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Research on the Adaptability of Outdoor Sites in Urban Communities
to Meet the Needs of Elderly Activities

GAO Wei

Japan Advanced Institute of Science and Technology

Doctoral Dissertation

Research on the Adaptability of Outdoor Sites in Urban Communities
to Meet the Needs of Elderly Activities

GAO Wei

Supervisor: Yukari Nagai

Graduate School of Advanced Science and Technology
Japan Advanced Institute of Science and Technology
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Abstract

Unlike developed countries, developing countries are aging very fast. China has the largest elderly population in the world. The aging population has brought unprecedented challenges to urban community infrastructure. The outdoor environment of communities can no longer meet the needs of the aging elderly. When the elderly population gradually becomes the main body of the population structure, their interest needs should be given enough attention. The research on the aging-friendly outdoor sites in urban communities is of great significance for the development of the elderly care model in China and the improvement of the living quality of the elderly. It also gives inspiration to developing countries that are about to enter the aging process.

The elderly livable community is a complex giant system, and its influencing factors are also characterized by pluralism and complexity. This research studies the aging-friendly outdoor sites in urban communities meeting the needs of elderly activities from the perspective of community outdoor environment, elderly activity needs and scientific evaluation.

In order to achieve the above objectives, the following three models have been constructed in this thesis. The typical communities in Dalian have been selected as examples for empirical research. 1. The supply and demand model of outdoor sites in urban communities. On the basis of the theory of supply and demand balance, the Likert scale Method and Semantic Differential Method (SD) have been used to make quantitative and qualitative research on the matching relationship between supply and demand of outdoor activity sites in sample communities. 2. Model for determining whether individual and community outdoor sites are aging-friendly. Based on P-E Matching theory, use One-way Analysis of Variance and post hoc test to study the differences in the needs of the elderly at different ages, with different physical conditions, device-aided elderly and nursing-cared elderly. Make path analysis of personal attributes, family attributes, physical conditions, activity habits and outdoor sites satisfaction and demand degree, and the relationship among several variables. 3. Outdoor environment evaluation system of elderly livable communities. Based on grounded theory, integrating literature review and in-depth interviews and in combination with the relevant specifications, the evaluation system is constructed. The evaluation process consists of the weight calculation of the evaluation index system and the index scores of each sample community, and the corresponding countermeasures are given.

The results show that: 1. The supply and demand of gated and gated group communities are well balanced. The allocation of environmental factors for the supply and demand balance should be maintained. Overdemand in open communities is obviously, which has been significantly improved after renovation. Emphasis should be placed on improving and perfecting the configuration of environmental factors in overdemand. 2. There are great differences in the activity needs of different elderly people. If the

individual has no pressure in the environment, and the satisfaction of the community's outdoor environment is high, it can be judged that the person matches the environment, and the environment is aging-friendly, and vice versa. The interaction and influence among individuals, families and activity habits determine the activity needs of the elderly. Meeting the activity preferences of the elderly can effectively improve the use efficiency of the site. 3. The evaluation results reflect that the overall evaluation of the quality of the livable environment for the elderly in the sample communities is not high, indicating that most communities have not yet made adequate preparations for the coming aging society. There are some common problems in the community environment construction, but the differences between communities are also obvious. Targeted design strategies are needed.

The study on the adaptability of outdoor sites in urban communities meeting the needs of the elderly provides a positive and effective action path to solve many social problems caused by aging. This multi angle study is a scientific, comprehensive and quantitative consideration of all environmental factors affecting the outdoor activities of the elderly. On the one hand, the study reflects the significant differences of urban communities in the construction of aging-friendly outdoor environment sites. On the other hand, it provides a practical basis and theoretical guidance for how communities adapt to the changes of population age structure and create a suitable outdoor environment for the elderly under the background of aging. It enriches the research on livable communities for the elderly, and provides a new research perspective for the research on human settlement environment science and aging geography.

Key words: Urban community outdoor sites, Aging-friendly, Supply and demand model, P-E model, Evaluation system

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List of Publications and Presentations

1. Conference proceedings

GAO Wei, Yukari Nagai and Zhang Ruifeng. 2020. “Influencing Factors and Intervention Strategies of Kindergarten Outdoor Environment on Children's Accidental Injury”. The 15th International Conferences on Knowledge, Information and Creativity Support Systems (KICSS2020) to be held at Online, on November 25-26, 2020.

2. Conference proceedings

GAO Wei, Yukari Nagai and Zhang Ruifeng. 2022.“ Study on The Influence of Urban Street Microenvironment on the Walking Activities of Older Adults Based on SD Method ”. OUR DIVERSE WORLD – Proceedings of The International Art & Design Doctoral Student Forum 2022. China Youth Publishing Group. (Accepted)

3. Journal paper

GAO Wei, and Yukari Nagai. 2021. “ The Influence of Street Microenvironment on the Walking Activities of Older Adults: A Longitudinal Study Based on the Structural Equation Model and Manipulated Photos ” Social Sciences 10, no. 12: 451. <https://doi.org/10.3390/socsci10120451>

4. Journal paper

GAO Wei, Yukari Nagai and Zhang Ruifeng. 2022.“ Longitudinal associations between community outdoor environmental renovation and elderly activities : an observational study ”. Building and Environment. (Ready to Submit)

5. Book

GAO Wei, GAO Hong and Zhang Ruifeng. 2021. Building Dreams for Childhood : New Concept Architectural Design of International Kindergartens. Designer Book. ISBN : 9789887450351

6. Book

Zhang Ruifeng, GAO Wei. 2023. Sustainable Design of Environmental Spaces. People's Fine Arts Publishing House. (Forthcoming)

7. Project

GAO Wei, et al. 2020.”An Empirical Study on the Influence of Urban Community Building Microenvironment on Outdoor Walking of the Elderly in Liaoning Province” Liaoning Provincial Department of Education, China, Class A Longitudinal Social Science Project. Project No.J2020075

Chapter 1.

Introduction

1.1 Research Background

According to the standard of UNESCO, a country or region is aging when the proportion of elderly people aged 60 and above to the total population of that country or region exceeds 10%, or when the proportion of elderly people aged 65 and above exceeds 7%. Compared with the global aging situation, China's aging is more serious. According to the latest statistics released by the National Bureau of Statistics, China's population over 60 years old has reached 264 million, accounting for 18.7% of the country's total population. China has become the country with the largest elderly population in the world. The impact of population aging is profound, and the rapidly expanding elderly population will have far-reaching effects and changes on all aspects of the economy, society, and politics. Therefore, the sooner we can understand the aging phenomenon and make a proper assessment of its social impact, the better we can fully and effectively prepare ourselves to meet the challenges of aging.

Population aging started in western countries, and France was the first country in the world to enter an aging society. Since then, Sweden, the United Kingdom, the United States, Japan, and other developed countries have also entered the aging society. In the 1950s, the United Kingdom launched the "anti-institutionalization movement", advocating the return of the elderly to their familiar families and communities (Li, 2014). The British health minister suggested that "the best place for older people is their own home" (Qi, 2010). In 1982, Sweden introduced a social service law to emphasize family care; in Japan, the Ministry of Health and Welfare formulated the "Hometown and Community Building for a Long and Healthy Life in the 21st Century", proposing a series of improvement measures including community, housing, and travel, aiming at creating a healthy and comfortable living environment for the elderly and encouraging them to return to their families and communities; according to a survey, in Germany, about 93% of people aged 65 and above live in In Germany, about 93% of people aged 65 and older live in a general community setting rather than in apartments or institutions built specifically for the elderly (Oswald F et al., 2005). Throughout the history of developed countries in the world, all of them have undergone the transformation from "institutional care" to "home care" and "community care". In this context, it has become the consensus of all countries to improve community elderly care service facilities and create an age-friendly living environment so that the elderly can comfortably live in

their familiar places of origin. The promotion of the "aging in place" policy has greatly emphasized the need for community aging-friendly construction (Lui C W et al., 2009).

Although aging is an inevitable trend in the development of the world population, due to the differences in national conditions, the situation of population aging in each country presents different characteristics, and the characteristics of China's aging society are a large base, rapid development as well as aging before the rich (Kalache A et al., 2000). While the economy is not yet developed enough, the elderly population is increasing. On the one hand, the elderly have an increasing demand for old-age care, on the other hand, the social supply is seriously insufficient and the imbalance between supply and demand is bound to lead to serious social conflicts. For this reason, the "13th Five-Year Plan" proposes to improve the elderly service system based on home, community, institutional and medical care. Shanghai and other cities proposed to adhere to the "9073" elderly service pattern (i.e. 90% of the elderly rely on home care, 7% on community care, and 3% on institutional care). While the "home care" approach focuses on the role of family care, it also emphasizes the supporting role of the community in elderly care services (Lin, 2019).

As we turn our attention to the community, there is an awkward reality that we have done very little to prepare the elderly population for the urban community-building process. After retirement, the social circle of the elderly slowly becomes narrower due to the change in their social roles, their various functions deteriorate with age, their activity space shrinks, and they become increasingly dependent on their living environment and community services (Yu et al., 2015), while the outdoor activities of the elderly are usually limited within or near the community where their homes are located (Carlson J A et al., 2012; Thomas et al., 2009), coupled with the fact that the elderly in China generally have the characteristic of "aging before getting rich"¹, therefore, public and free outdoor activity sites located in the community are more important for older adults (Ge S.L. 2017). The community has become the most important vehicle for the elderly to spend their old age peacefully. Older adults are more dependent on the community environment than younger adults. They rely on commercial facilities and services around the community to meet their material needs. They rely on the community to provide activity space and public facilities to meet their daily activities and fitness needs. Rely on the interpersonal environment provided by the community to meet the needs of social interaction.

The most important problem with the current construction of community outdoor activity sites in China is that the outdoor activities of the elderly are not sufficiently considered and cannot be adapted to their outdoor activity needs. For example, there is a lack of resting facilities, shade facilities, lighting facilities, etc. (Xie H.W. et al., 2011). In recent years, the main forms of outdoor activities for the elderly in China have

¹ Ye Z., "Getting old before getting rich" increasingly highlights new challenges brought by aging [EB/OL] (2013-02-28) <http://finance.people.com.cn/n/2013/0228/c1004-20626099.html>

changed significantly, especially square dancing, instrumental music, and brisk walking activities have flourished. The construction of outdoor sites in the community, however, has not been strained in time, and thus problems have arisen due to the small size and the insufficient number of sites (Qian X.F.,2009). The main consequence of the lack of sites for the adaptation of the elderly is a decrease in their activity level and low motivation to be active. In addition, the lack of sites can make many elderly people with exercise needs occupy other public spaces because they cannot find suitable sites, causing constant conflicts and contradictions. For example, in the "mob incident" in Linyi City, Shandong Province in 2017, a number of elderly people caused a serious traffic accident by occupying the motorway while running in the morning, which led to a social discussion about the elderly and issues related to national fitness¹. There were also fights between the elderly and young people over the basketball court because they wanted to do aerobics², and inappropriate behaviors such as occupying parking lots, spray-painting "no parking", and deflating the tires of parked cars³, all of which show that the demand for outdoor activity space by the elderly cannot be met.

The research on community aging in China is still in its initial stage, which is only more than ten years old. The existing domestic research mainly focuses on the introduction of community aging planning and design models, residential aging design, community elderly care service facilities, etc. The introduction of foreign-related policies and theories, cases, and design methods is also increasing, but the number of aging studies on community outdoor sites is relatively small, and a comprehensive and rich research system has not been formed. At the same time, we are aware of the differences within the elderly groups and need to conduct more detailed research on different health conditions and different aging levels of the elderly groups. At present, China's standards for the configuration of community activity sites are mainly the 2002 version of the "Planning and Design Specifications for Urban Residential Areas", the 2005 "Land Use Indicators for Construction of Urban Community Sports Facilities" and local planning and configuration standards. In these documents, there are only limited provisions for outdoor activities for the elderly, and none of them has made provisions or guidance for the supply of facilities, landscapes, and roads from the perspective of the elderly's activity needs. Therefore, in the context of deepening aging, China must provide guidance on the construction and renovation of community outdoor activity sites from the perspective of aging.

Whether the aging-friendly planning of community outdoor sites is scientific or not, the premise is whether a comprehensive, accurate, and objective evaluation of the sites can be conducted from the perspective of the outdoor activity needs of the elderly. At

¹ Chronicle of events On July 8, the elderly in Linyi were killed in a "fast walking group" traffic accident [EB/OL] (2017-07-08) . <http://www.dsj365.cn/front/article/733.html>.

² Tencent Sports Whose fault is square dancing occupying the basketball court? There are more contradictions behind it. [EB/OL].(2017-06-02). <http://sports.qq.com/a/20170602/008742.htm>.

³ Feng Chuanye, Lin Minyu, Wu Jing. The state has issued new rules, and four types of undesirable phenomena in square dance will be prohibited! Square dance, how? [EB/OL]. (2017-11-22).https://www.sohu.com/a/206141147_100014869.

present, there is an urgent need for a practical evaluation index system to measure the current situation of community outdoor space construction, and to propose targeted countermeasures based on the quantitative evaluation of the community's aging-friendly environment, to provide a realistic basis and theoretical guidance for the construction of community aging-friendly. Therefore, this research studies the aging-friendly outdoor sites in urban communities meeting the needs of elderly activities from the perspective of community outdoor environment, elderly activity needs and scientific evaluation. The supply and demand model of outdoor sites in urban communities, model for determining whether individual and construction community outdoor sites are aging-friendly, Outdoor environment evaluation system of elderly livable communities are constructed, and the corresponding countermeasures are given. The typical communities in Dalian have been selected as examples for empirical research.

1.2 Purpose Statement & Research Questions

The research goal of this study is to study the suitable aging of outdoor activity sites in urban communities. The specific research objective is to determine which key environmental factors in the community outdoor sites have a greater impact on the activity needs of the elderly from the perspective of supply and demand. Further, under the guidance of the matching theory between people and environment, it analyzes and evaluates whether the outdoor sites in the community meet the needs of the elderly with different activity abilities. A more constructive objective is to construct an evaluation system of community outdoor site suitable for aging, and develop an evaluation process. An empirical study is conducted with a typical community in Dalian as an example. In order to meet the needs of multiple activities of the elderly in urban communities, to achieve "Aging in Place".

This research will answer one Major Research Questions (MRQ) and three Subsidiary Research Questions (SRQ).

MRQ : How to analyze and evaluate the aging suitability of outdoor sites in urban communities to meet the activity needs of the elderly?

SRQ1 : Quantitative and qualitative research on the supply-demand relationship and key environmental impact factors of outdoor site and activity needs of the elderly in urban sample communities?

SRQ2: Community outdoor sites can meet the demand of different ability level of the elderly activities, how to reach people and the environment fit (P-E Fit) ?

SRQ3 : How to establish the outdoor environment evaluation system of elderly livable communities to meet their activity needs?

1.3 Research Originality & Novelty

The research innovation of this paper is mainly reflected in the following three aspects:

- Strengthen the fineness of suitable aging research.

This study conducted a detailed investigation and classification of the elderly population. On the one hand, the elderly group itself has the characteristics of difference, diversity, compatibility and representation. And due to the change of their social status and the decline of social support network, the focus and contradiction of the elderly in the use of public space environment are more prominent. On the other hand, judging from the current actual construction situation, due to the constraints of land shortage and community scale, the construction suitable for aging cannot be expanded blindly. It is also impossible to set up separate space systems for different groups such as the disabled, the elderly, and children. It can only enhance the efficiency of space use and improve the adaptability of the space environment, so that it can be used by as many groups as possible. This is of great significance for saving construction costs and promoting sustainable development of the space environment. Form a new understanding of "suitable for the elderly" and enhance the adaptability of community outdoor sites.

- Enhanced the comprehensiveness of appropriate aging research.

Shift the research perspective from focusing on community pension models, residences, and pension service facilities to community outdoor sites. From a new perspective, the research on the environmental aging of the community site is carried out, and it contributes to enhancing the comprehensiveness of the existing research theories on the aging of the community. Judging from the current research status, the research content of community aging in the field of architecture in China mainly focuses on community planning and design for aging, residential aging design, configuration of community elderly care service facilities, etc. Aging research is weak. This research focuses on the community outdoor sites, from the perspective of the daily activities and space needs of the elderly, using a large number of basic investigations and corresponding theoretical analysis, to study the appropriate aging of community outdoor sites.

- Expand the regional study of suitable aging

Although the research results of foreign countries and Shanghai, Beijing and other regions can provide us with reference. However, due to the differences in climate, culture and population characteristics, simply applying research results from other regions cannot solve various problems faced in the process of urban development. This study focuses on Dalian, which is helpful to expand the new direction of aging research on the basis of existing regional research. First of all, Dalian city environment is good. Was awarded the United Nations Habitat Award. It is also one of the ten most suitable cities for the elderly in China. Second, it has the severity of aging development. The proportion of the population over 60 years old in China ranks first among 21 cities with a population of over 7 million. And there is a trend of further deepening, so it is necessary to deepen and expand the research on suitable aging in Dalian.

1.4 Research Structure

The main content of this research thesis consists of eight chapters:

Chapter 1 introduces the research background and purpose statement, puts forward MRQ and three SRQs, and expounds the originality and novelty of the research and the framework of the thesis.

Chapter 2 conducts a literature search, provides a review of existing research, and presents the entry point of this study and defines the basic concepts of the study.

Chapter 3 the overall technical route and research methods of the study are introduced. The models of the three SRQs are established respectively, and their operation steps are explained.

Chapter 4 focuses on the collection of research information and the design of the questionnaire.

Chapter 5 based on the theory of supply and demand balance, this chapter constructs the supply and demand model of outdoor sites in urban communities, analyzes the relationship between the supply capacity of outdoor sites in communities and the activity demand of the elderly and elaborates the supply and demand matching characteristics of various environmental factors of outdoor sites in communities.

Chapter 6 based on P-E Matching theory, this chapter constructs a model for determining whether individual and community outdoor site are aging-friendly. Analyze and evaluate whether the allocation of community outdoor sites is suitable for the activity needs of different elderly people. It provides the basis for the subsequent specific community environment optimization suggestion design.

Chapter 7 the research purpose of this chapter is to establish a relatively complete outdoor environment evaluation system of elderly livable communities. Through the application of this evaluation system, we can find a short board for the outdoor environment of the community that affects the activities of the elderly, and provide strategies in the actual renovation and construction of the community.

Chapter 8 concludes with a discussion of the findings, research contributions and values for each SRQ, the contribution of this study to knowledge science, theoretical and practical implications, and limitations and recommendations for future work.

Chapter 2.

Literature Reviews

The research on the aging of community outdoor sites has achieved fruitful results by domestic and foreign scholars, which is worth learning from. This chapter first conducts a literature search of the research content through the Web of Science and China Knowledge Network. Secondly, a review of existing studies and the entry points of the research are presented. The previous studies are reviewed and the research perspective of this paper is constructed. Finally, the basic concepts related to this study are defined.

2.1 Literature search

Since the end of the 19th century, the developed countries in the West have entered the aging society one after another and based on the objective pressure, these countries have carried out aging-related research earlier. Many scholars and related organizations have published many research results and accumulated valuable experiences in the area of aging-friendly outdoor spaces based on different disciplines and from different research perspectives, which provide useful references for us.

In order to grasp the research results of foreign scholars as a whole, the paper was searched by Web of Science (core collection) using the search terms "Old people OR Aged OR Elderly" "Residential Area OR Community OR Neighborhood" and "Outdoor Activities". The search period was from 2000 to December 2021, and 459 papers were retrieved. After refining the research directions, 266 related papers were obtained, and 102 papers directly related to the research contents were finally obtained by identifying them one by one. The paper mainly analyzed the content and academic evaluation of the retrieved related papers by data statistical method.

