one of them. Looking at the entire Chinese market for elderly products, 60% -70% of the elderly products on the market are elderly health products. Although there is a corresponding market for other auxiliary products such as elderly mobility products, elderly functional beds, etc, the fact is not optimistic. In addition, by investigating furniture stores, enterprises, and some large-scale elderly industry exhibitions, I can find that there are only a handful of companies that have worked hard in the field of elderly furniture and have participated in it for a long time. At present, the design and development of suitable old furniture is also very scarce, and the research on the single category of furniture may be more functional. The personalized and diversified demands of contemporary elderly in China have put forward new requirements for the design of suitable furniture, and also brought new challenges to the development of suitable old furniture industry. Therefore, suitable for the old space and the old environment are in urgent need of suitable for the old furniture based on the theory of PSS to design and research.

2. Definition and Connotation of PSS

2.1. Definition of PSS

The concept of product service system (PSS) was first proposed by the United Nations Environment Programme in 1994, whose core idea is that what enterprises provide to consumers is the function or result of products, and users can not own or purchase products in physical form. PSS connects tangible products and intangible services. Through the provision of service functions, the product exists in a system, rather than a user who owns it. The function is maximized to maximize the benefits. The cycle is transformed into a consumption cycle, reducing waste of resources[2]. Customers no longer simply buy products, but want to be able to meet their needs and help them create the most value of the overall solution of products and services, called Product Service System (PSS).

In recent years, scholars at home and abroad have expounded the concept of product service system in many aspects, as shown in Table 1. In 2002, Oksana Mont proposed that PSS is a pre-designed combination system that includes products, services, and support structures that can meet consumer demands, it is an immaterial solution to consumer needs and preferences. Consumers must rethink the way they provide functionality and they must arrange a service network that meets the needs of customers in the market in advance, compared with non-systematic individual products and services, they can minimize the impact of the environment while meeting market demand. In 2009, Gu Xinjian and others believed that PSS is a new production system with high integration and overall optimization of products and services formed under the model of product manufacturing and enterprises responsible for the product life cycle service (extended producer responsibility system) [3]. Link product service systems with product life-cycle management, manufacturing services, etc., and the product service system is studied based on users' demand for product services, product innovation, differentiated competition among enterprises, enterprise competition for customers, environmental protection and other needs. In 2014, Geng Xiuli and Chu Xuening proposed that the concept of a PSS was mainly applied to the transformation of marketing models and the extension of responsibilities of traditional manufacturing enterprises, that is, the marketing model extends from selling products to the use or result of selling products[4]. None of these explanations has a unified definition, but different definitions have different emphasis. All of them are put forward in the context of green environmental protection and sustainable development, and all regard products and services as a whole system.

Table 1: Comparison of several typical definitions of PSS.

Time	Presenter	The core idea of PSS definition
1994	United Nations Environment Programme	What the enterprise provides to consumers is the function or result of the product, and the user may not own or purchase the product in physical form.
1999	Goedkoop	PSS is a system consisting of products, services, organizer networks, and support facilities, where the ratio of products / services can vary depending on the implementation of the function or the economic value of the function. The goal is to remain competitive, meet customer needs, and to reduce environmental impact compared to traditional business models.
2000	RobinRoy	PSS provides consumers with specific functions and results, and consumers do not need to own or purchase material products and results.
2002	OksanaMont	PSS is a pre-designed combination system that includes products, services and support structures that can meet consumer needs.
2003	Manzini, Vezzoli	PSS is an innovative strategy that transforms the economic model from focusing solely on the production and sale of physical products to focusing on the integration of products and services that meet customer needs.
2009	Gu Xinjian et al	PSS is a new production system which is highly integrated and optimized under the service mode of full product life cycle.
2014	Geng Xiuli, Chu Xuening	PSS is mainly applied in the transformation of traditional manufacturing enterprises' marketing model and the extension of responsibilities, that is, the marketing model extends from selling products to the use or result of selling products. PSS is a integrated overall solution.