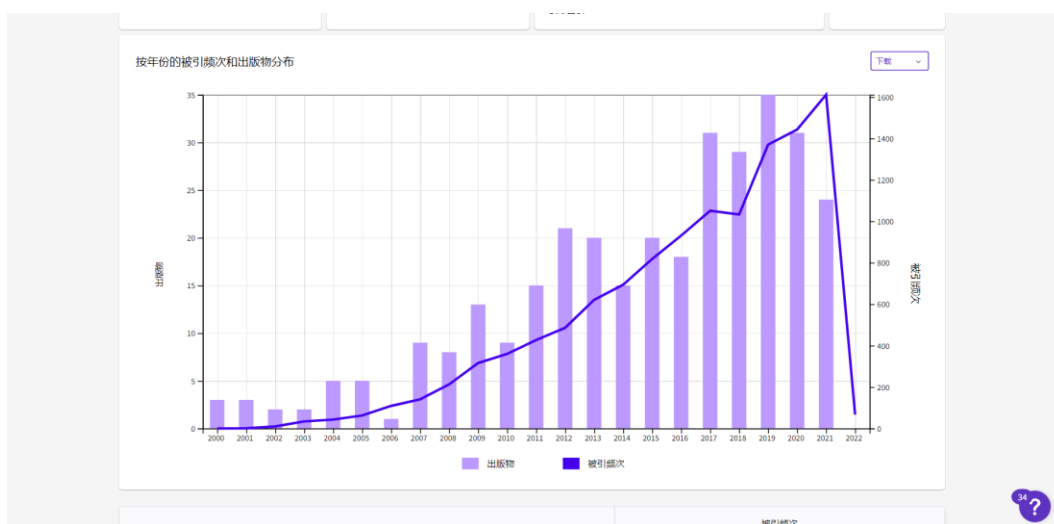
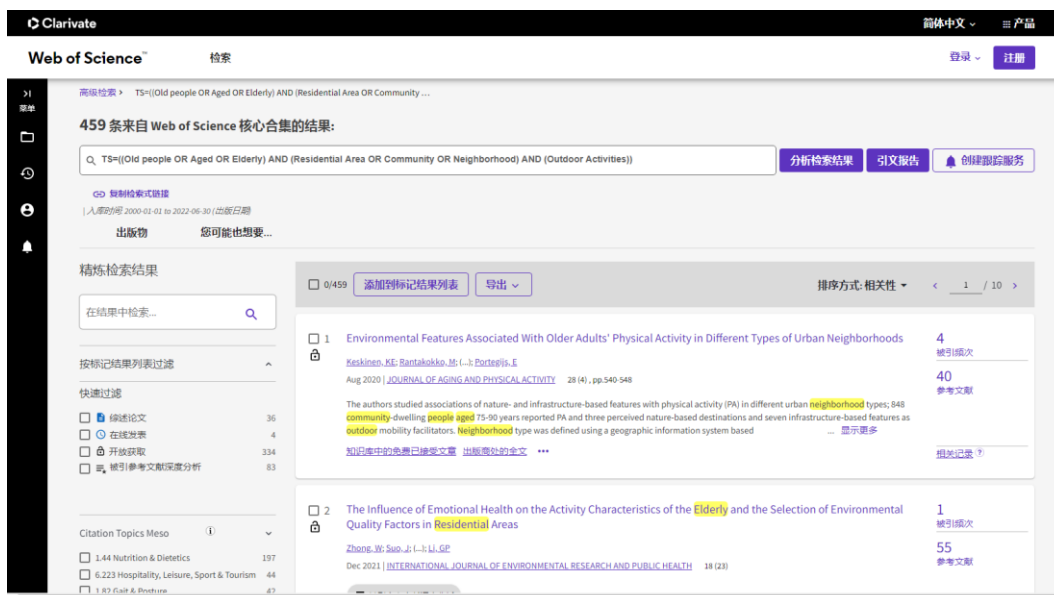
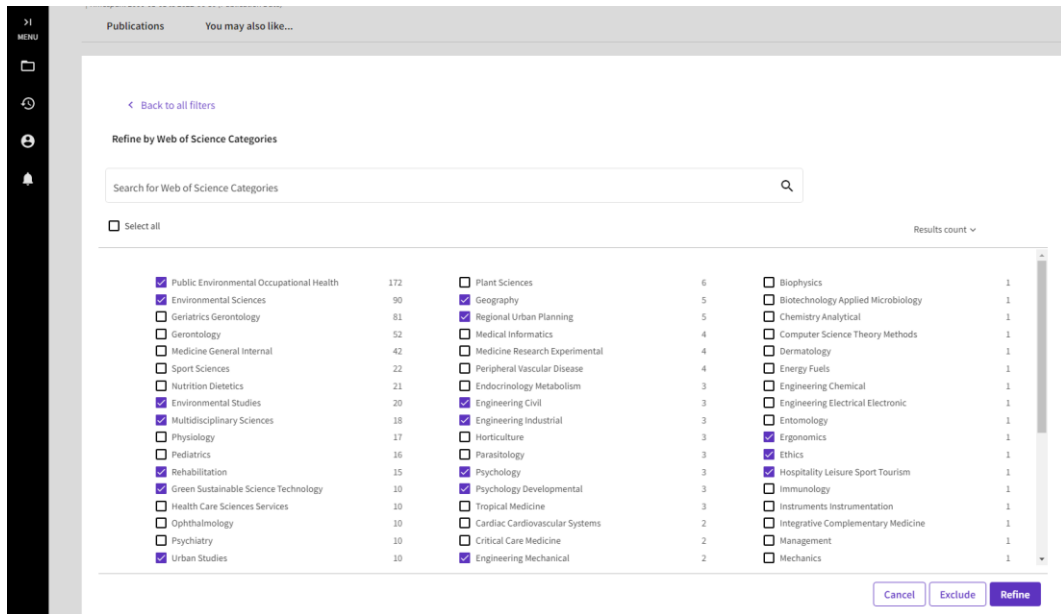


Figure 2-1. Literature and growth trends in the field of community outdoor sites suitability for aging in Web of Science (Core Collection), 2000-2021

From the search results (Figure 2-1), the overall number of foreign literature on senior livable communities showed an increasing trend from 2000 to 2021. The fluctuating trends during the period are as follows: before 2007, the number of literature was small and the growth was relatively small. However, from 2008 onward, the amount of literature increased steeply. This phenomenon may be attributed to the influence of the Global Friendly Cities Project promoted by WHO. The research search revealed that papers from this period were mainly about WHO's Age-Friendly Communities initiative and related practices around the world. This has led to a lot of scholarly thinking, which ultimately led to an increase in the number of results.



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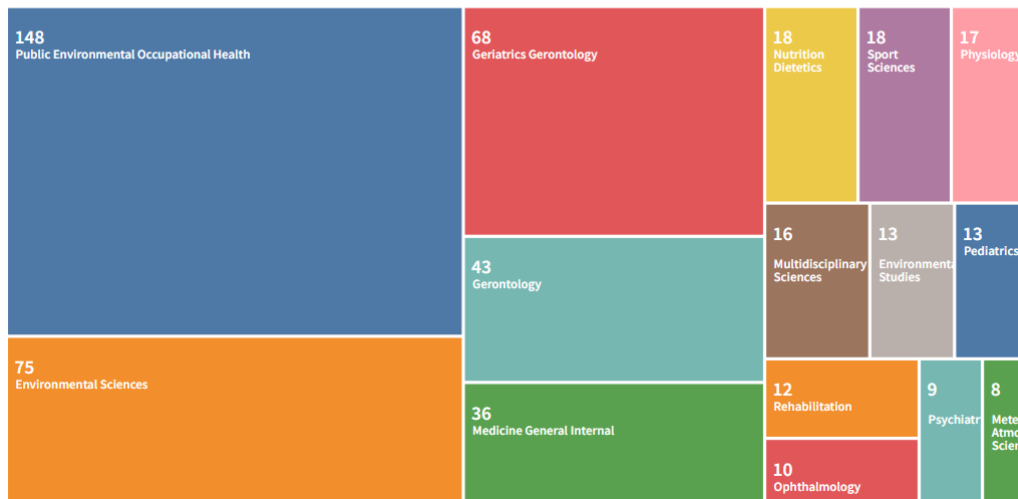


Figure 2-2. Disciplinary features of research on the aging of community outdoor spaces in Web of Science.

According to Figure 2-2, in terms of disciplinary classification, the discipline with the most relevant studies in the Web of Science is Public Environmental Occupational Health, with 148 articles, which is a clear advantage. The other disciplines are Environmental Sciences and Geriatrics Gerontology, Gerontology, etc. From the classification of disciplines, the research in the field of aging in community outdoor spaces spans a wide range of disciplines, involving humanities and social sciences (liberal arts) and natural sciences (science and technology), reflecting the comprehensive disciplinary characteristics of aging in community outdoor spaces that are compatible with the arts and sciences.

China is much later than developed countries in terms of aging, and scholars are still in the initial stage of research on Aging. This paper is based on "community + residential

area" AND "elderly + elderly" AND "leisure activities + outdoor activities + fitness activities" AND " Place + Site + Space + Environment" in China Knowledge Network (CNKI). The search time was from January 2000 to December 2021, and a total of 287 relevant papers were searched. Among them, 82 were academic journals, 199 were dissertations (4 for PhD and 195 for MSc), and 6 were conferences.

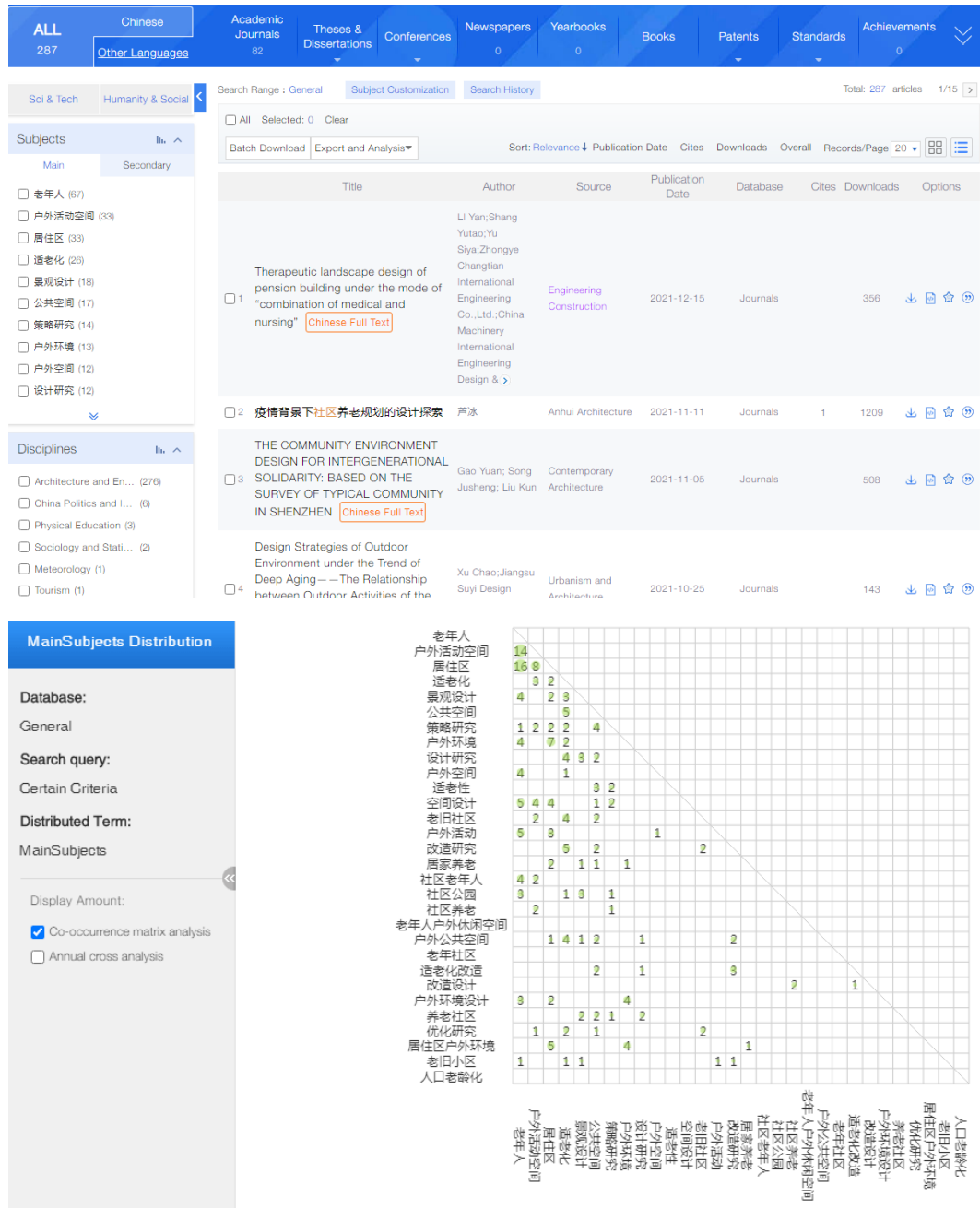


Figure 2-3. The keyword Co-Occurrence matrix in the CNKI.

Among them, there are many co-occurrences of "elderly, outdoor space, and residential area" in the literature (Figure 2-3). The co-occurring words can be used for knowledge discovery to find more associations with research topics and tacit knowledge. It is also more valuable for judging the content and depth of research topics. At the same time, it reflects the hot trend and development of aging research.

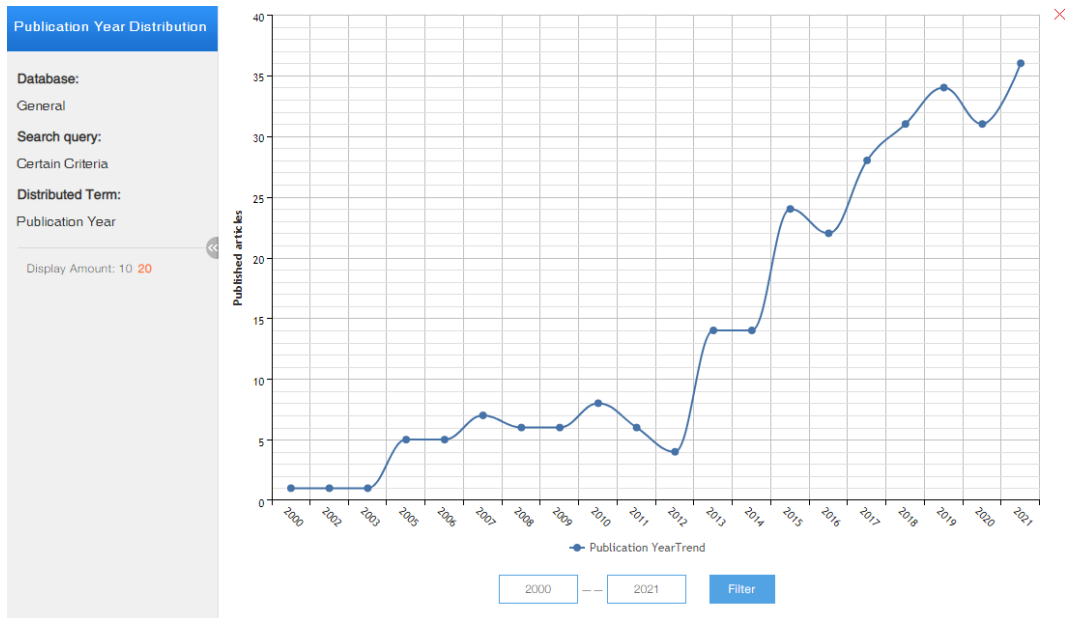


Figure 2-4. The growth trend of research on aging adaptability of community outdoor sites in CNKI

Statistical combing reveals that since the end of the last century (Figure 2-4), the issue of an age-friendly living environment has entered the research horizon of scholars in China, and related studies have started to increase. Especially after 2013, it has greatly promoted the research enthusiasm of scholars, and the number of related papers has increased significantly. The issue of outdoor activity sites for the elderly in the community has become a new research hotspot in the age of aging. It is foreseeable that, with the increasing seriousness of the aging problem and more and more scholars' attention to related issues, the research results on the aging-appropriate community outdoor sites will be more and more abundant.

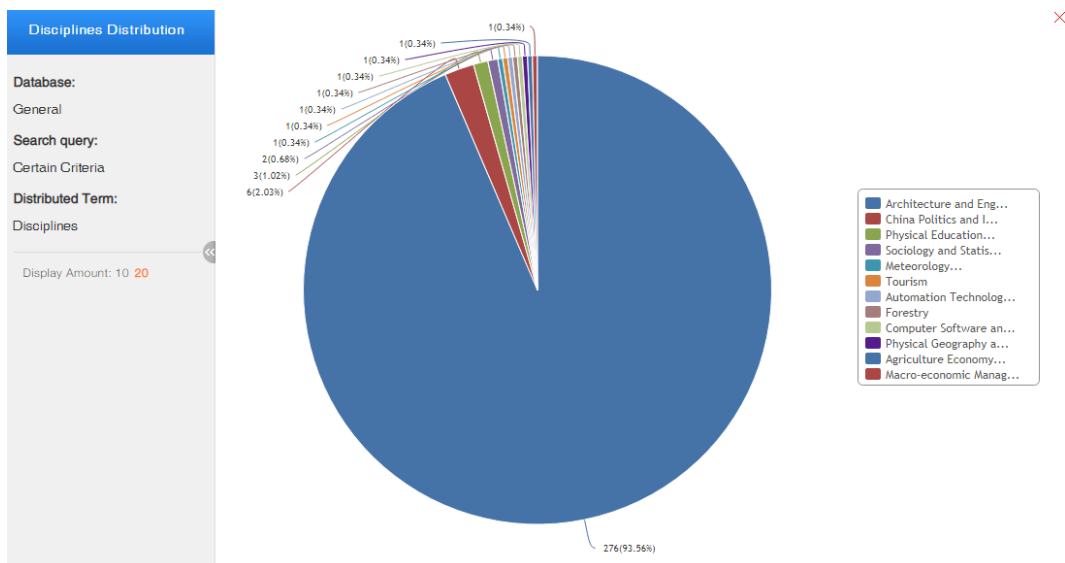


Figure 2-5. Disciplinary features of research on the aging of community outdoor spaces in CNKI.

From the perspective of the disciplines, the literature included in the CNKI full-text database, the discipline that conducts the most research on outdoor activity sites for the

elderly in the community is building science and engineering, with 276 papers, accounting for 93.56% of the total number of retrieved papers (Figure 2-5). It shows that the research of community aging in China presents the characteristics of a single discipline. There are no interdisciplinary comprehensive research results, which to a certain extent leads to the one-sidedness of theoretical research.

2.2 Review of existing studies and entry points for the study

Based on the above literature, plus academic monographs involving older adults related to residential or community outdoor venue environments. An overview of domestic and international research related to the use of community outdoor sites by older adults will be presented.

2.2.1 Research on Elderly Livable Communities

Age-friendly communities as a concept may be universally beneficial for age-friendly environments, but the specific approaches and implications may vary across cultures and societies (Hu T.H., 2016). China's political system, economic development, community governance model, and the characteristics of an aging society have distinct Chinese characteristics, and it is impossible to copy Western research paradigms, and there is an urgent need to build a paradigm for the study of age-friendly communities based on the Chinese context.

Age-friendly communities are an important part of geographic gerontology research. The concept originated from Lawton and Nahemow's ecological perspective of aging, and the basic idea is to emphasize the importance of the dynamic interaction between individual adaptation and environmental change in order to maintain the optimal functional status of the elderly (Lawton M.P et al.,1973). The importance of environmental gerontology research in the last few decades has contributed significantly to the discussion of age-friendly communities. In 2005, the "Global Age-Friendly Cities Project" promoted by the World Health Organization (WHO) started the age-friendly boom. The term "Age-friendly Communities" proposed by WHO has been expressed differently in different countries based on the differences in official policy preferences. The term "age-friendly community" is mainly found in Canadian policy documents¹; the term "liveable community" is more common in US policy documents²; and in the UK, policymakers use the term "lifetime neighborhood" when referring to building an enabling environment for senior citizens (Harding E.,2007). These terminological distinctions reflect differences in the policies and initiatives

¹ Public Health Agency of Canada. Age-friendly Communities Evaluation Guide[R]. 2011.

² Partners for Livable Communities. A Blueprint for Action: Developing a Livable Community for All Ages[R]. Advocacy, Action, Answers on Aging, 2007.

emphasized by policymakers, local community programs, and researchers, as well as differences in the models and frameworks of senior livability defined by different subjects.

WHO's the project on age-friendly cities and communities is conducted within the framework of active aging (T. Buffel et al.,2019 ; Wu P.Q.,2020), and therefore, WHO's description reflects the idea of active aging with an emphasis on respect, social inclusion, and community participation. In contrast to the focus of the WHO, Gitlin emphasizes from an ecological perspective that the settlement environment should serve to compensate and support the diminished abilities of older adults due to aging¹, and Deborah suggests from an urban planning and architectural perspective that an age-friendly community should include a range of easily accessible land uses (Gitlin L.,2015); the local government-driven US The model proposed by the Advant Age Initiative, promoted by local governments in the United States, places more emphasis on the physical environment of the community to meet the needs of older adults in the community (Howe D.,2016). In contrast to the focus on technology, building codes, design specifications, and the physical aspects of the community, the UK's formulation of lifelong neighborhoods focuses relatively more on the importance of "social relationships" (Hanson A, et al.,2006); Stephen et al. emphasize the social and emotional factors of the place of residence and the perceptions of older adults of the community's Perceived Neighborhood Environment (Harding E.,2007; Stephens C, et al.,2019). Thus, subjective perceptions of the community affect the well-being and health of older adults living in the community (La G, et al.,1985).