2.2. Connotation of PSS

The definition of PSS is relatively broad, so an effective classification method is needed to help us understand the connotation of PSS. Generally, the most representative classification method is to divide PSS into three major directions according to the proportion of products and services, which are product-oriented, user-oriented, and result-oriented. Product-oriented is the transfer of ownership of tangible products to consumers, but additional services are provided or added to existing product systems; The ownership of user-oriented tangible products is still owned by service providers. With improved logistics and payment systems, such as sharing, leasing, and ride-sharing, the service provider sells product functions to users. This type focuses on the "purpose" of selling the product rather than the product itself; The products in the result-oriented type are replaced by a service, which is actually the only service system that is truly oriented to the needs of users, looking for alternatives to the product through the service equipment. On this basis, Tukker and Tischner further divided them into eight categories: ①product-related services;②advice and consultation;③Product long-term lease;④Product rental or sharing;⑤Product sharing;⑥Event Management and Outsourcing;⑦Billing based on service level;⑧Functional result.

The essential characteristic of PSS is the organic combination of products and services, which emphasizes the transformation from tangible substances (products) to intangible functions (services), and realizing the transformation of design method through integrated design. As can be seen from the comparison and classification of the multiple definitions of the PSS mentioned above, PSS has the following specific characteristics: ①How to use the product service system is closely related to the type of product, use attributes and its functional value;②PSS is a combined system based on overall products and services; ③ PSS adheres to sustainable development; ④ PSS can be summarized as a new enterprise combat plan; ⑤PSS need the support of modern technology and network systems.

2.3. Connotation of PSS Suitable for Furniture Design

Through the comparison and analysis of the connotations of the above definition of PSS, the concept of "PSS is a combined system based on overall products and services" is the most suitable as the theoretical basis for the study of furniture design strategy. In other words, only the overall products and services can meet the multi-dimensional demands in the market, can solve the special problem of users comprehensively, and can reduce the environmental energy consumption to the minimum. For elderly furniture products, the overall product concept in PSS is particularly important, the overall product concept is conducive to solving the relationship between suitable old furniture and suitable old spaces, and it is conducive to solving the overall, systematic and the matching problem, it is also conducive to solving the problem of the consistency between the process of the old furniture product and the process of the original furniture company. Therefore, the overall product concept of the PSS has a positive guiding significance for the research on the design strategy of suitable old furniture, and the overall product concept will also be used as the research method of suitable old furniture design strategies.

3. The Design Research of Suitable Old Furniture

3.1. Front-end Design Analysis

With the development of society and the improvement of people's quality of life, the needs of the elderly for life are becoming more and more diversified. By consulting the data and conducting surveys, the author found that contemporary elderly have huge consumption demands, but the market cannot meet them well. By investigating the elderly's demand element for suitable old furniture (Table 2), and analyzing and summarizing the CMF of existing suitable old products, the following design arguments and design elements were extracted as suitable old furniture design strategies, the basis for decision-making are Molding style, Material, and Color. After an in-depth analysis of the three design elements of Molding style, Material and Color, a questionnaire and interview questions were designed. Taking into account the problems of poor eyesight, poor anxiety, and poor understanding of the elderly, the questionnaire is basically based on pictures. A total of nine groups of pictures are set, each of which represents a different design element. In other words, the nine pictures in each group have different attributes. A total of 100 questionnaires were distributed in this survey, of which 94 were valid questionnaires. Table 3 and Table 4 show the distribution of the number of elderly people surveyed in different age groups and educational backgrounds.

Table 2: Investigation on the demand factors of elderly people for elderly furniture.

Serial number	Demand factors(multiple choices)	Number of people selected (78 people in total)	Proportion	Serial number	Demand factors(multiple choices)	Number of people selected (78 people in total)	Proportion
1	Design of auxiliary medical functions	21	26.92%	10	Multi-color collision	19	24.36%
2	Eco-friendly materials and soft fabrics	32	41.03%	11	Identity design	2	2.56%
3	Comfortable and warm colors	27	34.62%	12	Simple, generous, dignified appearance modeling	7	8.97%
4	Stable structural design	34	43.59%	13	Storage function	10	12.82%
5	The appropriate cost or price	31	39.74%	14	Easy to learn and use, easy to operate	20	25.64%
6	High grade, high quality materials	2	2.56%	15	Lighting function	4	5.13%
7	Luxurious, layered surface texture craft design	2	2.56%	16	Anti-smash and anti-slip rounded arc design	44	56.41%
8	Fashion, deaging design	7	8.97%	17	Center of gravity support design	28	35.90%
9	Obvious style design	4	5.13%	18	Suitable pattern embellishment	20	25.64%

Table 3: Age distribution.

Gender\ Age	A 55-59 years old	B 60-64 years old	C 65-69 years old	D 70-74 years old	E 75-79 years old	F Over 80 years old	Subtotal
Male	13	11	4	8	4	1	41
Female	10	10	14	14	1	4	53

Table 4: Educational distribution.

Gender \ Education background	A Primary school and below	B Junior high school	C High school/technical secondary school/technical school	D University College	E Undergraduate college	F Master or above	Subtotal
Male	16	15	7	2	1	0	41
Female	27	16	7	3	0	0	53

3.1.1. Analysis of the Modelling Style Design of Suitable Old Furniture

According to the analysis of the survey data, it is clear that the influence of gender, age range and interest of the elderly on the style of furniture they choose is not very obvious, of which the most significant impact is the educational background. As shown in Figure 1, among the elderly surveyed, most of their education qualifications are concentrated in primary and junior high schools, and the higher the education background, the fewer the number. Take "C high school / secondary school / technical school" as the dividing line, except for the number of pictures in the third group,

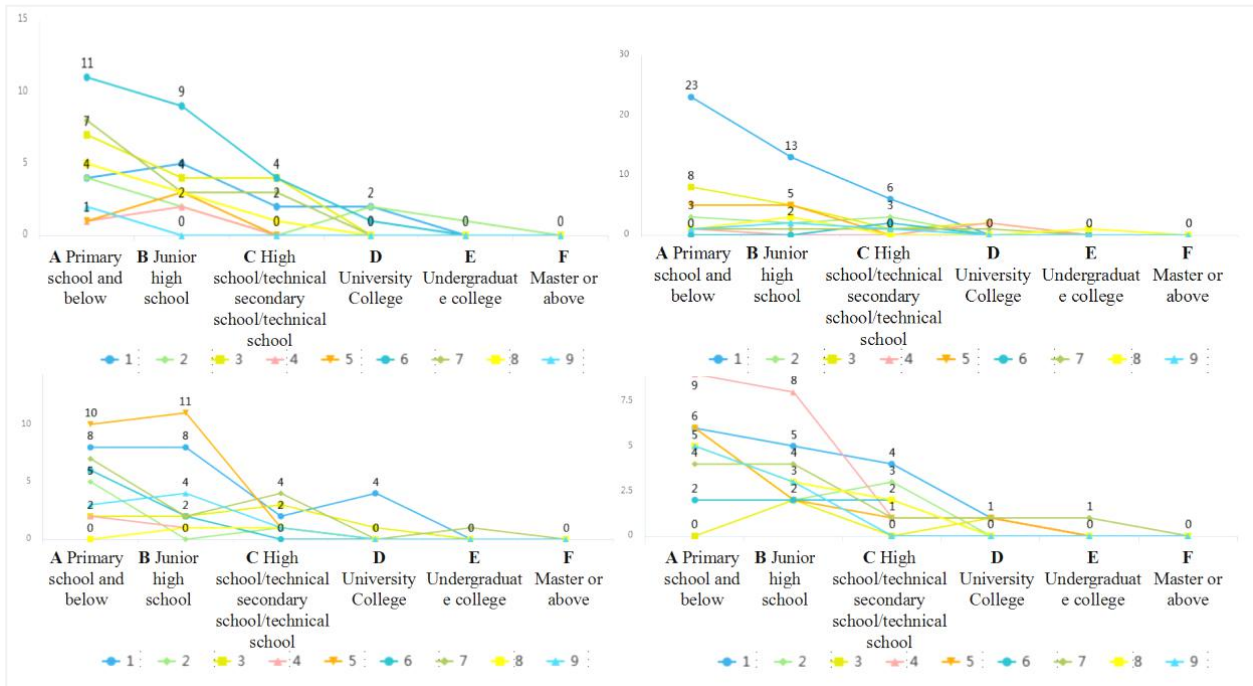


Figure 1: Comparison of pictures with different academic qualifications and styles.