What kind of community is suitable for the elderly? Scholars in China have not yet reached a consensus, and the relevant research results are relatively limited. Wang Fengming believes that a livable community for the elderly is a community that can meet the material and spiritual needs of the elderly and is suitable for them to live in (Wang F.M.,2011). Li Shan and Yang Zhongzhen pointed out more clearly that a livable community for the elderly should be safe, healthy, convenient, and comfortable, as well as well-served and with emotional belonging (Li S. et al.,2012). Li Xiaoyun emphasized that a livable community for the elderly should reflect the positive interaction between the elderly and the human environment, and believed that the core connotation of a livable community for the elderly is the harmonious coexistence between the elderly and the living environment (Li X.Y.,2012). Liu Yayun et al. argued that a livable community for the elderly should promote the social participation of the elderly and create conditions for their continuous and productive community participation (Liu Y.Y. et al.,2015). Zhou Yanmin emphasized on creating a detailed "aging-friendly design" by focusing on the outdoor environment of the residential area, which is the most frequently used activity space by the elderly (Zhou Y.M. et al.,2013). Yu Yifan emphasizes the functional role of senior-friendly communities, i.e., communities should provide compensatory and supportive living environments for the deterioration of the

¹ World Health Organization.Global age-friendly cities:a guide[EB/OL].<http://www.who.int/ageing/publications/age-friendly-cities-guide/en/>,2014-03-05.

elderly due to aging (Yu Y.F.,2017).

In summary, the general consensus among scholars at home and abroad is that a livable community for the elderly is a system domain containing multidimensional space, including not only physical space involving the ecological environment, land use, facility construction, etc., but also social-humanistic space involving interpersonal relationships and participation opportunities, and the physical and social environments of the community are interdependent and complementary (Plouffe L, et al.,2010). The research on senior livable communities in China started late, and from the studies of many scholars, our scholars have become more and more knowledgeable about senior livable communities. This study deepens the connotation and extends the extension of senior livable communities.

2.2.2 Study on the supply and demand of community outdoor sites

Since traditional community environmental planning is top-down (J. Phillips,2021). The supply situation of the source configuration is more considered to meet the basic requirements of the specification. This in turn leads to a certain degree of lack of consideration of the actual use of the community, especially the bottom-up outdoor activity needs of the elderly. Improving aging-friendly community site service facilities and space efficiency has become the focus of current research.

There have been many theoretical studies to explore the relationship between the community environment and residents' health activities, such as the Biophilia Hypothesis Theory (Kellert S R, et al., 1993) and Stress Reduction Theory (Ulrich R S, 1991). All the theories have analyzed that individual activities are the result of the interrelationship between people and the environment. In other words, individual activities are influenced by residents' own needs as well as the environment, and the mechanism of the community outdoor environment influencing residents' activities has received much attention from the academic community.

The physical environment has been proven to have a positive impact on promoting physical activity in the elderly (Hooper P. et al., 2020). The outdoor site environment, including walkability, accessible green space, fitness equipment and convenience facilities, is an important factor of promoting participation in outdoor activities (Levinger P. et al., 2020). These characteristics are particularly important to maintaining activity levels in older adults, who can be affected by local environmental and outdoor neighborhood conditions (Choi YJ. et al., 2018 ; Carrapatoso S. et al., 2018). In recent years, outdoor fitness equipment has become quite common as an important environmental infrastructure that provides opportunities for physical activity and socialization in community outdoor spaces (Lee JLC. et al., 2018). However, these designs rarely meet the needs of the elderly. The needs of older adults for outdoor spaces and related activity facilities need to be designed with careful consideration to better accommodate the aging population (Levinger P. et al., 2020).

The evaluation of the supply-demand matching relationship of the community environment supporting neighborhood activities is summarized in two main aspects.

- Service supply side.

Focusing the research on the community environment itself, Coombes et al. (2010) established an information database including data on green space attributes and health records of residents in the community and used regression model analysis to explore the correlation between environmental services and residents' activities, accessibility and obesity in the community. Mao Zhixia (2017) and Yu Bingqin (2014) constructed evaluation systems at different levels to analyze the composition of community park recreation attractiveness, such as the richness of facility types, and the number of features on recreation services. Wang et al. (2015) and He et al. (2015) showed that the mismatch between supply and demand is the main dilemma limiting the effective supply of community public goods and the main bottleneck affecting the improvement in urban resource utilization.

- User demand side.

Focus on the actual usage status of the users receiving community services. Klein et al. (2021) showed that the study of environment and behavioral activities should focus not only on the physical environment, but also on the physical and environmental elements at the perceptual level. The relationship between the physical environment and individual perceptions are emphasized to be fully studied in order to meet the needs of a wider range of people for public space activities. Rossi S D (2015) et al. studied the relationship between the perceptions of residents with different social attributes in the community environment and recreational activities. It was pointed out that individual perception is an important mediator between activity, environment, and individual, and the latter can interact with the environment through intention and cognition. Shao Lei (2016) et al. made suggestions for the configuration of public services in the protected residential areas of Beijing New Town by analyzing the characteristics of the population and the needs for public service facilities of the population.

In general, previous studies on matching the supply and demand of community environmental resources have mostly focused on the overall performance level such as the equity of spatial distribution and service accessibility, and have achieved rich research results in terms of theoretical studies, concrete implementation methods and practical evaluation, but research on matching supply and demand for the environmental factors that constitute them still needs to be improved.

From the perspective of supply and demand, this study:

(1) Can pay sufficient attention to understanding the relationship between the demand for activities of the elderly and the community outdoor supply environment, identifying the key environmental factors that support outdoor activities, which environmental factors are in balance between supply and demand, and which are in short supply? (2) To explore the environmental characteristics that truly meet the needs of the elderly, and to provide targeted and implementable optimization strategies for planning,

landscape and other environmental design guidance and control.

2.2.3 Study on person -environment matching in community outdoor sites

As the primary spatial vehicle for older adults' lives (Lawton, M.P. et al.,1982), the match between the community environment and older adults' abilities and needs will directly affect their quality of life of older adults. Scholars recognized the limitations of early person-environment studies that focused only on the built environment and also found a lack of research on matching person-environment at the community level, especially when older adults face increasing mobility restrictions and limited housing options, matching the community living environment becomes increasingly important (Kahana, E. et al.,2003).

The development of gerontological theory draws on classical approaches from psychology and behavior. Stress theory in psychology has recognized that behavior, attitudes, and psychological feelings are jointly determined by the person and the environment. Among them, Murray's need-press theory, or Lazarus' transactional model of stress and coping, asserts that the balance between individual needs and responses to external pressures will drive individual behavior. The ecological model of aging by Lawton and Nahemow views the aging process as a continuous adaptation to changes in the external environment and internal capabilities over the life cycle (Zhang Z.Q.,2020), and considers the ecological transaction as a function of the level of individual capabilities, the intensity of environmental pressure, the level of emotion and adaptation, and the optimal function; and by introducing the life course parameters of the person and the environment, the ecological concept of aging is proposed. The concept of environmental press and adaptation in aging ecology was proposed by introducing the life course parameters of human and environment (Scannell L. et al.,2010).

A distinction is made between the environmental docility hypothesis and the concept of environmental proactivity. The former suggests that as an individual's capacity declines, the behavior will be increasingly influenced by environmental characteristics. The latter suggests that increased individual capacity will enhance one's ability to use environmental resources and that older adults have the opportunity to actively change their environment to meet their needs. Since the ecological model of aging underestimates, the inverse effect of environmental stress on the ability to function and enhance behavior, Peace then developed the concept of "option recognition" to increase the perception of proactive responses to environmental stress (Atchley R C.,1989).

The person-environment fit or congruence theory is a theory originally used for career and educational choices. It also focuses on the interaction between individual characteristics, stress, and environmental provision. The central argument is that stress is not generated by the person or the environment alone. Rather, it is generated by the degree of fit or congruence between the two (Heckhausen J. et al.,1993). After

modification of the model by Nehrke et al. to apply to elderly studies (Lawton M P et al.,1973), Kahana proposed a model of congruence between the elderly and the environment through an empirical study of nursing homes (Nahemow L et al.,1973). The focus of person-environment matching research shifted from the built environment to the community environment, such as Glass et al. studied the community effects of coping with aging based on an extended ecological model of aging, emphasizing the joint promotion of person-environment matching through community support and strengthening individual capabilities (Glass,T.A. et al.,2003). Kahana et al. expanded their research from institutional to community environments to understand the dimensions of person adaptation to community environments (Kahana, E. et al.,2003).

Sociodemographic characteristics, such as gender, age, education, income, and family structure, have also been shown to be associated with physical activity in older adults (Menai et al., 2015 ;Gao W. et al., 2021). Although there is a large body of research on physical activity levels in older adults. However, fewer P-E fitting studies have been conducted in the community context based on the corresponding dimensions. Research on activity needs in community settings is lacking. This is because older adults often face increasing mobility restrictions and limited housing options. In addition, residential settings are particularly salient for older adults, who often exhibit limited residential mobility and often live in decaying inner-city neighborhoods (Carp,1982). Older adults are exposed to different types of environments in their daily lives depending on their mobility. Thus, their positive behaviors are influenced not only by their residential environment but also by the broader environmental context (Koohsari et al., 2018).

There are also relatively few studies on the effects of socio demographic and community characteristics on physical activity patterns of older adults. Mooney et al. (2015) investigated patterns of types of physical activity in older adults and the correlates of these patterns. They found that individual and community characteristics were associated with different patterns of physical activity. Steeves et al. (2019) examined differences in physical activity patterns of older adults in terms of number of activities/minute and duration of activity in different physical function groups. If we could better understand the interrelationship between physical activity intentions and perceived opportunities for older adults with different levels of physical activity. Improve the equity of physical activity opportunities for older adults and increase the opportunities for physical activity at different stages of functional limitations (Piercy, K.L. et al., 2020). We will have better prerequisites to find more optimal physical activity programs that meet the different needs of the elderly population.

In parallel with the gradual deterioration of the physical functioning of older adults, this study takes a person-environment matching perspective: (1) to examine differences in older adults' mobility and the adaptability of the community outdoor environment. (2) To achieve a state of equilibrium between the individual abilities of older adults and environmental stress. Gradually carry out the improvement of the surrounding environment to reduce environmental barriers and environmental pressure. So

community outdoor venues should meet the multi-level activity needs of the elderly as much as possible and have a positive impact on their lives.

2.2.4 Study on evaluation system of livable community for the elderly

In 2007, the World Health Organization (WHO) presented the programmatic document "Global Age-friendly Cities: A Guide"¹. The guide identifies key characteristics of Age-friendly Cities in three main areas, they are service provision, built environment and social aspects. This global guide to Age-friendly Cities has become the most commonly used document to promote and assess age-friendly goals (L. Plouffe, et al., 2016 ; S. Rémillard-Boilard, 2018). According to the guidelines, age-friendly community building involves eight major themes, namely, outdoor spaces and buildings, transportation, housing, community support and health services, communication and information, social participation, respect and social inclusion, and civic participation and employment. The guidelines proposed by the World Health Organization have served as a positive guide for the research and construction of age-friendly cities and communities around the world. However, scholars have also pointed out that the biggest problem in the implementation of the guidelines is the issue of their operability and realism, and although many different age-friendly baseline assessment methods have been used globally, there is little agreement or standardization on how to conduct the assessments (Dellamora, 2015).

Habitat evaluation of age-friendly communities is the application of scientific methods to evaluate and analyze the quality of the habitat environment by constructing an index system and collecting relevant data and information. Habitat evaluation promotes theoretical research to practical application and is an important way to study habitat issues in age-friendly communities (Verena H M et al.,2011). In order to more effectively guide and measure the construction of age-friendly communities, in 2015, the World Health Organization developed another set of core indicators, namely "Measuring the age-friendliness of cities: a guide to using core indicators " (WHO,2015a)². For monitoring and evaluating progress of improving the age-friendliness of urban environments (T. Buffel et al., 2019). Indicators emphasize the principles of equity, accessibility, and inclusiveness in the lives of older adults, the physical environment, and the social environment.

Davern et al. (2020) conclude that qualitative assessment of other factors should be carried out only after quantitative assessment of the main factors. In line with this statement, a large number of researchers have attempted to develop quantitative methods to assess the age-friendliness of a city or community. These attempts are usually (but not exclusively) rooted in the WHO inventory. Garner and Holland (2020)

¹ World Health Organization. Global age-friendly cities: a guide [EB/OL]. <http://www.who.int/ageing/publications/age-friendly-cities-guide/en/,2014-03-05>.

² World Health Organization. Measuring the degree of urban care for the elderly. [EB/OL]. <http://www.who.int/ageing/publications/age-friendliness-cities/zh/,2015-12-15>.

developed and validated their Age-Friendly Environment Assessment Tool (AFEAT), which assesses whether individual physical differences affect perceptions of environmental age-friendliness. the AFEAT consists of 10 items (using a 5-point Likert scale system) and is a valid and reliable instrument. Buckner et al. (2018 ; 2019) hypothesized that one of the challenges to evaluating Age-friendly Cities is identifying an evidence-based approach that reflects the contextual complexity of the initiative. Among the subject areas requiring evidence, the authors identified that older adult engagement, collaboration and interconnectedness, monitoring and evaluation are important. In addition, Chao (2018) calls for a more integrated research approach from urban planning related to Age-friendly Cities.

With the continuous promotion of the practice of building a livable community for the elderly, scholars in China have also conducted fruitful research on the evaluation of the habitat environment of the livable community for the elderly. Wong et al. (2015) conducted two surveys in Hong Kong with a quantitative approach to perceived age-friendliness. Two structured questionnaires were developed based on local adaptations of the WHO's AFC guidelines (85 dimensions and 50 aspects under 8 domains). Respondents rated their responses using a 6-point Likert scale, with higher scores indicating greater friendliness to older adults. A later study conducted by Yu et al. (2019) in Hong Kong. used the same 6-point Likert scale using a 53-item questionnaire covering both physical and social environmental domains. Zhao Dongxia et al. (2013) constructed indicators including ecological environment, health environment, living environment, and cultural environment by means of questionnaire survey. Wang Shang (2017) constructed an evaluation index system of livable community for the elderly based on the needs of elderly groups for elderly services in terms of community safety, community environment, community facilities, community convenience, community care, community activities, and community interpersonal interaction.

From the research results of scholars, the evaluation index system and evaluation methods are becoming more and more abundant, which fully reflects that the initiative of senior livable communities is receiving more and more responses and extensive attention from scholars. As more and more senior livable communities around the world grow and develop, more comprehensive and inclusive forms of assessment and evaluation are needed. Chinese scholars are increasingly aware of the differences between our communities and Western communities in terms of social institutions, construction models, and resource endowments, and are constantly exploring locally appropriate evaluation methods. However, there are some imperfections. Although scholars have constructed indicator systems, they have not yet applied them to conduct in-depth and systematic evaluation and analysis of communities.

The studies of related institutions and scholars at home and abroad have laid a solid foundation for the subsequent research and provided useful references for the development of this study. On this basis, based on China's national conditions and new realistic requirements. (1) An outdoor environment evaluation system of elderly livable communities was constructed and an evaluation process was developed. (2) An in-depth

and systematic measurement and analysis of community outdoor environments is conducted. (3) Propose targeted planning and design objectives, guidelines, and strategies for age-friendly community outdoor spaces.

In response to these research gaps, my study aims to address:

① For China's aging, which has a cultural and social background different from that of developed Western countries. This paper conducts a study on the adaptability of outdoor sites in urban communities to meet the needs of elderly activities. It is intended to deepen the connotation and expand the extension of elderly livable communities.

② For traditional community planning, the supply of resources is only "top-down" to meet the requirements of the specification. In this paper, we measure the match between the supply and demand of each environmental factor of the sample community outdoor sites. We identify the "bottom-up" environmental characteristics of the community outdoor sites that meet the activity needs of the elderly. To improve the efficiency of community environmental resource allocation.

③ For groups of older adults with different physical abilities, the existing community outdoor environment does not provide enough support for them. Through differentiated research on the outdoor activity needs of the elderly population. To meet the multi-level activity needs of the elderly and the adaptability of the community outdoor environment.

④ There is little consensus and standardized recommendations of the research and construction of age-friendly cities and age-friendly communities. In this paper, we adopt a more comprehensive research approach to build an evaluation system and process from the perspective of scientific evaluation. Combining China's national conditions and new realistic requirements, to achieve "Aging in Place".

2.3 Definition of basic concepts

2.3.1 Community

The concept of community has its roots in sociology, and in 1887 the German sociologist Ferdinand Tennes described the difference between "Gemeinschaft" and "Gesellschaft" in his book "Gemeinschaft und Gesellschaft". The difference between "Gemeinschaft" and "Gesellschaft". He argues that a "Gemeinschaft" is a humane social group of people with similar values, close social ties, and similar demographics. "Gesellschaft", on the other hand, is a mechanical grouping based on external interests. With the urbanization and modernization of society, the natural "Gemeinschaft" will inevitably be replaced by the artificially designed "Gesellschaft" (Ferdinand Tennes,1999), which provides a way to study the trends of social change (Chen Y.G.,2004). Later, with the rise of empirical sociology in the United States, the

translation from the German "Gemeinschaft" to "Community" and then to the Chinese "社区" has gradually taken on a regional dimension. The term "Gemeinschaft" was translated from the German "Gemeinschaft" to "Community" and then to "community" in Chinese, which gradually took on a regional meaning (Wang M.M.,1997; Wang X.Z.2002; Chen M.P.,2009).

The Chinese perception of "community" began in the 1930s, translated by Fei Xiaotong and other scholars from the word "Community" in the sociological treatise of the American sociologist Parker. Parker further clarified community from the perspectives of institutions, factors, ontological structures, and geography, and was called the functionalist school. As a result, Chinese communities have been distinctly regional from the beginning of their introduction. For China's urban communities, administrative forces are in the forefront of community formation. Liu Junde argues that under the current economic and management system in China, administrative district management and community management are inseparable, and that the vertical management system of a large city proper is actually a top-down management system (Liu D.J.,2002). He constructs a "district-community system" to sort out the organizational relationship between districts and communities, and its basic structural level is "city-district-community". The basic structure is "city-district-community". The city and the district are two levels of administrative districts, where the district is the grassroots of the city and the community is the self-governing unit (Liu D.J. et al.,1995). Urban communities are usually referred to as street-level and neighborhood-level communities (Liu D.J. et al.,1995; Ding S.M.,1997).

Based on the above definition of community, combined with the theory of habitat and environment, the theory of matching human and environment, and the connotation of community, the definition of urban community in this study is hereby determined as: A community in a city surrounded by urban arterial roads and natural dividing lines, and consisting of several residential neighborhoods and residential clusters.

2.3.2 Outdoor activities

The term "Outdoor Activities" is commonly used in everyday life to refer to any activity that takes place outdoors. With the need for refinement in research, the definition of outdoor activities is becoming more and more narrowly defined. Sonne et al. analyzed the characteristics of older adults' participation in recreational activities (social activities) and sports activities in residential areas, and investigated the effects of residential environment facilities and greenery on the intensity and participation of older adults' activities (Lemke S et al.,1989). Yasuhiro et al. concluded that spontaneous participation in social activities, cultural activities, and activities related to cognitive stimulation would reduce the risk of diseases such as Alzheimer's disease in older adults by investigating the characteristics of outdoor interaction activities in older adults' settlements (Fushiki Y et al.,2012).

Since the main participants of outdoor activities in this paper are elderly people. Their activity programs also have strong Chinese cultural and regional characteristics. The concept of outdoor activities that have been studied by foreign scholars does not match well with the outdoor activities of Chinese elderly people. Therefore, this paper mainly refers to the relevant studies of Chinese scholars to refine the definition of outdoor activities. Wang Huan (2009) et al. divided the activities of older adults into five categories: sports activities including Tai Chi, dancing, ball games, equipment, jogging, walking, etc., communication activities including chatting, art learning activities including opera, painting, and calligraphy, child care, etc., thinking activities including playing cards and chess, and other activities including walking birds and resting. Sun Xiaoxi et al. (2014) classified the activities of older adults into four categories: fitness activities including ball games, playing tai chi, group exercises, apparatus exercises, walking and jogging, cultural activities including dancing, singing, calligraphy practice, etc., leisure activities including chess and card activities and painting, and interaction activities including chatting and sitting around. Song Jusheng et al. (2017) divided the outdoor activities of the elderly into three categories: sports and fitness activities including square dancing, apparatus sports, table tennis, etc., chess and card recreational activities including poker, mahjong, singing, etc., and leisure and care activities including walking and communicating, walking the dog, and taking care of pregnant women and the elderly and infirm.