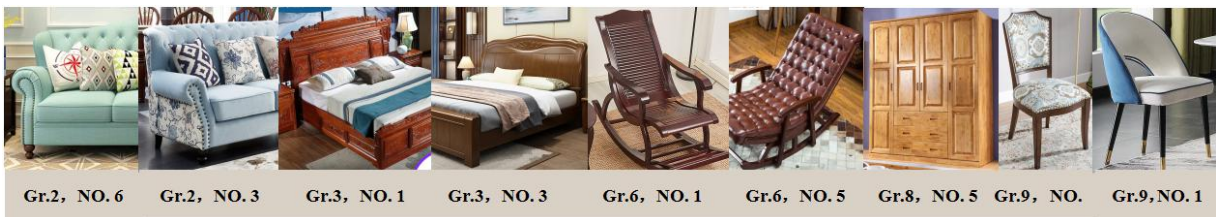


Figure 2: Choose more pictures in different styles.

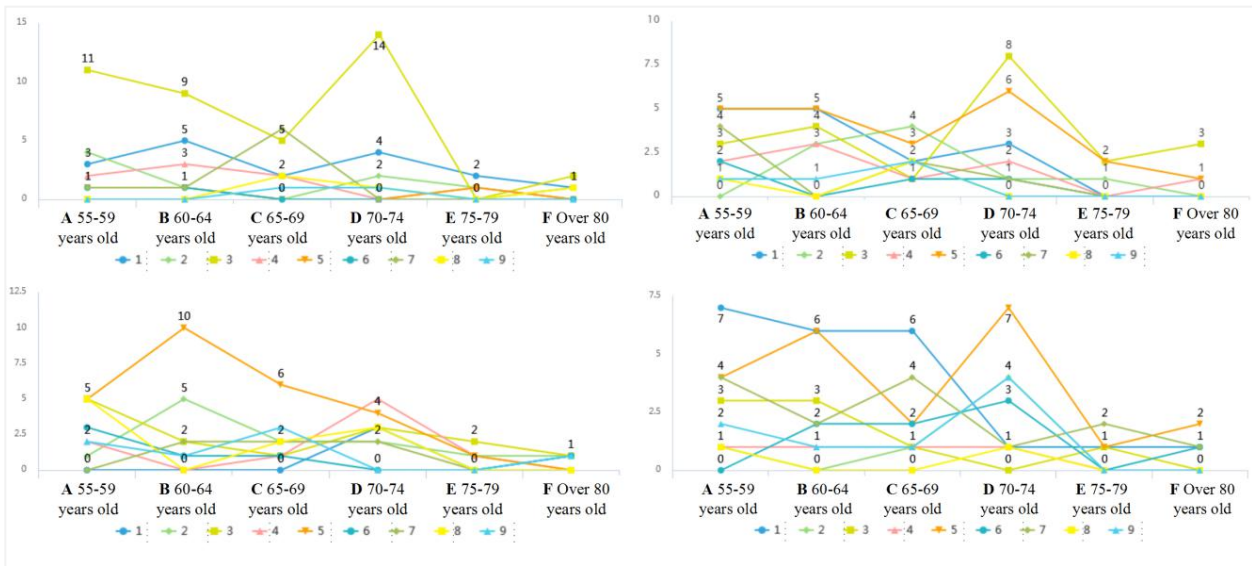


Figure 3: Comparison of pictures of different materials.



Figure 4: Choose more pictures from different materials.

which always ranks first, except for the number 1 picture in the third group, all the rest of the line segments have intersections, showed the different educational backgrounds of the old man to the be fond of of furniture style, the higher the degree of the old man can accept the style of furniture modelling slightly younger. Figure 2 shows the top-selected pictures from groups with different styles. It can be seen from the styles of these pictures that Chinese style, modern style and simple beauty style stand out. Taking the bed as an example, some elderly people still like antique, exquisitely decorated, dignified and massiness Chinese traditional furniture; taking sofas and chairs as an example, some elderly people have simple style, light shapes, and simple modern style furniture and small American style furniture more endearment.

On the modelling scale of the furniture, some elderly people said that the sofa sits deeper and wants to have a suitable sitting depth to lie down. They hope that the dining chair is light and has a back and can be put under the dining table to maintain a clean home atmosphere. Hope armchairs have appropriate proportions, it can effectively play a supporting role and so on. In addition, avoid the use of complicated and cumbersome structures in the modeling design, the elderly's sensitivity to the outside world has decreased significantly, and there are many hidden dangers in daily life[5]. There are also some elderly people who like traditional handmade wooden furniture, because it can not only create a natural and smooth beauty, but also maintain the charm of Chinese traditional culture.