From the existing studies in the literature, it can be seen that the outdoor activities in which the elderly participate are mainly outdoor sports and leisure activities with physical exercise, as well as skill-based cultural and artistic activities, and rehabilitation activities, and parent-child education activities. From this paper, we can conclude the characteristics of outdoor activities for older adults: recreation, exercise, rehabilitation, and play with grandchildren as the main types of activities.

2.3.3 Community outdoor activity sites

In specific studies, scholars have converged on the understanding of "site", which can be understood in both a broad and a narrow sense (Zhang L.L. et al., 2011). In a broad sense, the concept of site is comprehensive, permeable, and complex. The site should include all the natural, artificial, and social environments needed to meet the site's functional development (Liu L.,2007). In a narrow sense, the site refers to all the contents other than the building, such as the square, outdoor activity field, outdoor exhibition field, and parking lot are included.

Sites need to provide physical space to support different outdoor activities. Consider the definition of "community" and "outdoor activities" in this paper. The main focus of this paper is on the existing studies by Chinese scholars. Most of the existing studies have concluded that the physical activities of the elderly are strongly related to the characteristics of the venue, and different physical activities require different physical space conditions. For example, fitness activities (ball games, taijiquan, group exercises,

apparatus sports, etc.) with a relatively large amount of activity generally require a large and flat surface area and fitness equipment with a high safety factor; cultural activities (singing, calligraphy practice, etc.) with a medium amount of activity generally require a wide and flat surface area, which also provides activity space and corresponding rest facilities for the viewing public; light activity Leisure activities (chess and card activities, painting, chatting, sitting, walking) generally do not require large spaces but need multifunctional rest facilities, and chess and card activities often require shade facilities and combined tables and chairs (Wang H. et al.,2009;Sun X.X. et al.,2014).

To sum up, the community outdoor activity space in this paper refers to the free open ground space within the community, which is capable of carrying outdoor activities for the elderly. Unless otherwise specified, the term "site" in this paper refers to the community outdoor activity site defined above.

2.3.4 Elderly and Aging

The United Nations World Health Organization (WHO) has divided the elderly into three age groups based on global human quality and average life expectancy, namely: 60-74 years old are the young elderly, who have just entered the early stages of aging, and are mostly active. 75-89 years old are the elderly, whose physical functions decline with age, resulting in reduced mobility. Most of the elderly people in this age group are completely incapacitated. Marcus, a foreign scholar, in his book "People Places: Design Guidelines for Urban Open In Human Places: Design Guidelines for Urban Open Space, Marcus classifies the types of activities and abilities of the elderly: the lower age group of 55-70 years old has a strong ability to The lower age group of 55-70 years old is more active, tends to socialize in multiple groups, and has a higher demand for outdoor environments; the older age group of 70 years old and above belongs to the middle and The older age group of 70 and above are middle and older, with lower physical function and more static activities (Marcus C et al.,1998).

In 2013, China Architecture Press published the "Building Design Code for Elderly Facilities GB 50867-2013"¹, which divided the elderly into three categories according to their living status and living ability, which are: Self-helping Aged People (SHP), Self-helping Aged People (SHP), Self-helping Aged People (SHP), and Self-helping Aged People (SHP). People are those who can completely take care of themselves and do not depend on others for activities; Device-helping Aged People are those who have a certain degree of self-help. helping Aged People are the semi-disabled elderly who have some ability to act but need to use handrails, crutches, wheelchairs, and other assistive devices to carry out activities. The Device - helping Aged People are semi-disabled elderly people who have some ability to move around with the help of handrails, crutches, wheelchairs, and other assistive devices; Under Nursing Aged People are elderly people with dementia and disability who need care. Under Nursing,

¹ Ministry of Housing and Urban Rural Development of the People's Republic of China Code for Building Design of Elderly Care Facilities GB 50867 (2013 Edition). 2013.9

Aged People are seniors with dementia and disability who need care.

Based on the above divisions and combined with the current situation of the residential outdoor activity research population, this study was defined as elderly people aged 60 years and above. In combination with the national conditions of China, we define 60-69 years old as low age, 70-79 years old as middle age, and 80 years old and above as high age.

"Age-appropriate" refers to the design that takes into account the functional status of the elderly and is designed to meet the activity and travel needs of those who have entered or will enter the elderly life. People go through physical and mental changes from young to old, but most of the time, living environment and facilities are not modified accordingly with the changes of people's physical condition. Many studies have shown that a community environment adapted to the needs of the elderly can facilitate their activities (Yi G et al.,2014), while the opposite can hinder their activities (Lucie R et al.,2012).

The current industry code "Building Design Code for the Elderly (GB 50340-2016)" provides for the public space, set of space, physical environment, and building equipment of various types of residential buildings used by the elderly, and puts forward specific design requirements and design details for the intermediate and intermediate care elderly respectively, emphasizing the specialized, care and nursing services for the elderly under the conditions of declining physical functions. The design concept of aging-friendly design is emphasized.

However, the needs of the elderly for community space are not only limited to home care and nursing care but also involve multiple aspects such as interaction, entertainment, leisure, sports, and living services. The community outdoor activity space is the main position of daily activities for the elderly, and according to its spatial function, the elderly uses the space more for exercise, socialization, and leisure. Therefore, the community outdoor activity sites as the core of the aging should be more inclined to the adaptability of the activities of the elderly, to meet their limited ability to travel, preference for free services, and the need to carry out outdoor activities.

Sugiyama and Thompson (2007) suggested the supportiveness of community environments for outdoor activities of older adults, and that supportive community environments allow for easy and enjoyable travel options for older adults and will lead to more frequent and habitual use of outdoor activity spaces. The age-appropriate connotation of the community outdoor activity space in this study is based on the special physical and mental health needs of the elderly population and provides the necessary objective conditions for the elderly who are capable of outdoor activities.

2.4 Summary

First, a search of the Web of Science literature retrieved 405 relevant papers from 2000-2021. The overall number of foreign literature on senior livable communities shows an increasing trend. The discipline that has conducted the most relevant research is Psychology, and the disciplines engaged in the research of aging in community outdoor spaces span a wide range of disciplines, reflecting the comprehensive disciplinary characteristics of aging in community outdoor spaces that are compatible with literature and science. A literature search of the research content was conducted on China Knowledge Network. From 2000 to 2021, a total of 287 relevant papers were retrieved, and after 2013, the research enthusiasm of Chinese scholars was greatly promoted and the number of relevant papers increased significantly. The discipline that conducted the most relevant research was building science and engineering. The research on elderly livable communities in China is characterized by a single discipline. To a certain extent, this has led to the one-sidedness of theoretical research.

Secondly, a review of the research on senior livable communities is conducted. This study deepens the connotation and expands the extension of senior livable communities. The relationship between demand and supply of outdoor spaces in the community is reviewed, and the relationship between demand and supply of outdoor environments in the community is explored from the perspective of supply and demand. A review of the research on the matching of people and environment in community environments is conducted to examine the age and activity ability differences of older adults and the suitability of community outdoor environments from the perspective of matching people and environment and the relationship between the variables. The evaluation system of community outdoor sites to meet the activities of the elderly is reviewed. Based on China's national conditions and new realistic requirements, the outdoor environment evaluation system of elderly livable communities was constructed, the evaluation process is developed and targeted goals, guidelines, and strategies for venue planning and design are proposed.

Finally, the basic concepts relevant to this study are defined. A "community" is an urban neighborhood surrounded by urban arterials and natural boundaries and composed of several residential neighborhoods and groups. "Outdoor activities" are in line with the characteristics of Chinese elderly people's activities, with recreation, exercise, rehabilitation, and early childhood education as the main types of activities; the number of activities is medium or less, or even static; the location is outdoors, and the natural or artificial environment is not limited. "Community outdoor activity space" is defined as an open, free surface space within the community that can accommodate outdoor activities for the elderly. The term "senior citizens" refers to those aged 60 and above. The meaning of "aging-friendly" is to provide the necessary objective conditions for the elderly who are capable of outdoor activities, starting from the special physical and mental health needs of the elderly group.

Chapter 3.

Methodology & Model construction

In this chapter, the general technical approach and research methodology of this study are firstly presented. Secondly, we develop models for each of the three SRQs, including the supply and demand model of outdoor sites in urban communities, the model for determining whether individual and community outdoor sites are ageing-friendly, and the outdoor environment evaluation system of elderly livable communities. The operational steps of each of the three models are also explained.

3.1 Technical route and research methods

Figure 3.1 shows the technical route and research methodology of this paper. The corresponding research objectives are determined for SRQ respectively. And under the guidance of relevant theories, the research contents are determined. And the corresponding research methods were selected.

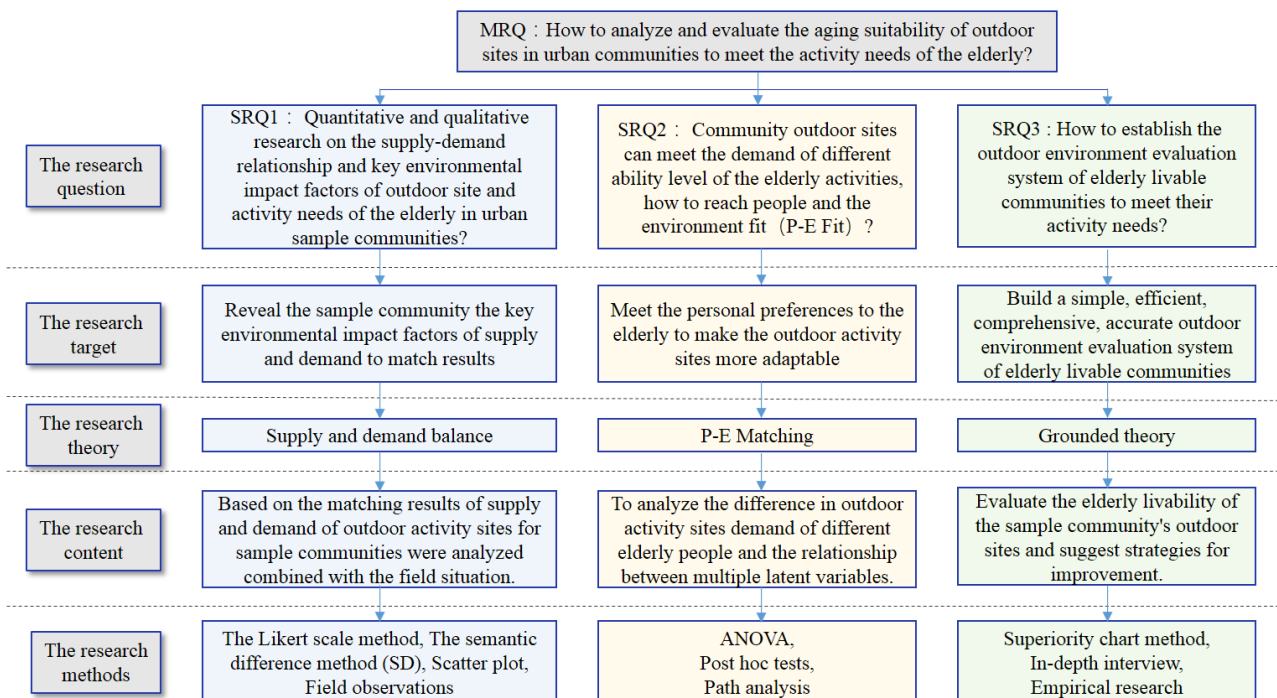


Figure 3-1. The overall framework of the technical route and research methodology of this paper

3.2 Model construction

3.2.1 The supply and demand model of outdoor sites in urban communities

More details of this sub-study are explained in Chapter 5. There are three steps to establish the supply and demand model of outdoor sites in urban communities. To explore the activity demand of the elderly and the supply capacity of the community outdoor environment, and to understand the supply and demand matching characteristics of each environmental factor of the community outdoor venue. A good community environmental resource supply and demand relationship means that the community venue environment has efficient and distinct spatial characteristics. This can, on the one hand, actively respond to the actual activity needs of the elderly and support various forms of outdoor activities, so that the elderly can be greatly satisfied in terms of emotion and environmental use. At the same time, it can also appropriately match environmental resources and play the functional role of local government in enhancing the efficiency of public space resource allocation. The specific explanation is as follows.

Step 1: Construct the supply and demand matching evaluation matrix and supply and demand matching index calculation and analysis. Using the balance of supply and demand theory, the environmental factors of community outdoor sites are used as the main subjects of the study to construct the model. Identify, filter, and rank them in order to explore the characteristics of environmental factors with different supply-demand matching relationships.

Step 2: The supply-demand matching relationship of environmental factors in 5 major categories and 25 sub-categories of environmental factors. Based on the questionnaire survey, the Likert scale method was applied to measure the supplied degree of environmental factors through the satisfaction of the elderly with the outdoor environment of the current living community. The semantic difference (SD) method was applied to measure the demand degree of environmental factors through the assessment of an ideal community environment that meets the activity needs of the elderly. The environmental factors that support the outdoor activities of the elderly were identified.

Step 3: Characterization of supply and demand balance environmental factors in each community. The demand and supply matching index were calculated for each community. Scatter diagrams were used and combined with field observation photos. To explore in depth the supply and demand matching of environmental factors of outdoor sites in each case community. To provide empirical support for accurate allocation of site resources.

3.2.2 The model for determining whether individual and community outdoor sites are aging-friendly

More details of this sub-study are explained in Chapter 6. The model for determining whether individual and community outdoor sites are aging-friendly was developed in three steps. The needs of the elderly for "Aging" have commonalities and differences, and the common needs include enhancing the supply capacity of the community environment, public facilities, and other services, as well as the configuration standards of facilities. At the same time, there are some differences in the needs of the elderly. The match between the elderly and the environment also depends on the consistency between diverse needs, including age, physical condition, personal and family attributes, outdoor activity habits, and environmental resources. Therefore, the construction of a community outdoor environment is not only a matter of facility construction but also the integration and coordination of the interests and needs of differentiated groups. The specific explanation is as follows.

Step 1: Based on the P-E matching theory, the model is constructed. The interaction between individual ability and environmental pressure was analyzed. The community outdoor environment satisfaction is high, and the individual is stress-free in the environment. It can be judged that the person matches with the environment and the environment is suitable for the elderly. If the satisfaction level of the outdoor environment is low, the individual has stress in the environment. It can be judged that people do not match with the environment, and the environment is not suitable for the elderly.

Step 2: Study the differences in the activity ability of the elderly, their preferences, and the suitability of the community outdoor environment in a hierarchical manner. Community outdoor sites should meet the multi-level activity needs of the elderly as much as possible. To study the differences in the needs of older adults of different ages and physical conditions. One-way Analysis of Variance (ANOVA) is used to analyze the differences in personal attributes, physical condition, outdoor activity habits, and satisfaction and demand for the outdoor environment of the elderly and to conduct post hoc tests. The differences in outdoor activity habits and satisfaction with the outdoor environment in the community among the intervening and intermediate elderly were path analyzed.

Step 3: A path analysis of how personal attributes, family attributes, physical condition, activity habits, and satisfaction and demand degree affect the activity characteristics of older adults in the community outdoor environment, and the interrelationship between several variables.

3.2.3 The outdoor environment evaluation system of elderly livable communities

More details of this sub-study are explained in Chapter 7. The establishment of the evaluation system consists of four steps. By applying this evaluation system, the shortcomings of the community outdoor environment that affect the activities of the elderly are identified and provided with improvement strategies in the actual renovation and construction of the community, which can also play a normative role in the evaluation and testing of the suitable aging community, and thus promote the construction of a suitable outdoor environment for the elderly in urban communities. The specific explanation is as follows.

Step 1: Use grounded theory to collect data and code. The evaluation system is constructed. The empowerment method of the indicator system and the scoring criteria of the case community indicator were determined. An evaluation process was developed.

Step 2: The weights of the evaluation index system were calculated. The weighting of the indicators follows the principle of the superior order diagram method. The three-level hierarchy of the community outdoor venue aging-appropriate evaluation system was constructed. The weights of the criteria level were calculated first, then the weights of each indicator level were aggregated, and finally, the total ranking weights of the hierarchy were calculated.

Step 3: Comparison of the scores of each community index. Through the subjective and objective indicators, the scores of each community indicator were calculated comprehensively. By weighing all the scores and adding them up, the final evaluation score of each case community is finally obtained.

Step 4: Through the comparison and analysis of the evaluation results, we propose targeted strategies to improve the outdoor environment of each community.

Chapter 4.

Information collection and Structured Questionnaire

This chapter first collects the basic information about the community outdoor sites adaptive aging model. The city where the information is collected, the time of information collection, and the information collection case community and specific collection scheme are determined. Next, the composition and technical route of the questionnaire are described. Based on the literature review and in-depth interview word frequency statistics, the evaluation system environment factors are obtained on a comprehensive basis.

4.1 Collection of information

4.1.1 The city where the information is collected

The cities selected for research should have good conditions for outdoor activities. For example, climate, social security, economic conditions, etc., so that the influence from the non-physical spatial environment can be excluded. There should be a strong land use conflict and an aging crisis. There is a strong demand for space-adapted aging transformation. The study of space aging in this case is conducive to resolving the pressure on space use brought about by the more serious aging crisis in the future. As a city with a high level of development, it is also easy to have a benchmarking effect on other cities in China, and the research results have a greater practical value.

Dalian is located in the southernmost part of Northeast China and is surrounded by the sea on three sides (Figure 4-1). The climate in Dalian is generally comfortable and the air is relatively humid, which is very favorable for recuperation and healing. Dalian has received the UN Habitat Award and is considered one of the most livable cities in China (Zhang W.Z. et al.,2021) . It is also one of the top 10 most suitable cities for retirement in China. As of 00:00 on November 1, 2020, the resident population of Dalian was 7,450,700. Of the 21 cities in the country with a mega population of over 7 million, Dalian ranks first in terms of the percentage of people over 60 years old(Figure 4-2)! Dalian's aging rate is relatively serious.

In China's high-density residential environment, most empirical studies on the environment and the health of the elderly have focused on first-tier cities such as

Beijing and Shanghai. Relatively few studies have been conducted on non-Tier 1 cities with special geographical environments. This reality makes it necessary to conduct a geographically specific community-based aging study for Dalian.

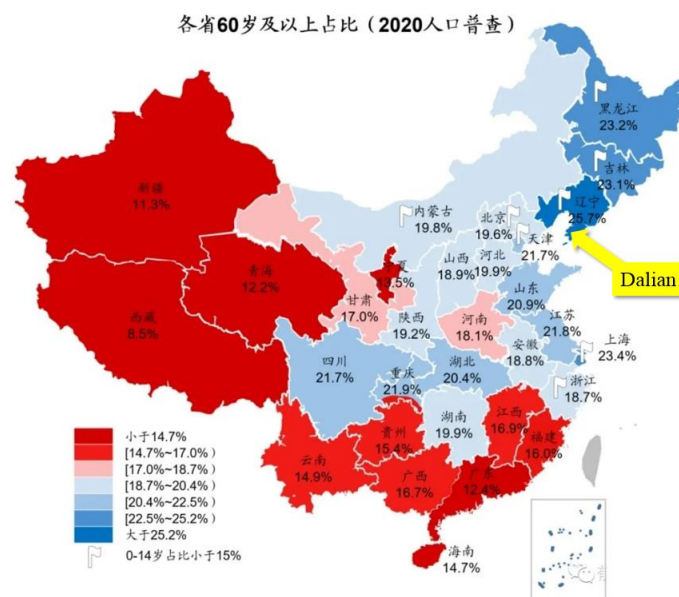


Figure 4-1. Proportion of over 60 years old by Province. 2020 Census (Source: National Bureau of Statistics)

City	Population (10000)	Including: urban population (10000)	Sex ratio (female =100)	0 to 14 years old population proportion (%)	15 to 59 years old population proportion (%)	Population over 60 years old (%)
上海市	2487	1987	107.33	9.80	66.82	23.38
北京市	2189	1775	104.65	11.84	68.53	19.63
深圳市	1749	1744	122.43	15.08	79.59	5.33
重庆市	3205	1634	102.21	15.91	62.22	21.87
广州市	1868	1488	111.98	13.87	74.72	11.41
成都市	2094	1334	101.03	13.28	68.74	17.98
天津市	1387	1093	106.31	13.47	64.87	21.66
武汉市	1245	995	108.07	13.05	69.72	17.23
东莞市	1047	956	130.06	13.12	81.41	5.47
西安市	1218	928	104.53	15.54	68.41	16.05
杭州市	1194	874	108.67	13.02	70.12	16.87
佛山市	950	854	119.12	15.10	74.37	10.52
南京市	931	791	104.27	12.75	68.27	18.98
沈阳市	907	707	99.38	11.40	65.36	23.24
青岛市	1007	601	103.90	15.41	64.31	20.28
济南市	920	588	100.50	16.44	63.60	19.96
长沙市	1005	555	102.49	16.64	68.03	15.33
哈尔滨市	1001	550	100.09	10.46	67.56	21.98
郑州市	1260	534	105.44	19.05	68.11	12.84
昆明市	846	534	104.74	14.98	70.62	14.40
Dalian 大连市	745	521	99.19	11.65	63.64	24.71

Figure 4-2. Population of megacities and megacities in the Seventh National Population Census (Source: National Bureau of Statistics)

4.1.2 The time when the information is collected

Information collection season. Experiments by Kansas State University and ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) have shown that the human body feels most comfortable at temperatures around 25°C. Temperature can have a significant effect on the frequency, length of stay, and content of outdoor activities of older adults (Li Z.Y.,2013). During more extreme weather periods, the frequency and length of stay of older adults will be greatly reduced and the number of activities will be relatively less, while the opposite is true for suitable periods (Cai Qing,2009). Choosing a time of moderate temperature and suitable for outdoor activities for the study can, on the one hand, exclude the interference of weather on respondents' subjective needs, and on the other hand, reach more active people and obtain more comprehensive information. Li Dihua et al. (1999) conducted a study on the use of community parks by the elderly, and the results confirmed the tendency of the elderly to go out at times when the outdoor environment is suitable.

Dalian is an important central city, port, and scenic tourist city on the north coast of China. It has a temperate monsoon climate, with no severe cold in winter and no scorching heat in summer, and pleasant temperatures. Meteorological data show that the average monthly temperature in Dalian is close to 20°C from April to May, so the field study of this study was conducted during this period. The specific research period was from April 18 to May 10, 2022, when the weather was clear.

Information collection period. Different times of the day (morning, afternoon, evening, and night) can also have an impact on outdoor activities. For example, studies by Tacken (1998) and Collia (2003) concluded that older adults' travel time is mainly concentrated between 9:30 am and 3:00 pm. Older adults who travel for leisure and fitness purposes have a relatively early departure time (Zhang Z. et al.,2011). Therefore, the time periods of this paper are 9:00-11:00, 15:00-17:00, and 18:00-20:00, from the morning when the activity starts to the evening when it ends, so as to exclude the interference of subjective demand caused by the time difference.

4.1.3 The sample community where the information is collected

Based on the definition of the concept of community in 2.2.1, the community selected for this study needs to have a high number of older adults in it to ensure the richness of the information provided. There is a need to provide a rich and diverse range of activities to facilitate analysis of the characteristics of the activities. The presence of closed and open settlements and the diversity of settlement patterns need to be ensured to facilitate comparative studies. Need to present a distribution of high, medium and low quality tiers. Select communities with different degrees of newness and age. Facilitate cross-sectional comparative study of the differential effects of different construction times and different environmental factors on outdoor activities with the

elderly.

Table 4-1. Age composition of population in each area of Dalian City (Source: Dalian Municipal Bureau of Statistics)

Age composition of population in Dalian (%)				
District	0-14 years old	15-59 years old	Over 60 years old	Over 65 years old
Dalian	11.65	63.64	24.71	16.87
Zhongshan	11.67	62.39	25.93	17.72
Xigang	10.85	62.22	26.93	18.32
Shahekou	10.79	62.31	26.91	18.59
Ganjingzi	13.00	65.54	21.47	14.01
Lushunkou	10.08	65.28	24.65	17.16
Jinpu New District	13.13	67.34	19.53	13.36
Pulandian	9.92	58.67	31.41	22.08
Changhai County	8.91	64.54	26.55	18.49
Gaoxin	12.50	72.52	14.98	9.72
Changxing Island	13.94	65.45	20.61	14.82
Wafangdian	11.10	58.66	30.24	20.86
Zhuanghe	9.31	59.41	31.27	21.61

In this paper, three case communities were selected for information collection in Shahekou District, which has a more concentrated distribution of elderly population in Dalian city (Table 4-1). Shahekou District is located in the western part of Dalian city, with a total area of 48.32 km². There are 90 communities within it. Among them, Xinghai Family Community (XH) is a gated community. Happy e Home Community (XF) is a group gated communities. The closed communities are normally inaccessible and the public service facilities therein are only available to residents within the settlement. Mixed open community (HS), in which residential buildings in the community are gated and public service facilities and activity sites are open (Figure 4-3, Table 4-2).



Figure 4-3. Three sample communities selected from Shahekou District, Dalian City (Source: <https://map.qq.com/>)

Table 4-2. Sample Community Details

Community	Time for completion	Area occupied	Greening rate	Number of Households	Total buildings	Type characteristics
XH community	2004	220000 m ²	51%	2078	69	Gated
XF community	2009	249000 m ²	45%	3313	55	Group Gated
HS community	1990	110000 m ²	25%	3352	51	Mixed Open

4.1.4 Information collection schemed to design

In the information collection of the basic data of this study model, the objective status of the community and the number of elderly activities on the site were obtained through data collection and on-site observation.

① Observation of the objective status of community outdoor sites.

We designed the "Objective Status of Community Outdoor Space Usage Statistics Form" (Table 4-3) to initially record the status of outdoor functional space, facility configuration, landscape and greenery, and site maintenance in the residential area (Appendix 4).

Table 4-3. Objective Status of Community Outdoor Space Usage Statistics Form

X Community Area X			
Classification	Specific content	Judgment criteria	Detailed description
Site conditions	Site area estimation	___m ²	Proportion of hard blanket area in total area___%; Proportion of grassland/landscape area in total area___%
	Whether the site topography is undulating	With/without	
	Site openness / privacy density	Open / Private / Suitable	
	Whether there is space for parent-child activities	With/without	
	Whether there is parking occupation	With/without	
Facilities condition	Number of recreation and fitness facilities	Number	Fitness equipment___, chess tables and chairs___, courts___.
	Availability of shade/rain shelter facilities	With/without	
	Availability of lighting facilities	With/without	
	Accessibility design	With/without	
	Number of resting	Number of standard	Alternative seat (flower-

	facilities	seats	stand, pool edge, etc.) with/without
Landscape conditions	Availability of public toilets	With/without	
	Guidance signage facilities	With/without	
	Sculpture Landscape	With/without	
	Water Landscape	With/without	
	Bird activity	With/without	
	Shrub species	Rich/monotonous	
	Tree Species	Rich/monotonous	
Road conditions	Road accessibility	Short / winding route Unobstructed/difficult to walk, obstacles	
	Safety of the road		
	Separation of pedestrian and vehicle traffic	Yes/No	
	There is parking occupation	Yes/No	
Maintenance conditions	There are many ramps and steps	Yes/No	
	Trash cans	With/without	
	Site Maintenance	With/without	
	Site trash	With/without	

② Observation of the number of elderly activities in outdoor sites.

The observation of the number of elderly activities in each site in the community was carried out in two ways: squatting on the site and aerial photography by drones (Figure 4-4). The number of instantaneous activities in each site was counted (Table 4-4). All the elderly people who were doing activities on the site were considered as elderly people with the ability to do outdoor activities. Whether elderly people have inherent diseases and whether the degree of diseases will have an impact on the ability of leisure activities are not discussed here. In terms of the statistics of activity items, all older adults who stay or pass through the site are likely to be older adults who are participating in the activity. In this study, when counting the use of the site by older adults, only the number of older adults accommodated by the instantaneous site can be used as the statistical target.

Table 4-4. Statistical table of community elderly people's outdoor activities

X community / Survey Date: / Weather/°C		Area X				Area ...							
Activity group classification	Type of outdoor activities	9:00-	11:00-	15:00-	17:00-	18:00-	20:00-	9:00-	11:00-	15:00-	17:00-	18:00-	20:00-
Elderly	Walking, dogs												
	Sit still												
	Chat												
	Bask in the sun												
	Chess												
	Views												

Play with grandchildren
Fitness exercise
Dance and sing
Total number of elderly people
Number of Adults
Number of Children
Total number of people in each region

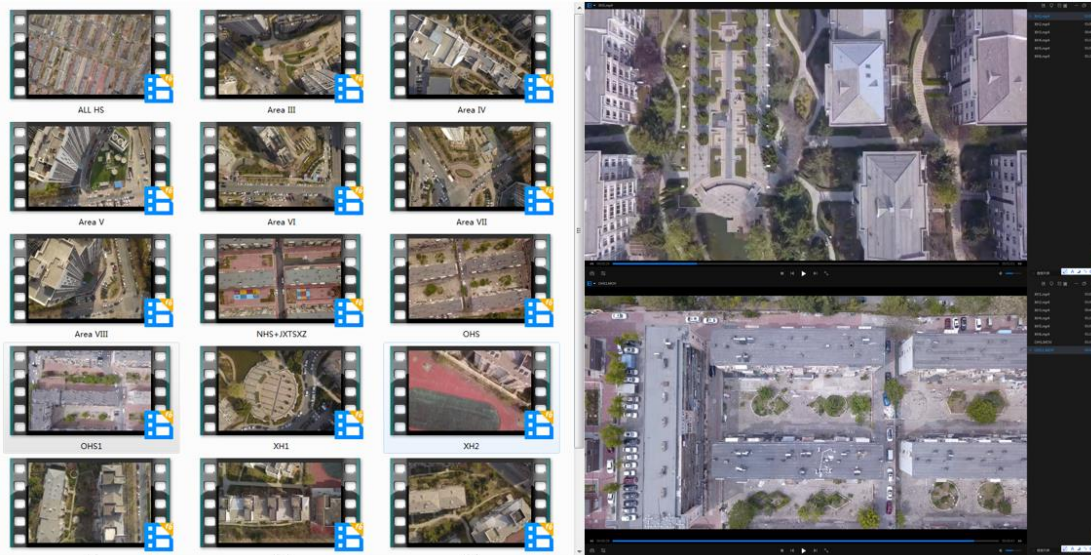


Figure 4-4. UAV aerial photography data (Source: author)

③ Observation data.

The statistics of the number of elderly people using the outdoor sites in each community mainly include the statistical table of outdoor activities of elderly people in the community by time, together with the map of outdoor activities of community residents, and the statistical table of the minimum size demand of outdoor activity sites of community residents. This provides a strong basis for analyzing the size characteristics of outdoor activity sites for the elderly (Appendix 4).

It should be noted that the area of the site used for each type of activity was estimated by multiplying the area of space stretched during individual activities by the peak number of people. The area of space stretched during individual activities is referred to as the Technical Requirements for Urban Community Sports Facilities (JG/T 191-2006).

4.1.5 Sample community residents outdoor activities field survey

① **XH community.** Gated community. As shown in Figure 4-1, the inner activity space consists of several small activity places and a large central square.



Figure 4-5. Map of XH community residents' outdoor activities (Source: author)

Table 4-5. Proportion of activity area demand of the elderly in each area of XH community

XH community	Area A	Area B	Area C	Area D	Area E
Peak number of older adults	45	1	2	21	27
Activity area of the elderly	147 m ²	3 m ²	10 m ²	53 m ²	164 m ²
Peak number of adults	33	1	4	4	13
Area for adult activities	99 m ²	3 m ²	12 m ²	12 m ²	39 m ²
Peak number of children	59	2	3	3	20
Area for children's activities	177 m ²	6 m ²	9 m ²	9 m ²	60 m ²
Summary of peak numbers	137	4	9	28	60
Area occupied by residents' activities	423 m ²	12 m ²	31 m ²	74 m ²	263 m ²
Proportion of site demand for the elderly	34.8%	25%	31.2%	71.6%	62.4%

From the results of the peak number of people in XH community and the map of residents' outdoor activities (Figure 4-5, Table 4-5). Area A (137 people) is the community center square, which gathers the largest number of people. The area is composed of a circular square, a central pond and a rectangular landscape sculpture promenade. The site environment attracts residents to outdoor activities. Area E (60 people) is the sports area of the community, with activity areas such as tennis courts, practice courts and fitness equipment, which is also a more attractive activity place for

residents. Among them, areas B (4 people) and C (9 people) outdoor environment is not attractive to residents. The percentage of outdoor space for seniors in the five regions, Region D (71.6%) has the highest demand for outdoor space for seniors. Region E (62.4%) was the next highest.

Details of the outdoor activities of the elderly are shown in the attached table (Appendix 4). Region A and Region E have more seniors active in the morning hours and Region D has more seniors active in the afternoon hours.

② **XF community.** This type of community is a grouped gated community. Each cluster is small and the clusters are close in form. The internal activity space as shown in the figure consists of several small, scattered activity spaces.

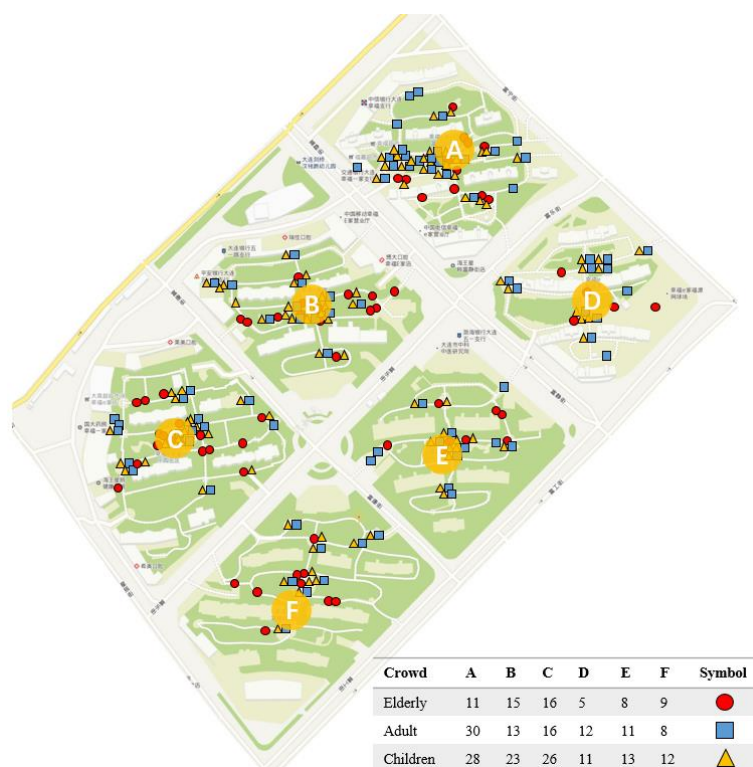


Figure 4-6. Map of XF community residents' outdoor activities (Source: author)

Table 4-6. Proportion of activity area demand of the elderly in each area of XF community

XF community	Zone III A	Zone IV B	Zone V C	Zone VI D	Zone VII E	Zone VIII F
Peak number of older adults	11	15	16	5	8	10
Activity area of the elderly	46 m ²	51 m ²	52 m ²	24 m ²	26 m ²	30 m ²
Peak number of adults	30	13	16	12	11	8
Area for adult activities	90 m ²	39 m ²	48 m ²	36 m ²	33 m ²	24 m ²
Peak number of children	28	23	26	11	13	12
Area for children's activities	84 m ²	69 m ²	78 m ²	33 m ²	39 m ²	36 m ²
Summary of peak numbers	69	51	58	28	32	30
Area occupied by residents' activities	220 m ²	159 m ²	178 m ²	93 m ²	98 m ²	90 m ²
Proportion of site demand for the elderly	23%	32%	29.2%	25.8%	26.5%	33.3%

From the results of the peak number of people in XF community and the map of residents' outdoor activities (Figure 4-6, Table 4-6), we can see that Zone III A (69 people), Zone IV B (51 people) and Zone V C (58 people) have relatively more outdoor activities. Zone VI D (28 people), Zone VII E (32 people) and Zone VIII F (30 people) have relatively less outdoor activities. The situation of outdoor activity areas for the elderly is the same as the overall situation of residents. None of the activity sites had a high demand.

Details of the outdoor activities of the elderly are shown in the attached table (Appendix 4). Zone VI D, Zone VIII F have more elderly people active in the morning hours, Zone IV B, Zone V C, Zone VII E have more elderly people active in the afternoon hours. Only Zone III A has more elderly people active in the evening.

③ **HS Community.**

This part of the area is a combination of 3 old mixed open communities. Among them, Nanping Garden (A) and Jinxiu Taishan Xiaozhu (C) are semi-closed communities with small community size and fence enclosed around the periphery of the community. Houshan Community (B, D, E) are open community with large community size. These three community areas are collectively called HS Community, and there are no dedicated recreational areas or landscaped areas in and around the community. The elderly living in this area gather at the entrance of the building or at the access road of the community. The map also shows that there are no places for activities and gatherings in the surrounding area. Walking is only possible in the streets of the community.

At the beginning of 2021, with the support of Dalian municipal government and local community management, the renovation of old neighborhoods was fully carried out. According to the actual situation of the old neighborhood, we will implement infrastructure renovation of road square tiles, drainage, green, lighting, fitness equipment, seats, drying racks, garbage collection and storage in the courtyard of the neighborhood. (<http://dl.bendibao.com/news/2022128/70747.shtm>)

HS Community happens to be one of the renovated communities. The areas covered in red (B, D) are renovated areas, and area E is an unrenovated area (Figure 4-7). Just formed the same community transformation before and after the contrast of the situation. In order to easily identify the unrenovated area as Old HS labeled OHS, and the renovated area as New HS labeled NHS.

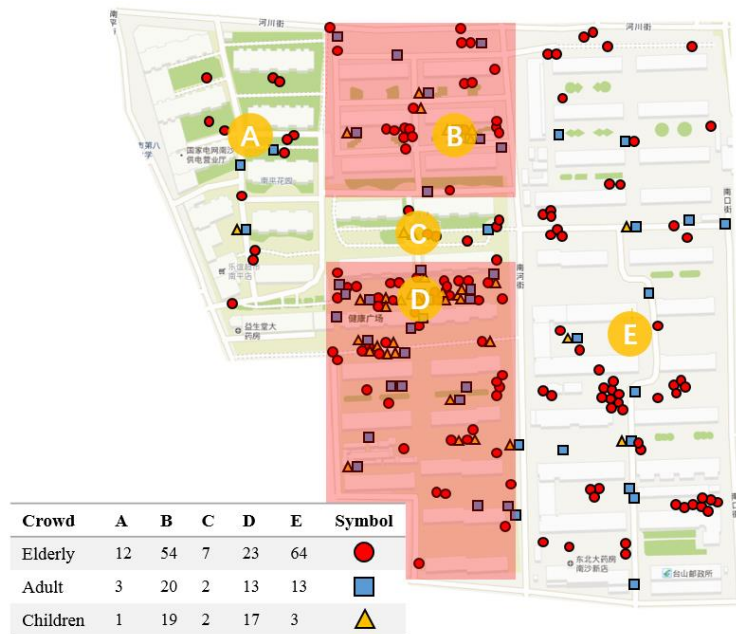


Figure 4-7. Map of Mixed community residents' outdoor activities (Source: author)

Table 4-7. Proportion of activity area demand of the elderly in each area of Mixed community

Mixed community	NP A	JX C	HS B	Health Plaza D	HS E
			NHS	OHS	OHS
Peak number of older adults	12	7	54	23	64
Activity area of the elderly	36 m ²	23 m ²	224 m ²	101 m ²	216 m ²
Peak number of adults	3	2	20	13	13
Area for adult activities	9 m ²	6 m ²	60 m ²	39 m ²	39 m ²
Peak number of children	1	2	19	17	3
Area for children's activities	3 m ²	6 m ²	57 m ²	51 m ²	9 m ²
Summary of peak numbers	16	11	93	53	80
Area occupied by residents' activities	48 m ²	35 m ²	341 m ²	191 m ²	264 m ²
Proportion of site demand for the elderly	75%	65.7%	65.7%	52.9%	81.8%

From the results of the peak number of people in Mixed community and the map of residents' outdoor activities (Figure 4-7, Table 4-7).

The NHS areas (B and D) gather a large number of people. Among them, area D is a community fitness square with more fitness equipment and ping pong tables, and the site environment attracts residents to outdoor activities. Area A (12 people) and Area C (7 people) have fewer residents for outdoor activities, and the outdoor environment is not attractive to residents. The percentage of the outdoor activity area for the elderly in the five areas is higher than 50%, and the demand for outdoor activities for the elderly in OHS area E is as high as 81.8%.

Details of the outdoor activities of the elderly are shown in the attached table (Appendix 4). Areas A, B, and E have more seniors active in the morning hours. Area C has more seniors who are active in the afternoon. Area D has more elderly people who are active in the evening.

4.2 Structured Questionnaire

4.2.1 Questionnaire model and technical route

The content of the questionnaire mainly includes two aspects of personal characteristics and site characteristics. The personal characteristics were divided into three parts: personal information, physical condition and activity habits. The site characteristics consisted of two parts: satisfaction with site supply measured by the Likert scale method and demand for elderly activity sites measured by the SD method (Figure 4-8).