3.1.2. Material Design Analysis of Suitable Old Furniture

There are many groups of pictures with different materials, among which the most representative groups are selected for analysis, as shown in Figure 3. In general, the preferences of older people at

different age groups are more consistent for materials. Each group of pictures has one or two fixed furniture products, such as No. 3 in the first group, No. 1 in the third group, No. 5 in the fifth group, and No. 1/No.5 in the sixth group. Figure 4 is a picture of selecting a high number from a group of different materials. From the materials of these furniture, it can be seen that solid wood furniture, especially traditional solid wood furniture in China, has many advantages such as superior quality, sturdy structure, natural texture. The advantages have left a very good impression on most elderly people, followed by rattan furniture and bamboo furniture. In terms of fabrics, according to interviews, the elderly consider more factors such as whether they are easy to clean, whether they are resistant to dirt, whether they are resistant to friction, whether they are breathable, etc. The cloth is soft, breathable, and resistant to friction, while the leather has strong texture, stain resistance, and easy cleaning. Both have their own advantages, so the choice of cloth and leather for the elderly is comparable.

Different materials can give people different visual and tactile feelings. For the elderly, they prefer furniture made of natural materials. Therefore, when designing suitable old furniture, more flexible and affinity natural materials should be used, such as wood warm material, cotton-linen fabric with breathable function, rattan, bamboo, etc. Common hardwood materials such as mahogany, rosewood, yellow flower pear, manchurian ash, birch, etc. These are good materials for furniture, which can be selected according to the user's consumption level. And like glass, mirror, stainless steel and other cold materials as far as possible do not appear in large areas, these materials are likely to give the elderly the illusion of being reflected by the sun, causing psychological uneasiness or a safety accident.

3.1.3. Color Design Analysis of Suitable Old Furniture

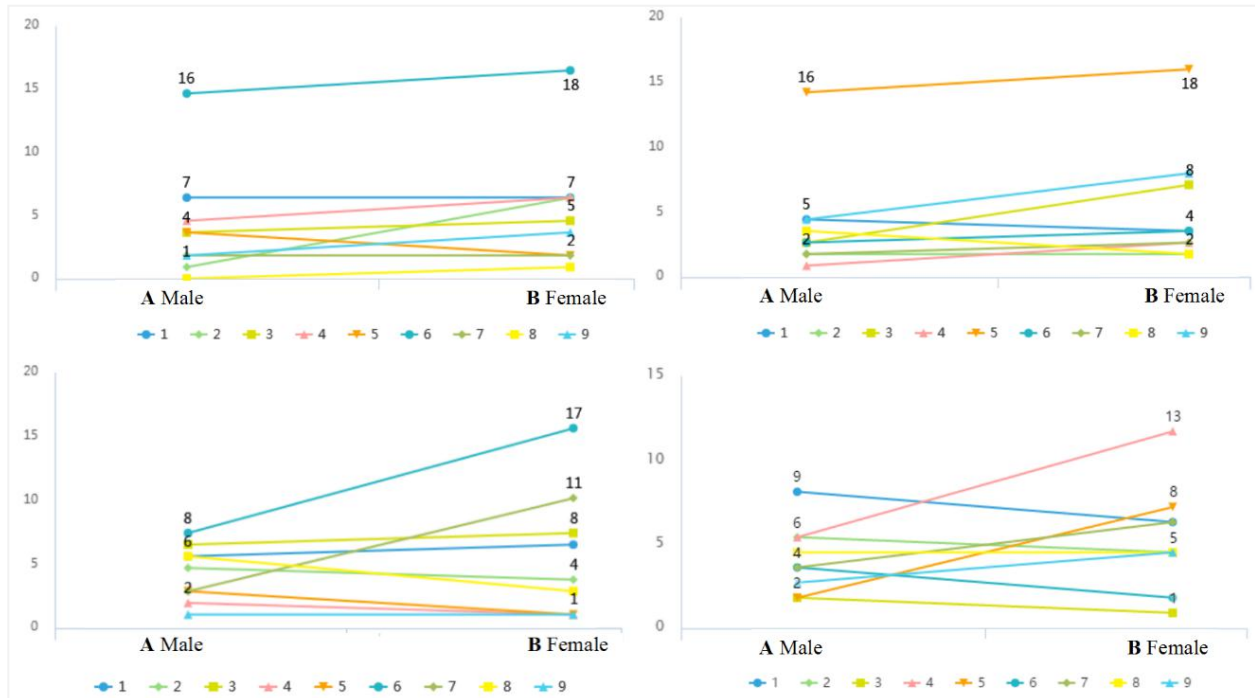


Figure 5: Comparison of pictures of different genders.



Figure 6: Choose more pictures from different materials.

As can be seen from the survey results in Figure 5, the fourth and seventh groups of men and women have a parallel trend in the number of choices of furniture, indicating that the elderly of different genders have little deviation in furniture color preference. Figure 6 is a selection of top-level pictures from groups with different color combinations. From the colors of these furniture, we can see that there are choices for cold and warm colors. Cold colors are mostly reflected in the choice of furniture fabrics. The choice of fabric and wood is reflected. In general, the color matching of the selected furniture is balanced and uniform. For example, the light green and light blue of the second group No. 6/No.3, and the ninth group No. 1/6 are conducive to adjusting balance and eliminating tension; No.1 in the first group, No.5 in the fourth group and No.5 /3 in the fifth group, the matching colors such as beige, light brown and light gray are helpful to eliminate fatigue, rest and sleep; No.3 in the first group, No.5 in the fourth group and No.6 in the seventh group are matched natural and simple wood color, which can make the elderly harvest a more peaceful mood. These simple, deep yet elegant colors are perfect for the physical and psychological characteristics of the elderly. The No. 1 in the fifth group is a black leather sofa—the number of choice is 0, the No. 9 in the second group is a lemon yellow sofa—the number of choice is 2, and the No. 9 in the first group is a bright orange dining chair—the number of choices is 2. This phenomenon can be explained according to relevant psychological studies, the bright colors are likely to cause the elderly to fluctuate, and the black will cause the elderly to have negative emotions, so the number of choices is very small.

Color is mainly reflected in people's feelings and perceptions about it, color objectively promotes people's feelings and can also reflect and express subjectively[6]. For the elderly, physical function is increasingly weak, physical diseases and mobility inconveniences can easily lead to emotional instability and mental states such as irritability and depression. Therefore, the color design of suitable old furniture should be more stable, conservative warm colors, and fresh and elegant low-purity, low-lightness color; On the choice of color, the colour with different hue, different lightness, different purity should be in accordance with arrange in a certain order to achieve a balanced color intensity. Only by putting aside the complicated and gorgeous color matching and choosing a uniform and gentle color can we create a peaceful and comfortable living atmosphere for the elderly. Still discover in the investigation, the choice of colorific of individual elderly people to furniture also has to believe geomantic say, for example the furniture of vermilion is not easy not only fade, easy clean, still very festival, and have ward off evil effect more.

3.2. Design Strategy Research

To the design of suitable old furniture, the most popular words are function, environmental protection, safety, and barrier-free, when designers actually design furniture, the main demands of the design object determine the general direction of the design, they have to consider the design of the design of the main points and minor points, and from the perspective of professional analysis and design. A comprehensive survey of the design preferences of the elderly (Table 5), shows that the nine pictures in each group represent different design elements. Based on the representative

attributes and the first and last three of the number of people selected, the priority order of each two variable elements is obtained through comprehensive analysis.

Table 5: A comprehensive survey of the preferences of design elements in the elderly.

Quantitative element	Variable element	Group	Top three picture selectors(number in brackets)			Last three picture selectors(number in brackets)			Priority conclusion
			No.1	No.2	No.3	No.4	No.5	No.6	
Modeling style	Material Color	Gr. 1	No.3(41)	No.1(17)	No.7(9)	No.5(3)	No.6(2)	No.9(2)	Material>Color
		Gr. 4	No.5(34)	No.9(14)	No.3(11)	No.7(5)	No.2(4)	No.4(4)	Color>Material
		Gr. 5	No.5(26)	No.3(14)	No.2(12)	No.6(6)	No.7(6)	No.1(4)	Color>Material
Material	Modeling style	Gr. 2	No.6(25)	No.3(15)	No.7(14)	No.5(4)	No.4(3)	No.9(2)	Color>Modeling style
	Color	Gr. 7	No.6(34)	No.1(14)	No.4(12)	No.9(6)	No.7(4)	No.8(1)	Modeling style>Color
		Gr. 9	No.4(19)	No.1(16)	No.2/7(11)	No.9(8)	No.6(6)	No.3(3)	Color>Modeling style
Color	Modeling style	Gr. 3	No.1(42)	No.3(16)	No.5(10)	No.9(4)	No.4(3)	No.6(2)	Material>Modeling style
	Material	Gr. 6	No.1(22)	No.5(22)	No.7(14)	No.2(6)	No.4(4)	No.8(2)	Material>Modeling style
		Gr. 8	No.5(22)	No.3(21)	No.1(1)	No.6(4)	No.9(4)	No.8(3)	Modeling style>Material