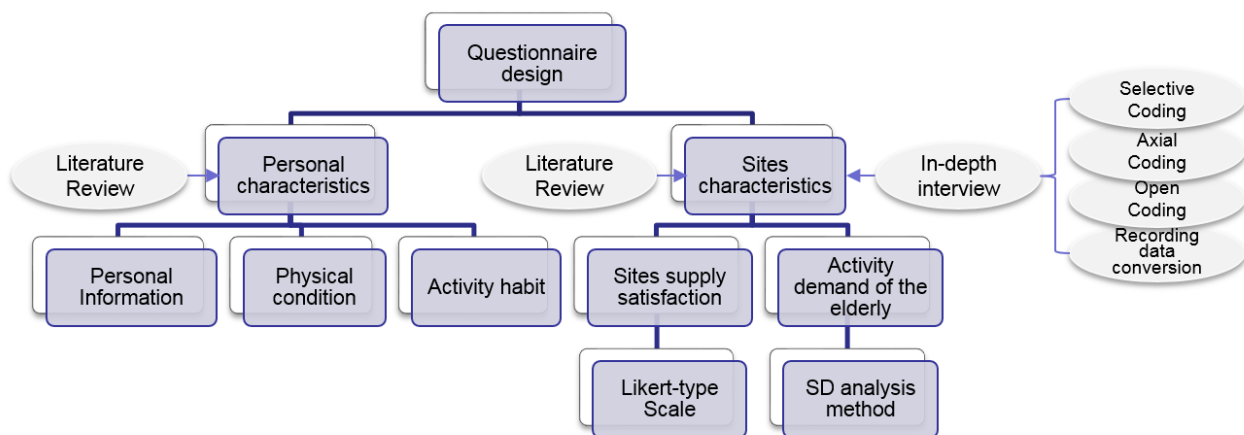


Figure 4-8. Questionnaire model and technical route

4.2.2 Questionnaire Composition

Socio-demographic information. This includes gender, age, educational level, employment condition, occupation before retirement, monthly income, living status, residence model, period of residence, floor of home, elevator condition.

Assessment of physical condition. Subjects were asked to rate their physical condition, assistance needed for outdoor activities, conditions affecting outdoor activities, number of times they went out daily, and length of stay in outdoor activities per day.

Assessment of outdoor activity habits. This included the time period of outdoor activity, the place of activity, the content of the activity and the reason for infrequent activity in the residential area, as well as which type of activity was preferred (group activity with more than 5 people/small activity in a group of 3-5 people/two people together/alone) and the distance to the outdoor activity site.

To assess satisfaction with the supply of outdoor environment in the current residential

community. The Likert scale method was applied. It consists of five answers: dissatisfied, somewhat dissatisfied, irrelevant, somewhat satisfied, and satisfied, with a rating scale of 5 (1, 2, 3, 4, 5, the higher the score the better the evaluation).

To assess the degree of demand for outdoor activities in ideal communities among older adults. The semantic difference method (SD) was applied. 25 pairs of adjectives were formed for different environmental factors and rated on a 5-point scale (1, 2, 3, 4, 5, the higher the score, the better the rating).

4.2.3 Data analysis

All participants had to be over 60 years old. Prior to data collection, a protocol experiment and questionnaire were administered to 10 older adults, and based on the results, unclear or vague statements from these questions were adapted to corresponding words that were more easily understood by older adults. Some fill-in-the-blank questions were adapted to multiple-choice questions about older adults to answer.

A total of 321 elderly people completed the questionnaire, resulting in a final sample of 310 for analysis, with a validity rate of 96.57%. The 11 invalid questionnaires, which were those with incomplete basic information or missing items in the response process, were excluded from the statistics.

After initial processing of the scale findings, for valid questionnaire collection data were entered into SPSS 23.0 software. Frequency analysis was performed to analyze the socio-demographics of the sample and to describe the characteristics of the participants. Reliability and validity tests were also conducted to examine the reliability of the collected data.

① From the socio-demographic frequency analysis (Table 4-8), it is clear that 65.8% of the sample is female in majority. The highest percentage of "60-69 years old" was 62.6%. The proportion of "Junior middle school" and "High middle school and Vocational study" was close to about 28%. 88.4% of the elderly were not working. The percentage of "enterprise staff" was 32.9%. 29.7% of the sample were "2000~3000 CNY". More than 50% of the sample were "Living together with their spouses". More elderly people in the sample live in "Gated communities", and 31% had lived in their current residence for "Over 16 years". The highest percentage of seniors living in "4th~10th floors" was 46.8%. The percentage of seniors without elevator in the building is 58.7%.

Table 4-8. Descriptive characteristics of the sample (n= 310).

Classification	Classification Level	Frequency	Percent	Mean	Std. Deviation
Gender	Male	106	34.2%	1.66	0.475
	Female	204	65.8%		
Age	60-69 years old	194	62.6%	1.54	0.786
	70-79 years old	73	23.5%		
	80-89 years old	36	11.6%		
	Over 90 years old	7	2.3%		
Educational level	Primary school and below	54	17.4%	2.74	1.236
	Junior middle school	89	28.7%		
	High middle school and vocational study	87	28.1%		
	Junior college	44	14.2%		
Employment condition	Bachelor's degree and above	36	11.6%	1.88	0.321
	Employed	36	11.6%		
Occupation before retirement	Not employed	274	88.4%	3.38	1.622
	Civil servants and managers	39	12.6%		
	Employees of public institutions	58	18.7%		
	Enterprise staff	102	32.9%		
	Self-employed	22	7.1%		
	Farmer	36	11.6%		
	Others	53	17.1%		
Monthly income	Less than 1000 CNY	27	8.7%	3.61	1.534
	1000~2000 CNY	46	14.8%		
	2000~3000 CNY	92	29.7%		
	3000~4000 CNY	55	17.7%		
	4000~5000 CNY	35	11.3%		
	Over 5000 CNY	55	17.7%		
Living status	Living alone	48	15.5%	2.41	1.041
	Living together with their spouses	158	51%		
	Living together with their children	44	14.2%		
	Three generations under one roof	49	15.8%		
	Others	11	3.5%		
Residence model	Gated community	92	29.7%	2.24	1.240
	Group type gated community	85	27.4%		
	Mixed open community (Renovated)	74	23.9%		
	Mixed open community (Unrenovated)	59	19%		
Period of residence	1-5 years	71	22.9%	2.58	1.151
	6-10 years	84	27.1%		
	11-15 years	59	19%		
	Over 16 years	96	31%		
Floor of home	1st~3rd floors	124	40%	1.75	0.720
	4th~10th floors	145	46.8%		
	11th~20th floors	26	11.6%		
	More than 21 floors	5	1.6%		
Elevator condition	Yes	128	41.3%	1.59	0.493
	No	182	58.7%		

② Reliability test.

To test the true reliability of the sample data, i.e., whether the respondents truly answered the questionnaire measure items, reliability analysis is to be conducted. In this paper, Cronbach's Alpha reliability coefficient (Cronbach's Alpha coefficient should be greater than 0.7, indicating that the internal consistency of the data is barely acceptable) is used to determine the reliability level of the data collected by the questionnaire, and the specific values are shown in Table 4-9. In this reliability test, the standardized Cronbach's Alpha coefficient is 0.971, which is greater than 0.9, indicating that the overall reliability quality of the questionnaire is very high.

Table 4-9. Reliability Statistics

Dimension	N of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Hotelling's T-Squared	F	df1	df2	Sig.
Overall	50	.971	.972	554.692	9.562	49	261	.000
Satisfaction	25	.976	.976	290.793	11.214	24	286	.000
Demand Degree	25	.964	.967	250.171	9.648	24	286	.000

③ Validity test.

Through the study of related literature, we summarized the factors and characteristics of the community outdoor environment to support the activities of the elderly and designed the semantic measurement items of the questionnaire accordingly. According to the KMO and Bartlett's spherical test, the overall KMO coefficient of the questionnaire is greater than 0.7, Sig.<0.000, and less than 0.1. Bartlett's spherical test shows that the data are independent of each other to a certain extent, and the data are qualified for factor analysis. Therefore, the research questionnaire of this study is reasonably designed, and the sample data have strong applicability to the measurement of relevant issues.

Table 4-10. KMO and Bartlett's Test

KMO Measure of Sampling Adequacy.		0.951
Bartlett's Test of Sphericity	Approx. Chi-Square	16590.062
	df	1225
	Sig.	0.000

Based on the above results (Table 4-10), we can see that the result of KMO test is 0.951, this value is higher than 0.9, the validity of the study data is very good. The coefficients of the KMO test range from 0 to 1. The closer to 1 means that the validity of the questionnaire is better. It can also be seen based on the significance of the sphericity test. The significance of this test is infinitely close to 0. The original hypothesis is rejected. So the questionnaire has good validity.

4.3 Summary

The data required for the research model in this paper are all from actual cases, and the ability to meet the modeling data needs and exclude all unnecessary data interference is the key to case selection.

Dalian's good urban environment and outdoor activity conditions, coupled with strong land use conflicts and aging crisis, the results of the study will serve as a benchmark for other cities in China. The three case communities in Shahe Kou District meet the criteria for selecting the case communities in terms of their exemplary role, outdoor activity conditions, the abundance of outdoor activity sites, and the number of the elderly population.

The case information collection scheme was the on-site observation of objective community conditions and on-site observation of the number of senior citizens' activities in the sites, and the processing of actual measurement data in each community. In general, the XH community center's large site is the most attractive to all residents except for the elderly. The size of outdoor activity sites required by seniors in Region D and Region E accounted for more than 60% of the overall demand. the number of seniors active in each region of the XF community was closer and the percentage of seniors' venue demand was not high in any of the regions. the analysis of the Mixed community survey found that the government's policy of renovating outdoor environments in older communities was effective and necessary. The number of outdoor activities in the renovated NHS areas is significantly higher than in the non-renovated OHS areas. The demand for outdoor activities of elderly people in Mixed communities is generally higher than other groups, especially in unrenovated areas OHS. for areas with high demand for elderly sites, it is recommended that at least 2/3 of outdoor activity sites need to be renovated with age-appropriate design to meet the needs of elderly people.

The questionnaire was constructed on the basis of relevant literature combined with the collection of example information. The structured questionnaire collected socio-demographic information. Physical function was assessed, outdoor activity habits were assessed, satisfaction with the outdoor environment in the residential community was assessed, and the degree of need for an ideal community was assessed. As the content of the questionnaire was specifically set for the current study, an overall reliability test was conducted. The overall credibility quality of the questionnaire was very high, and the validity of the research data was very good. The research questionnaire of this study was well designed, and the sample data had strong applicability to the measurement of the relevant questions.

From the on-site observation of objective conditions in each community and on-site observation of the number of elderly activities in the site, further research is needed to address the relationship between the supply and demand of community outdoor sites,

the matching of people and the environment in the community environment and the evaluation system of community outdoor sites that meet the activities of the elderly.

Chapter 5.

Supply and demand model of outdoor sites in urban communities

Based on the theory of supply and demand balance, this chapter constructs the supply and demand model of outdoor sites in urban communities, analyzes the relationship between the supply capacity of outdoor sites in communities and the activity demand of the elderly and elaborates the supply and demand matching characteristics of various environmental factors of outdoor sites in communities. Modeling is divided into three steps (Figure 5-1) , details are as follows:

Step 1: Model construction and connotation analysis. Elaborate outline of supply and demand balance theory. The evaluation matrix of supply and demand matching and the calculation of supply and demand matching index are analyzed.

Step 2: Based on the questionnaire survey, the Likert scale Method and Semantic Differential Method (SD) are used to determine the supply and demand matching relationship of 5 major categories of environmental factors and 25 subcategories of environmental factors, and identify the environmental factors that support outdoor activities of the elderly.

Step 3: Analysis on the characteristics of environmental factors in the supply and demand balance of the sample communities. Through the scatterplot and combined with field observation photos, the matching situation of the supply and demand of environmental factors in the outdoor sites of the sample communities is discussed in depth.



Figure 5-1. Chapter 5 Research steps

5.1 Model construction and theoretical analysis

5.1.1 Model construction and connotation analysis

Since the community outdoor sites is the supplier of the environment and the activity demand of the elderly is the demand side, the supply and demand entities are related to each other. When the elderly carry out various activities in community outdoor sites, they may think that the environmental facilities are deficient, but they still carry out activities for their own needs. However, there is subjective demand willingness to change the current situation of the activity site, which is manifested as the environmental demand degree of individual activities. The supply level of environmental factors in community outdoor sites reflects the allocation of environmental supply through specific indicators, that is, the degree of environmental supply. The matching situation of supply and demand obtained from the assessment is a key indicator reflecting the quality of environmental support for outdoor activities of the elderly in communities and the efficiency of resource allocation. The higher the supply and demand matching index, the better the supply and demand relationship is. Based on this study, a supply and demand model of outdoor sites in urban communities is built (Figure 5-2).

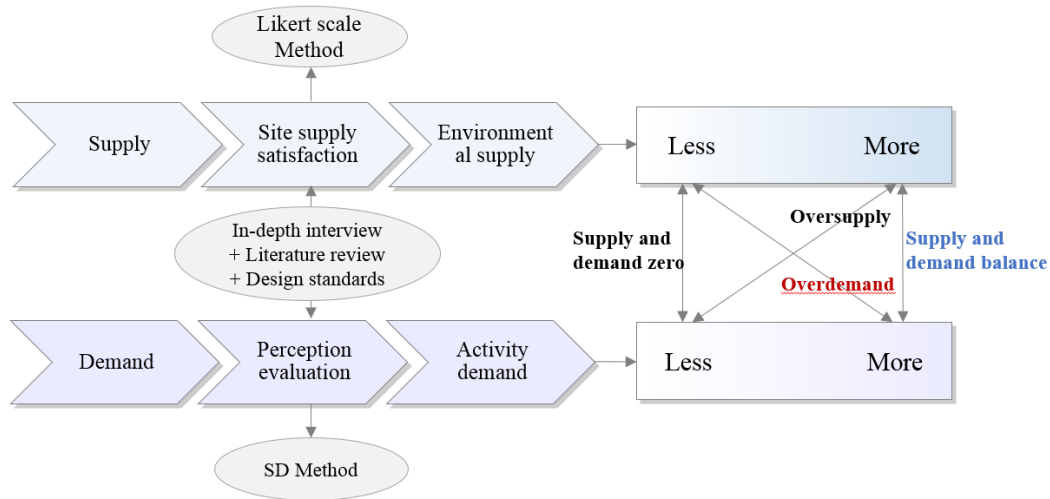


Figure 5-2. Supply and demand model of outdoor sites in urban communities

The model is based on a questionnaire survey. In the measurement of the supply degree of outdoor environmental factors in communities, the Likert scale Method is used to measure the satisfaction of the elderly with the outdoor environment of the current residential communities. In the measurement of the demand degree of the elderly, the Semantic Differential Method (SD) is used to measure the demand degree of the elderly for the ideal outdoor environment in communities. By combing previous research literature, in-depth interviews, field surveys and combining with design standards and

cooperating with the supply and demand matching index analysis matrix, jointly evaluate and measure the supply and demand matching of environmental factors (Li Y.H. et al.,2018; Wu S.Y. et al.,2019). The connotation of the matching index of relevant environmental factors is explained as follows:

① **Supply and demand balance.** The supply of community outdoor sites and the needs of the elderly have reached a high matching. Such an environment can give full play to the support value of activities. Attention should be paid to the supply of such environmental factors.

② **Oversupply.** There are too many such environmental configurations in the outdoor sites of communities, resulting in dislocation with the actual activity demand of the elderly. The elderly have low or no demand for such environment during activities. The configuration of relevant environmental factors should be reduced to avoid resource waste.

③ **Supply and demand zero.** The configuration level of environmental factors that the elderly do not pay attention to or have low demand in activities and the configuration of community outdoor sites is also low should be reduced.

④ **Overdemand.** The allocation of environmental factors in the community outdoor sites is too low to meet the needs of the elderly for the environment. Emphasis should be placed on improving the allocation of relevant environmental factors.

5.1.2 Supply and Demand Balance theory

The matching relationship between supply and demand is an important analytical theory in economics. It refers to the relationship between supply and demand under the condition of commodity economy. It reflects the restriction and relevance of production and consumption in the market.

At first, the research on the satisfaction of service supply and demand only focused on one-dimensional quality or satisfaction evaluation(Chen B.,2008) (Figure 5-3). Then, it was inspired by the two-factor theory of Herzberg, a behavioral psychologist. Noriaki Kano, a professor at Tokyo University of Science, introduced satisfaction and dissatisfaction into quality related fields for the first time to analyze the impact of user demand on user satisfaction and reflect the nonlinear relationship between product performance and user satisfaction. Therefore, a two-dimensional quality model was proposed, that was, Kano model. According to the relationship between different types of quality characteristics and customer satisfaction, the factors that affect the quality of products and services are divided into five categories: basic demand, expectation demand, charm demand, undifferentiated demand and reverse demand (Figure 5-4).

As an important public space for daily activities of the elderly, urban community outdoor sites also face the severe problem of mismatch between supply and demand. To sum up, this study holds that the principle of "supply and demand matching" of urban community outdoor sites is similar to that of private products.

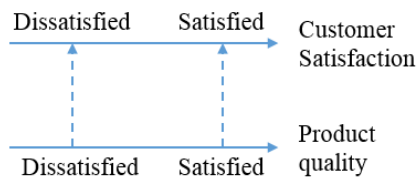


Figure 5-3. One-dimensional quality perception cognitive model (Source: author)

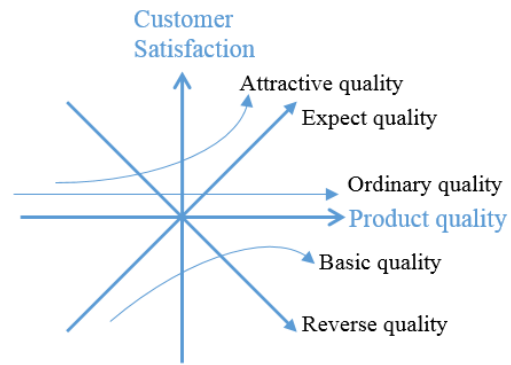


Figure 5-4. KANO Quality Model (Source: author)

5.2 Supply and demand matching evaluation matrix and calculation analysis

5.2.1 Supply and demand matching evaluation matrix

The relationship between supply and demand of urban community outdoor sites environment is jointly determined by environmental supply and activity demand factors of the elderly. By analogy to the research on supply theory and demand theory in economics, the research on supply and demand matching of environmental factors focuses on the same issues in essence, both of which focus on the service provided by the supplier to meet the needs of the user groups, so as to maximize the benefits (He JX. et al.,2015).

Therefore, based on Pigou model and similarity theory, this study improved "Important Performance Analysis" (IPA) analysis method of Martilla&James(1977), combined with Kano model(Wang J.F et al.,2018; Xu D.Y. et al.,2015; Weng L. et al.,2018), and built a supply and demand matching evaluation matrix of community outdoor environmental factors supporting elderly activities (Figure 5-5). In most cases, the supply and demand situation is reflected by building relevant indicators to measure the supply and demand matching degree of research objects. The higher the supply and demand matching index is, the better the supply and demand relationship will be. Therefore, the research takes the environmental factors of community outdoor site as the research objects, and identify, screen and sort through the supply and demand matching model to explore the characteristics of environmental factors with different matching relationships.

5.2.2 Supply and demand matching matrix calculation analysis

Both the Likert scale Method and Semantic Differential Method (SD) rating scales are 5 levels (1, 2, 3, 4, 5, the higher the score the better the evaluation). The origin of the

evaluation matrix coordinate of the supply and demand matching index is the point where the supply degree=3 and the demand degree=3, and 3 is the reference horizontal line.>3 is relatively good, <3 is relatively poor, and the higher the evaluation is, the more the outdoor environment of the community meets the needs of elderly residents. Specific analysis: (Figure 5-5)

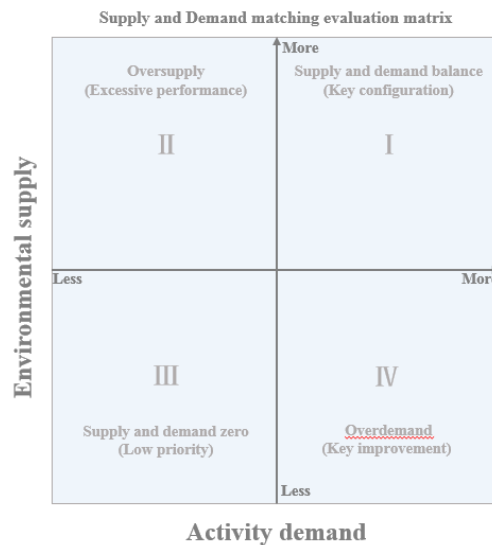


Figure 5-5. Evaluation matrix of matching supply and demand of outdoor sites in urban communities (Source: author)

I. Supply and demand balance (Key configuration). Supply degree >3, demand degree >3. The data is in quadrant I of the matrix, indicating that the supply and demand of environmental factors match. The supply degree of outdoor environmental factors is high, and the demand degree of the elderly outdoor activities is also high, which is the optimal state of supply and demand.