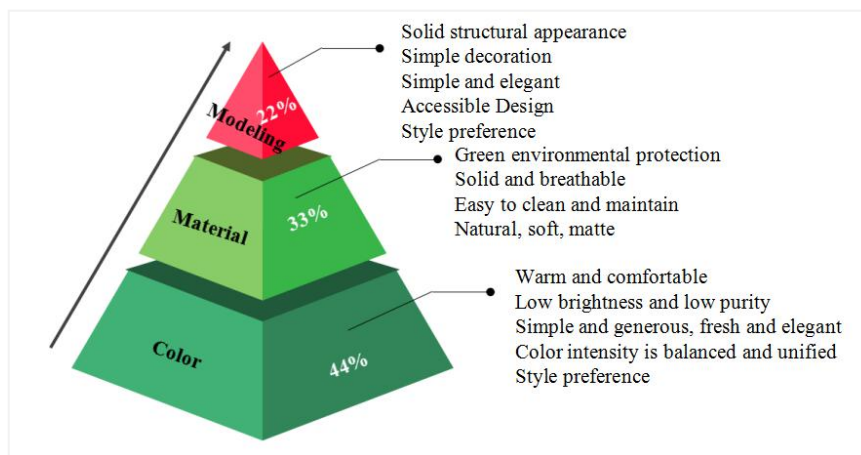


Figure 7: Decision model of furniture design for the elderly.

Based on the overall product concept of the product service system, a decision model for suitable old furniture design strategies was proposed according to the priority order of the nine groups of picture variable elements (Figure 7). In the preferred order, color design elements based on physiological functions and aesthetic needs should be preferred first, followed by natural environmental protection, soft and comfortable material design elements, and then simple, generous, safe, stable, and barrier-free modeling style design elements. In this decision-making model for suitable furniture design strategies, the design elements are relatively complementary, and each design element has different attributes, designers in the design, must be based on the consumption level of the elderly, aesthetic needs, market positioning for comprehensive consideration.

In addition, according to the survey of daily life activities of the elderly (Figure 8), in addition to the basic self-care life, the most common activities for the elderly are buying vegetables, cooking,

doing housework or helping their children with children., followed by watching TV and playing cards, and stay at home most of the time. Figure 9 is the main activity route of the elderly room, when carrying on suitable old furniture design, the focus should be on the furniture design of the bedroom, dining room, and kitchen, such as the bed, wardrobe, and cabinets commonly used by the elderly. Based on the overall product concept of the product service system and the improvement of the elderly's quality of life in the old age, we should also improve the overall and supporting design of suitable old furniture, and improve the configuration of suitable old furniture. For example, in addition to the basic configuration of the bed, wardrobe, bedside table and so on, dressing tables, seats, TV cabinets, coat racks, and other supporting furniture should be added; Sitting room besides sofa, tea table, TV ark besides, still should increase change shoe stool, book newspaper stands, show ark to wait for form a complete set furniture.

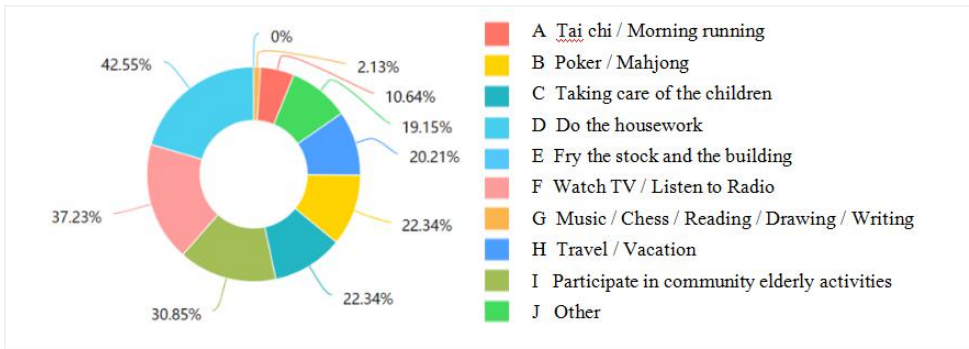


Figure 8: Survey of daily life activities of the elderly.