II. Oversupply (Excessive performance). Supply degree >3, demand degree <3. The data is in quadrant II of the matrix. It means that the supply and demand of environmental factors do not match. The supply degree of outdoor environmental factors is too high, and the demand degree of the elderly outdoor activities is too small. It can be explained that when the elderly have low demand for such environment when they carry out outdoor activities, the community environmental supply causes the elderly residents' aversion. That is, the supply of outdoor environmental factors exceeds the demand, wasting resource allocation.

III. Supply and demand zero (Low priority). Supply degree <3, demand degree <3. The data is in quadrant III of the matrix, indicating that the supply and demand of environmental factors match, too. The supply degree of environmental factors is low, and the demand degree for outdoor activities of the elderly is also low. Excessive supply of environmental allocation only wastes outdoor environmental resources, but also affects the quality of activities.

IV. Overdemand (Key improvement). Supply degree <3, demand degree >3. The data is in quadrant IV of the matrix. It means that the supply and demand of environmental

factors do not match. The supply degree of outdoor environmental factors is too small, and the demand degree of the elderly outdoor activities is too high. It can be explained that the elderly believe that such outdoor environmental factors play an important role in promoting outdoor activities and have a strong demand. However, the supply of such environment is poor, which affects the quality of their activities. The subjective image of the elderly also deepens the intention of changing such environment. This quadrant factor is the key improvement factor.

5.3 The matching relationship between supply and demand of outdoor environmental factors

After preliminary processing of the scale findings, the valid questionnaire collection data were entered into SPSS 23.0 for statistical purposes. Reliability and validity tests were also conducted to examine the reliability of the collected data. The results showed (4.2.3) that the research questionnaire of this study was well designed and the sample data had strong applicability to the measurement of the relevant questions.

5.3.1 Matching results and characteristics of supply and demand of 5 environmental factors

According to the in-depth interview in 4.2.4 above, the site environmental factors were sorted out and summarized, and 5 categories of environmental factors and 25 subcategories of environmental factors were determined.

Through the analysis of the questionnaire data, the overall supply and demand matching characteristics of five types of environmental factors (five criteria layers) are analyzed. It can be seen from the analysis that there were only two situations in the relationship between supply and demand of environmental factor categories of community outdoor site suitable for the elderly: I. Supply and demand balance and IV. Overdemand.

Table 5-1. Matching indices of supply and demand of 5 environmental factors

5 environmental factors	Environmental supply	Activity demand
Site	3.275	4.196
Facilities	2.946	3.854
Landscape	3.209	3.995
Road	3.275	4.170
Maintenance	3.335	4.315

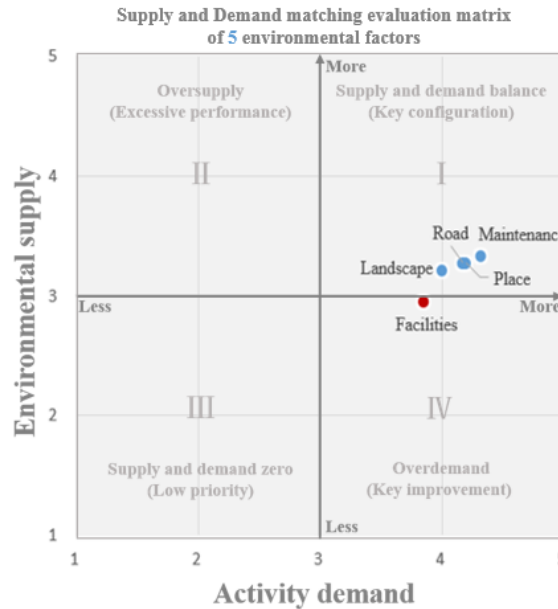


Figure 5-6. Matching matrix analysis chart of supply and demand of 5 environmental factors

As can be seen from Table 5-1, the community outdoor environment supply is more than adequate. The ranking of the five categories of factors environmental supply is maintenance (3.335), site (3.275), road (3.275), landscape (3.209), and facilities (2.946) in order. The demand degree of the elderly is relatively high. The five categories of factors environmental demand ranked in the order of maintenance (4.315), grounds (4.196), roads (4.170), landscape (3.995), and facilities (3.854).

As shown in Figure 5-6, The four categories of environmental factors, including site, landscape, road and maintenance, are in a state of balance between supply and demand, indicating that the current configuration of community outdoor site and the use needs of elderly activities have reached a good matching, and all kinds of environmental factors can play the maximum functional value in the elderly activities. Among them, the environmental supply degree of facilities is low, while the elderly have a high demand for them. The overall situation is in overdemand, indicating that such environment configuration in the community cannot meet the real activity needs of the elderly, which needs to be improved.

5.3.2 Matching results and characteristics analysis of supply and demand of 25 sub-categories of environmental factors

Supply and demand matching data were calculated for 25 subcategories of environmental factors (Table 5-2). It was also combined with the supply and demand matching matrix analysis diagram (Figure 5-7). To reveal the characteristics of different environmental factors of community outdoor.

Table 5-2. Matching indices of supply and demand of 25 subcategories of environmental factors

Label	Environmental factor	Environmental supply	Activity demand	State of supply and demand
C1	Area of activity site	3.33	4.14	Supply and demand balance
C2	Fluctuation degree of activity site	3.36	4.31	Supply and demand balance
C3	Openness of activity site	3.52	4.11	Supply and demand balance
C4	Parent-child activity space	3.32	4.18	Supply and demand balance
C5	Exclusive space for the elderly	2.85	4.24	Overdemand
C6	Recreation and fitness facilities	3.09	3.88	Supply and demand balance
C7	Sun/rain shelter	2.78	3.69	Overdemand
C8	Lighting facilities	2.94	3.96	Overdemand
C9	Barrier-free design	2.89	3.88	Overdemand
C10	Rest facilities	3.13	3.87	Supply and demand balance
C11	Public toilet	2.71	3.92	Overdemand
C12	Signage facilities	3.08	3.78	Supply and demand balance
C13	Sculptures	3.10	3.78	Supply and demand balance
C14	Water &Scape	2.95	3.82	Overdemand
C15	Green planting	3.37	4.33	Supply and demand balance
C16	Flowers and plants	3.27	4.18	Supply and demand balance
C17	Cicadas and birds singing	3.35	3.86	Supply and demand balance
C18	Road smoothness	3.48	4.40	Supply and demand balance
C19	Road safety	3.40	4.39	Supply and demand balance
C20	Separation of passengers and vehicles	3.26	4.37	Supply and demand balance
C21	Road parking	3.01	4.34	Supply and demand balance
C22	Ramp and step	3.22	3.36	Supply and demand balance
C23	Environmental facility maintenance	3.22	4.41	Supply and demand balance
C24	Garbage bin facilities	3.37	4.13	Supply and demand balance
C25	Environmental sanitation	3.42	4.40	Supply and demand balance

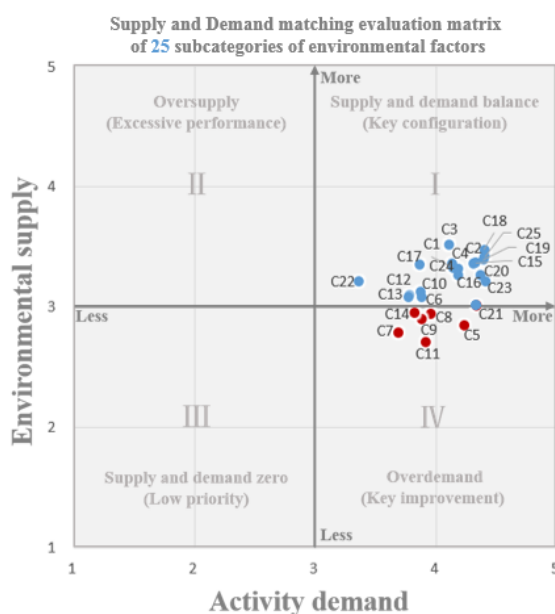


Figure 5-7. Matching matrix analysis chart of supply and demand of 25 subcategories of environmental factors

The results show that there are 19 environmental factors with balanced supply and demand. In general, the supply and demand of these environmental factors have reached a high match. In the future, we can continue to optimize the allocation of these environmental factors to achieve the "place optimization" effected of matching supply and demand. This will effectively promote the development of activities for the elderly and improve the quality of their activities.

Overdemand environmental factors are 6, namely C5, C7, C8, C9, C11, C14. Overall, these 6 environmental factors are not sufficiently supplied, and the demand of the elderly is high, which is the "blind spot" of community outdoor space construction. If we do not effectively improve these environments, it will restrict the activities of the elderly and cause the problem of "lack of space" in empty sites. In the design and construction of community outdoor space, we should focus on improving the quality configuration of such environment.

C5 Elderly exclusive sites. Our country is entering the aging process at a very fast pace and time. Although there are sites available for residents to use outdoors in the community. However, the original sites are unable to meet the activity needs of the elderly as they gradually age. Exclusive sites for the elderly should have a large enough effective activity area as well as more recreational and fitness facilities. At the same time, there should be guaranteed facilities for the sites that can sustain the activities of the elderly for a longer period of time. The type and quantity of facilities in the venue represented the usability and suitability of the outdoor activity space to a certain extent.

C7 Shading / Rain shelter facilities. Elderly people have the habit of sunbathing. It can promote the body's production of vitamin D, which facilitates the absorption of calcium and helps a lot to improve their health. However, there is also a strong demand for this facility. Adding this facility can effectively reduce the exposure of the elderly to the strong summer sun. It can also keep outdoor activities from being immediately terminated when the weather is poor, such as light rain or snow. Therefore, adequate shade facilities can effectively extend the time of outdoor activities for the elderly, and also provide conditions for longer continuous activities (Tan S.H. et al.,2019; Lin G.S. et al., 2019) .

C8 Lighting facilities. Most older adults report not engaging in outdoor activities in the evening after dark around 8:00 pm. This is caused by a mismatch between the decline in individual attributes such as sensory and mobility abilities of older adults and the greater environmental stress. Poor lighting of community outdoor sites may be difficult or even dangerous for older adults (Kwok J Y C. et al., 2008). Therefore, we need to pay special attention to the importance of lighting for outdoor activities of the elderly (Woo J et al., 2010).

C9 Barrier-free design. Walking is the predominant mode of transportation for older adults. Barrier-free design is to reduce the disturbing factors that affect walking trips. For example, maintain the road surface frequently to reduce the slippery section,

expand the width of the trail, reduce the crowdedness of the trail, adopt barrier-free road design, avoid high difference road surface, bumpy road surface, etc. Improve the level of greening on both sides of the trail, and set up escalators or elevators to facilitate the elderly to travel.

C11 Public toilets. The demand for Public toilets among older adults is very high due to their physiological characteristics (Thompson C W, et al., 2008; Temelová J et al., 2012). Through in-depth interviews, we learned about the needs and perceptions of older adults in the sample community regarding Public toilets. Most of the elderly felt the need for Public toilets, not only for the physical characteristics of the elderly, but also for the physical needs of children who are active outdoors. Some seniors expressed their understanding of the absence of Public toilets in the community because they considered that its sanitary maintenance, as well as its location setting, would cause problems to the community management and nearby residents. However, we believe that community planners and designers should still consider outdoor Public toilets as a priority for future community planning and decision making.

C14 Waterscape. is a community landscape environmental factor. Waterscapes are in many cases considered to have an important influence on the use of the site by older people, and there is consensus in many design cases. Corti et al. found that aesthetic satisfaction can influence space use and physical activity (Corti B et al., 1996). Landscaping should be an aesthetic need for older adults after meeting basic needs such as grounds and facilities. The spiritual and cultural needs of the elderly should also be given more consideration in the community to create more possibilities for various outdoor activities to occur.

5.4 Analysis of environmental factor characteristics of supply and demand balance in sample communities

A cross-sectional comparison of the supply and demand matching status of environmental factors of elderly residents in each community was conducted. Each sample community was analyzed by means of a 25-item environmental factor supply and demand matching data calculation table, combined with a supply and demand to match matrix analysis chart. to reveal the characteristics of different environmental factors of outdoor areas in each community.

5.4.1 XH community

Table 5-3. Matching indices of supply and demand of XH community environmental factors

Label	Environmental factor	Environmental supply	Activity demand	State of supply and demand
C1	Area of activity site	4.41	3.29	Supply and demand balance
C2	Fluctuation degree of activity site	4.53	3.35	Supply and demand balance
C3	Openness of activity site	3.94	3.76	Supply and demand balance
C4	Parent-child activity space	4.53	3.76	Supply and demand balance
C5	Exclusive space for the elderly	4.24	3.35	Supply and demand balance
C6	Recreation and fitness facilities	4.47	3.41	Supply and demand balance
C7	Sun/rain shelter	4.53	2.59	Overdemand
C8	Lighting facilities	4.24	2.24	Overdemand
C9	Barrier-free design	4.41	2.59	Overdemand
C10	Rest facilities	4.24	3.12	Supply and demand balance
C11	Public toilet	4.47	2.12	Overdemand
C12	Signage facilities	4.47	3.06	Supply and demand balance
C13	Sculptures	3.71	4.24	Supply and demand balance
C14	Water &Scape	4.29	4.24	Supply and demand balance
C15	Green planting	4.71	4.29	Supply and demand balance
C16	Flowers and plants	4.53	4.47	Supply and demand balance
C17	Cicadas and birds singing	4.06	4.29	Supply and demand balance
C18	Road smoothness	4.76	3.12	Supply and demand balance
C19	Road safety	4.59	3.29	Supply and demand balance
C20	Separation of passengers and vehicles	4.41	3.29	Supply and demand balance
C21	Road parking	4.47	2.35	Overdemand
C22	Ramp and step	1.47	3.41	Oversupply
C23	Environmental facility maintenance	4.76	3.59	Supply and demand balance
C24	Garbage bin facilities	3.29	4.06	Supply and demand balance
C25	Environmental sanitation	4.88	4.29	Supply and demand balance

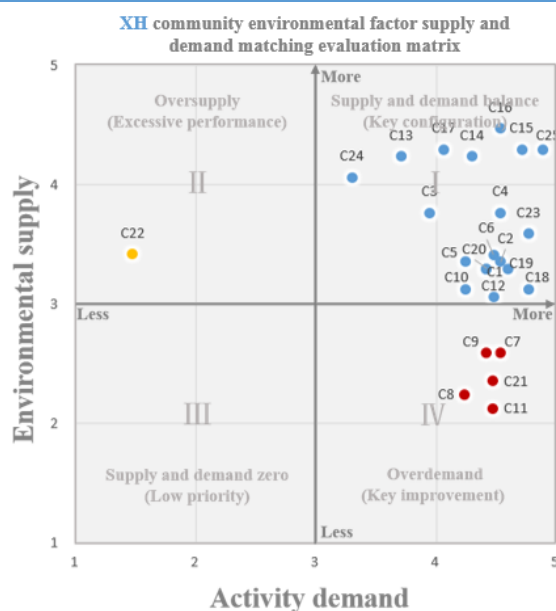






Figure 5-8. XH community environmental factor supply and demand matching evaluation matrix

In general, a high fit was achieved between the supply of outdoor spaces and the demand of the elderly in XH community (Table 5-3, Figure 5-8). The results show that there are 19 environmental factors for the balance of supply and demand. There are 5 environmental factors of overdemand, namely C7, C8, C9, C11, and C21. 1 environmental factor of oversupply is C22 (Table 5-4).

Table 5-4. Analysis of environmental factors of supply and demand mismatch in XH community (Source: author)	
Balance of supply and demand. In the future, the 19 environmental factors of supply and demand balance should be optimally configured to achieve "place optimization".	
Overdemand. C7,C8,C9,C11,C21 The configuration of outdoor environment elements in the community is too low to effectively meet the needs of the elderly. This causes problems such as "lack of places". In the design and construction, we should focus on improving the configuration of such environments.	
C7 Shading / Rain shelters facilities. There are a large number of outdoor sites in XH community, but the number of facilities dedicated to shading and rain shelter is not enough to meet the needs of the elderly in the community. Through in-depth interviews, we understand that some of the elderly tend to engage in group activities with 3-5 people, such as chatting, group fan dancing, playing mahjong and cards. It is hoped that social activities can be continued regardless of the weather.	
C8 Lighting facilities. Outdoor lighting is very important to the nighttime activities of the elderly. At present, the community outdoor night lighting can meet the main road lighting, but the brightness and range of lighting in front of buildings and branch roads are still slightly insufficient.	
C9 Barrier-free design. The terrain in the XH community is generally flat and basically meets the activity needs of the active elderly. However, it is also found that the activity places have more flooring and dotted stepping stones decorating the park, small artificial slopes and grass, all of which are not conducive to the safety of elderly people's passage.	
C11 Public toilets. The field survey understands that there are no outdoor Public toilets in this community. The XH community is relatively large in size and has relatively more activity areas. The activity areas chosen by the elderly are generally at a certain distance from the buildings and units they live in, which also increases the difficulty for the elderly to go to the bathroom and leads to a decrease in satisfaction.	
C21 Road parking, with the rapid growth in the number of private cars in China, underground parking is saturated. Residents have no choice but to park on the street side of main roads. This is not only an obstacle for the elderly to get around. It also poses a safety hazard to residents of other ages, such as children. Adding community above-ground parking to solve the problem of on-street parking is the direction of future improvement.	

Oversupply. C22 is over-configured in community outdoor spaces, causing problems such as "place deterioration" in activity spaces. Such factors should be mitigated in future design and construction.

C22 Slopes, steps. for supply exceeds demand environmental factor. The roads are flat to facilitate travel for the elderly. Although the topographic variation of XH community site is not significant. Still, more changes in ground level are set in the community site and landscape plan. Too many ramps and steps affect the elderly to travel and carry out outdoor activities. This environmental factor should be reduced in the community outdoor environment.



5.4.2 XF community

Table 5-5. Matching indices of supply and demand of XF community environmental factors

Label	Environmental factor	Environmental supply	Activity demand	State of supply and demand
C1	Area of activity site	4.18	3.76	Supply and demand balance
C2	Fluctuation degree of activity site	4.71	4.06	Supply and demand balance
C3	Openness of activity site	4.06	3.71	Supply and demand balance
C4	Parent-child activity space	3.88	3.18	Supply and demand balance
C5	Exclusive space for the elderly	4.53	2.06	Overdemand
C6	Recreation and fitness facilities	4.59	2.18	Overdemand
C7	Sun/rain shelter	4.18	3.47	Supply and demand balance
C8	Lighting facilities	4.82	2.29	Overdemand
C9	Barrier-free design	4.41	3.35	Supply and demand balance
C10	Rest facilities	4.47	4.00	Supply and demand balance
C11	Public toilet	3.24	2.35	Overdemand
C12	Signage facilities	3.53	3.35	Supply and demand balance
C13	Sculptures	3.76	3.76	Supply and demand balance
C14	Water &Scape	3.53	3.12	Supply and demand balance
C15	Green planting	4.76	4.24	Supply and demand balance
C16	Flowers and plants	4.35	3.65	Supply and demand balance
C17	Cicadas and birds singing	3.88	4.29	Supply and demand balance
C18	Road smoothness	4.76	4.76	Supply and demand balance
C19	Road safety	4.71	4.47	Supply and demand balance
C20	Separation of passengers and vehicles	5.00	4.76	Supply and demand balance
C21	Road parking	4.41	4.29	Supply and demand balance
C22	Ramp and step	1.41	3.88	Oversupply
C23	Environmental facility maintenance	4.65	3.18	Supply and demand balance
C24	Garbage bin facilities	3.82	3.59	Supply and demand balance
C25	Environmental sanitation	4.71	4.06	Supply and demand balance

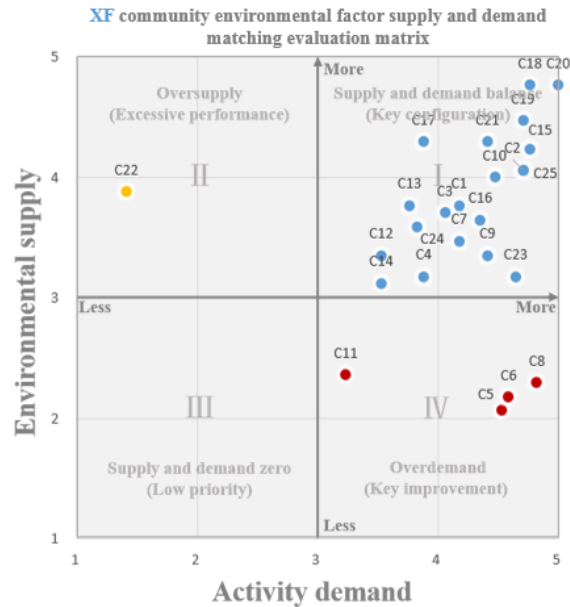


Figure 5-9. XF community environmental factor supply and demand matching evaluation matrix

In general, the supply of outdoor space in XF community and the demand of the elderly reached a high fit (Table 5-5, Figure 5-9). The results show that there are 20 environmental factors for the balance of supply and demand, 4 environmental factors for overdemand are C5,C6,C8,C11, and 1 environmental factor for oversupply is C22 (Table 5-6).