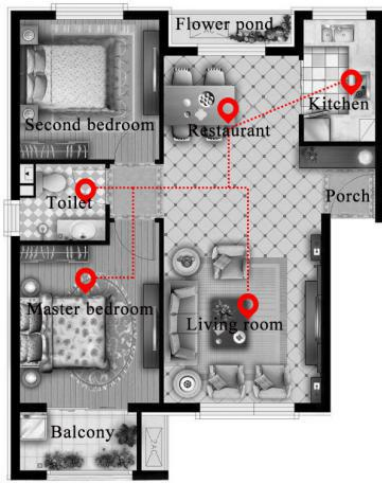


Figure 9: The plan of the main activity route of the old house.

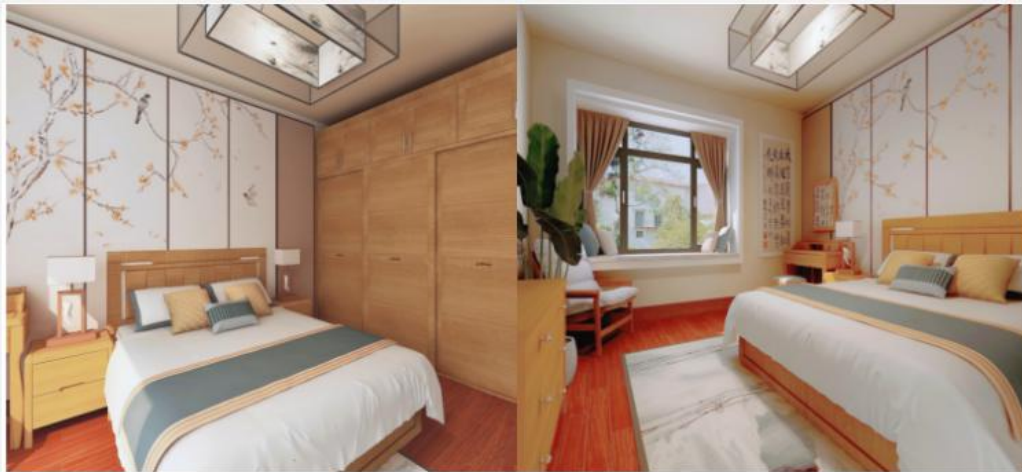


Figure 10: Furniture and space for the elderly.

3.3.Examples of Arguments

As shown in Figure 10, this is a design example of suitable old furniture in suitable old bedroom space. According to the body size of the elderly, custom-made bedding is designed. A highly suitable bed helps elderly people who have difficulty bending their knees and some use wheelchairs. A soft and hard mattress is helpful to ensure sleep quality. The corners of the furniture are rounded using the barrier-free design concept. Its structural appearance is simple, generous and stable, and it is particularly safe and light. With a dressing table, the elderly can dress and learn in quiet and private spaces. The setting on the bay window provides a leisure space for the elderly to play chess, read newspapers and drink tea. The lightweight sliding door wardrobe design takes into account the wheelchair users and the versatility of the design, saves the space occupied by the hinged door, and solves the problem of difficult to open and close the cabinet door. The color of the wood is suitable for old furniture, with green plants and decorative painting, making the whole space extra warm. This case focuses on the functional and safety requirements of the user as a whole, and is designed based on the integrity and matching of the product to create a comfortable and safe living space for the elderly.

4. Results and Discussion

In furniture design, the problem that PSS focuses on is the professionalism of product design and the matching between products. PSS is no longer designed for a single furniture product, but the overall design to solve the problems in the environment and state of use of the product, is to provide the overall product for the furniture and the existence of the furniture. With the progress of society and the development of the times, the needs of contemporary elderly will become more and more novel, trendy and diversified. How to improve the matching of suitable furniture and how to solve the problem of correlation with other products requires We study product service systems more deeply, which is the main research direction in the future.

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