Table 5-6. Analysis of environmental factors of supply and demand mismatch in XF community (Source: author)

Balance of supply and demand. In the future, the 20 environmental factors of supply and demand balance should be optimally configured to achieve "place optimization".

Overdemand. C5,C6,C8,C11 The configuration of outdoor environment elements in the community is too low to effectively meet the needs of the elderly. This causes problems such as "lack of places". In the design and construction, we should focus on improving the configuration of such environments.

C5 Elderly exclusive sites. The overall outdoor environment and activity sites in XF community are well configured. Through the field survey, we understand that the outdoor activities of the elderly are more often to play with their grandchildren, and more activity sites and features are set up in the community mainly for children. There is a lack of activity places for the elderly to gather and socialize. Not to mention the exclusive sites suitable for the activities of the elderly.



<p>C6 Fitness facilities. The XF community is a grouped gated community. Each group is equipped with a small number of dispersed fitness equipment. First of all, the types of fitness equipment, in addition to meeting the needs of the general public fitness. In addition, the needs of the elderly should be fully considered, and rehabilitation training equipment should be provided that is more suitable for the characteristics and needs of the elderly. Secondly, the fitness equipment in XF community is mostly set in the edge and small area, which is not convenient for the elderly who take care of their grandchildren. It is also inconvenient to form a gathering place for the elderly to socialize.</p>	
<p>C8 Lighting facilities. Common Problems. The existing lighting facilities in the community cannot meet the needs of the elderly for nighttime travel and activities.</p>	
<p>C11 Public toilets. Common needs. The vast majority of communities in the country lack Public toilets in their settings. It needs to be focused on.</p>	
<p>Oversupply. C22 is over-configured in community outdoor spaces, causing problems such as "place deterioration" in activity spaces. Such factors should be mitigated in future design and construction.</p>	
<p>C22 Slopes, steps. For the supply exceeds demand environmental factor. XF community sited terrain although the height difference is not large. However, there are still more steps in the site plan. It increases the difficulty of walking for the elderly and becomes an obstacle to their travel and activities.</p>	

5.4.3 NHS community

Table 5-7. Matching indices of supply and demand of NHS community environmental factors

Label	Environmental factor	Environmental supply	Activity demand	State of supply and demand
C1	Area of activity site	4.57	3.71	Supply and demand balance
C2	Fluctuation degree of activity site	4.57	3.14	Supply and demand balance
C3	Openness of activity site	3.29	4.29	Supply and demand balance
C4	Parent-child activity space	3.71	4.14	Supply and demand balance
C5	Exclusive space for the elderly	4.57	3.29	Supply and demand balance
C6	Recreation and fitness facilities	3.86	4.57	Supply and demand balance
C7	Sun/rain shelter	3.57	3.14	Supply and demand balance
C8	Lighting facilities	4.43	2.57	Overdemand
C9	Barrier-free design	4.00	3.00	Overdemand

C10	Rest facilities	4.00	4.71	Supply and demand balance
C11	Public toilet	3.14	2.00	Overdemand
C12	Signage facilities	2.57	3.14	Oversupply
C13	Sculptures	3.00	2.57	Overdemand
C14	Water&Scape	2.86	2.43	Supply and demand zero
C15	Green planting	4.57	3.00	Overdemand
C16	Flowers and plants	4.14	3.29	Supply and demand balance
C17	Cicadas and birds singing	3.00	3.29	Oversupply
C18	Road smoothness	4.71	2.86	Overdemand
C19	Road safety	4.86	4.14	Supply and demand balance
C20	Separation of passengers and vehicles	4.43	3.29	Supply and demand balance
C21	Road parking	4.57	2.00	Overdemand
C22	Ramp and step	1.57	1.57	Supply and demand zero
C23	Environmental facility maintenance	4.86	3.71	Supply and demand balance
C24	Garbage bin facilities	3.57	3.57	Supply and demand balance
C25	Environmental sanitation	4.71	3.43	Supply and demand balance

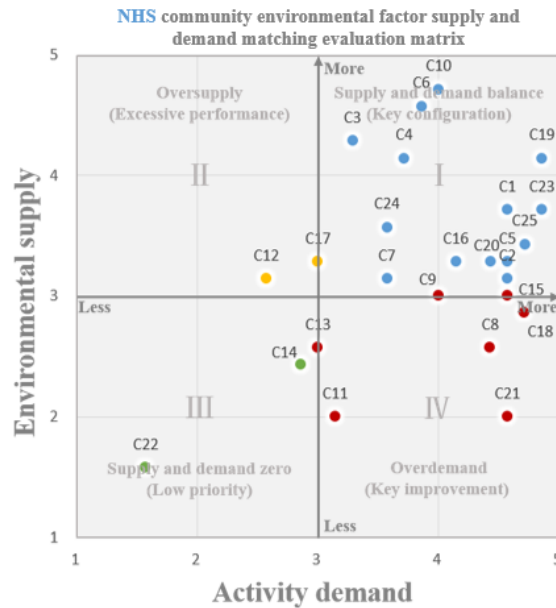


Figure 5-10. NHS community environmental factor supply and demand matching evaluation matrix

In general, the NHS area is a renovated area in the government's Older Communities Renewal Program. A certain fit was achieved between the supply of outdoor space and the demand of the elderly (Table 5-7, Figure 5-10). The results show that there are 14 environmental factors of balance between supply and demand, 7 environmental factors of overdemand are C8, C11, C18, C21, while C9, C13, C15, are at the boundary and considered necessary to be improved. The oversupply environment factor is 2 items C12, C17. The zero point of supply and demand is 2 items C14 and C22 (Table 5-8).

Table 5-8. Analysis of environmental factors of supply and demand mismatch in NHS area (Source: author)

Balance of supply and demand. In the future, the 14 environmental factors of supply and demand balance should be optimally configured to achieve "place optimization".

Overdemand. C8,C11,C18, C21, C9, C13, C15 .The configuration of outdoor environment elements in the community is too low to effectively meet the needs of the elderly. This causes problems such as "lack of places". In the design and construction, we should focus on improving the configuration of such environments.

C8, Lighting facilities, despite the improved environment and facilities in the renovated NHS area, the lighting facilities still do not meet the needs of the resident elderly. Good outdoor lighting can extend the time of outdoor activities for the elderly.



C11 Public toilets . Common issues. Urgent need for future community planning and renewal to address.

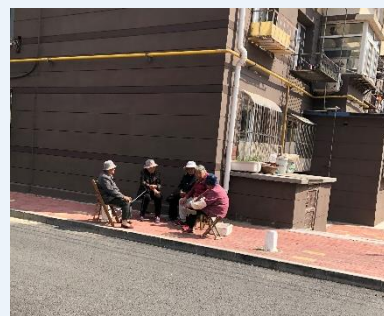
C18 Road patency and C21 Road parking, The HS community is an open community, and the outdoor activities for the elderly are mainly in the open space in front of the building and in front of the unit. Although the NHS area has undergone environmental and facility renovations. However, the scale of the open space in front of the building and the road between the buildings cannot be changed. The roadside parking not only affects the accessibility of the residents, but also poses many safety hazards to the outdoor activities of the elderly.



C9 Barrier-free design and C15 Green planting. At the boundary of I and IV. It is close to the balance of supply and demand. It indicates that the elderly have some satisfaction with these two environmental factors after the area renovation. the NHS area has considered the accessibility design in walking, such as set a gentle slope in front of the unit door and resurfacing the floor. However, there is still a need to consider the outdoor activity needs of elderly people with different physical conditions. Although the planting area has been increased, it is still single in the configuration of plants, and there should be a reasonable mix of trees, shrubs and lawns. Improve the ornamental and comfort level of the outdoor site.



C13 Sculpture sketches. Sculptural vignettes are an aesthetic necessity. Sculptural vignettes are not the focus of community renovation and transformation. It is at the boundary of III and IV. This shows that the elderly do not pay much attention to it. The current community outdoor renovation is mainly focused on securing the basic needs of outdoor activities for the elderly.



Oversupply. C12, C17 is over-configured in community outdoor spaces, causing problems such as "place deterioration" in activity spaces. Such factors should be mitigated in future design and construction.

C12. Guide marking facilities. With the renovation of the area, the signage configuration in the community grounds has been improved. However, for the elderly people living there, whether the orientation is clear or not does not matter much to them, and thus there is not much demand for this factor.



C17 The cicada sings the bird. Dalian has a good climate and ecological environment. For the residents, the insects and birds are already accustomed to the chirping. Therefore, the elderly do not have a strong demand for this environmental factor and are not concerned about it.



Supply and demand zero. C14,C22 are factors of no concern or low demand for elderly activities, and the configuration of community outdoor sites is low. The allocation level of such environmental factors should be reduced in the future.

C14 Waterscape. Water feature viewing is an aesthetic need. Like sculptural vignettes, it is not the focus of community renovation. Nor is it a basic activity need for the elderly. This environmental factor can be disregarded for the time being.



C 22 Slopes, steps. There are many hilly areas within the city of Dalian, and a certain degree of slope exists throughout most of the city. Although there is a height difference in HS community outdoor sites. However, this is influenced by geographical factors. This environmental factor can be left out of consideration for the time being.



5.4.4 OHS community

Table 5-9. Matching indices of supply and demand of OHS community environmental factors

Label	Environmental factor	Environmental supply	Activity demand	State of supply and demand
C1	Area of activity site	4.11	1.89	Overdemand
C2	Fluctuation degree of activity site	4.89	2.11	Overdemand
C3	Openness of activity site	3.78	2.78	Overdemand
C4	Parent-child activity space	4.11	2.22	Overdemand
C5	Exclusive space for the elderly	4.56	1.44	Overdemand
C6	Recreation and fitness facilities	4.78	1.33	Overdemand
C7	Sun/rain shelter	4.00	1.78	Overdemand
C8	Lighting facilities	4.89	1.33	Overdemand
C9	Barrier-free design	3.67	1.44	Overdemand
C10	Rest facilities	4.78	1.33	Overdemand
C11	Public toilet	4.33	1.67	Overdemand
C12	Signage facilities	3.11	2.67	Overdemand
C13	Sculptures	3.22	2.56	Overdemand
C14	Water &Scape	2.89	2.22	Supply and demand zero
C15	Green planting	4.67	2.22	Overdemand
C16	Flowers and plants	3.78	2.44	Overdemand
C17	Cicadas and birds singing	3.67	2.78	Overdemand
C18	Road smoothness	4.67	2.56	Overdemand
C19	Road safety	4.67	1.78	Overdemand
C20	Separation of passengers and vehicles	4.78	1.56	Overdemand
C21	Road parking	4.00	1.56	Overdemand
C22	Ramp and step	1.44	1.56	Supply and demand zero
C23	Environmental facility maintenance	4.56	1.56	Overdemand
C24	Garbage bin facilities	3.44	1.89	Overdemand
C25	Environmental sanitation	4.67	1.33	Overdemand

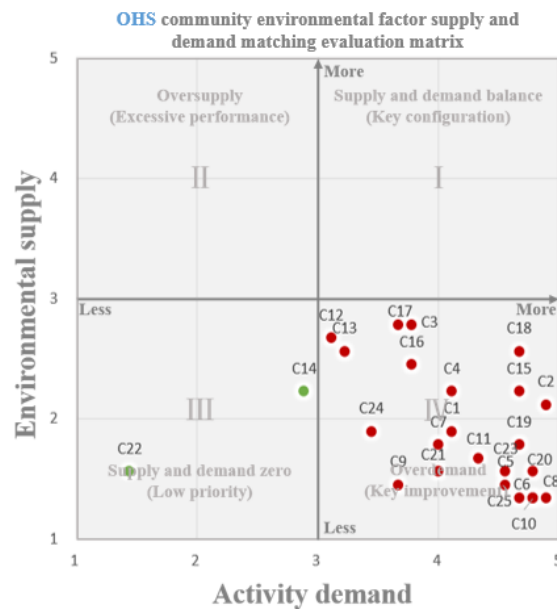





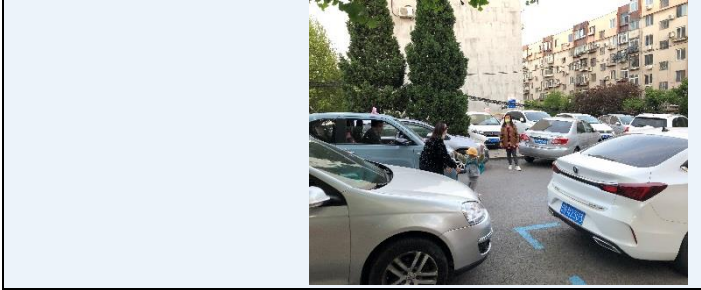
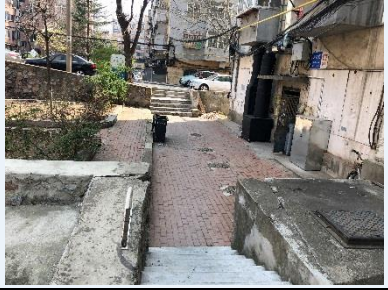

Figure 5-11. OHS community environmental factor supply and demand matching evaluation matrix

The results show that there are 23 environmental factors of overdemand, and 2 items of supply and demand zero C14, c22.

In general, from the supply and demand matching index calculation and the supply and demand matching assessment matrix (Table 5-9, Figure 5-11), it can be seen that the allocation of environmental factors in community outdoor sites in the OHS region is too low to meet the environmental needs of the elderly for outdoor activities. The problem of "lack of places" is serious. In the construction, we should focus on improving the design of such environment. C14 and C22 are the same as NHS areas, which are not concerned about or have low demand for elderly activities, and the configuration of community outdoor space is also low. The configuration level of these environmental factors should be reduced in the future (Table 5-10).

The OHS area is an unrenovated area in the government's old community renovation project. Through in-depth interviews and field observations, we learned about the current status of outdoor sites in the OHS area.

Table 5-10. Analysis of environmental factors of supply and demand mismatch in OHS area (Source: author)	
<p>Site factors. There are few areas that can accommodate outdoor activities for the elderly. The site is open and unobstructed. There is no exclusive space for children and the elderly.</p>	
<p>Facility Status. There is no fitness equipment on the site. There are no outdoor resting seats or shade and rain shelter facilities. The elderly brought their own chairs and cushions to put together the outdoor rest area. No signage and barrier-free design. There are no outdoor public restrooms.</p>	
<p>Landscape Status. There are dilapidated tree ponds, but plants are very sparse. There are no sculptural vignettes or floral water features. The outdoor environment is unappealing.</p>	

<p>Road Status. Due to geographical factors, there are more height differences on the site. There are more ramp steps, broken railings, fewer handrails and poor safety. Most of the site is occupied by parking. Both sides of the street and the open space in front of the unit building are parked, and it is impossible to separate pedestrian and vehicle traffic.</p>	
	
<p>Maintenance Status. The floor tiles are badly damaged. Some areas of the building siding are falling off. It brings danger to travel. The number of garbage cans is too small, and domestic and construction garbage is piled up around the garbage cans. Foul odors and insects and rats are increasing. The overall condition of the community's outdoor environment is very poor and in urgent need of renovation.</p>	

5.5 Summary

This chapter measures the supply degree of outdoor environmental factors in the existing communities and the demand degree of the ideal community from the elderly. It builds a supply and demand model of outdoor sites in urban communities to measure the supply and demand matching of outdoor environmental factors in sample communities.

Overall, among the 5 categories of environmental factors, facilities are among the environmental factors that are in overdemand. 19 of the 25 sub-categories of environmental factors are in balance, while 6 are in overdemand. Among them, C7 Shading / rains shelter facilities, C8 Lighting facilities, C9 Barrier-free design, and C11 Public toilets are all in the category of facilities. Activity facilities play an important role in enhancing the activities of older adults, and many studies support this view. chow (2013) argues that outdoor fitness equipment also promotes social interaction among older adults and their physical and mental health (chow H., 2013). c5 Elderly exclusive sites, older adults especially enjoy social group activities, so the planning and design of the sites should be based on physical activity, outdoor activities, and outdoor activities. C14 Waterscape, a beautiful waterscape can enrich the scenery of the site and play an important role in the design of the site.

By analyzing and comparing the characteristics of environmental factors of supply and

demand balance in sample communities, the results of outdoor environment supply and demand in XH community and XF community are close. Most environmental factors are in balance with supply and demand. After renovation, the outdoor environment of NHS community has been improved. However, environmental factors such as oversupply, supply and demand zero and overdemand are more than XH and XF communities. Environmental factors overdemand in unrenovated OHS communities account for the vast majority. The outdoor environment of the community is in urgent need of improvement. In particular,

① **Supply and demand balance.** If the higher the degree of environmental supply configuration, then the better the quality of activities for the elderly. It will effectively promote the development of activities and improve the quality of activities for the elderly. In the future design and construction, we should optimize the allocation of such environmental factors to achieve "place optimization".

② **Oversupply.** If too much is allocated, the resources will be left idle and "unattended". In addition, the oversupply will cause the elderly to resent the activities and cause problems such as "place deterioration" in the activity space. In the future design and construction, such factors should be mitigated.

③ **Supply and demand zero.** If these environmental factors are oversupplied, not only will they not be "affirmed" by the elderly, but they will also cause waste of resources. In the design and construction, it can be allocated with low priority.

④ **Overdemand.** Such resources are allocated in a "slapdash" manner without considering the actual usage. This will not only prevent the elderly from carrying out activities outdoors, but also not make full use of the efficiency of the activity space, resulting in "lack of space" and other related problems. In the design and construction, we should focus on improving the design of such environments.

In conclusion, based on the perspective of supply and demand matching, the relationship between the environmental factors of community outdoor site and the outdoor activity needs of the elderly in the community is discussed, to reveal the matching characteristics of supply and demand of community outdoor site environmental factors, so as to explore the space environment that truly meets the needs of the elderly outdoor activities. It plays an important role and significance in improving the service efficiency of community outdoor environment and allocating facility resources in a fine manner, which is also the fundamental reason for the research in this chapter.

Chapter 6.

Model for determining whether individual and community outdoor sites are aging-friendly

Based on P-E Matching theory, this chapter constructs a model for determining whether individual and community outdoor sites are aging-friendly. The needs of the elderly for outdoor environment have similarities and differences. Analyze and evaluate whether the allocation of community outdoor sites is suitable for the activity needs of different elderly people. It provides the basis for the subsequent specific community environment optimization suggestion design. Modeling is divided into three steps (Figure 6-1.), details are as follows:

Step 1: Model construction and connotation analysis. Describe the outline of P-E matching theory.

Step 2: Use One-way Analysis of Variance and post hoc test to study the differences in the needs of the elderly at different ages, with different physical conditions, device-aided elderly and nursing-cared elderly.

Step 3: Path analysis of how personal attributes, family attributes, physical condition, activity habits and outdoor site satisfaction and demand degree affect the characteristics of outdoor activities of the elderly, and the relationship among several variables.

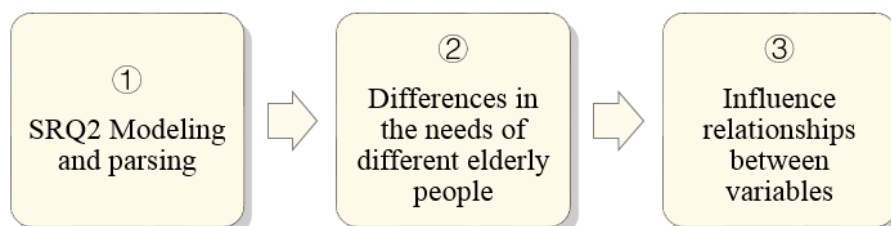


Figure 6-1. Chapter 6 Research steps

6.1 Model construction and theoretical analysis

6.1.1 Model construction

The purpose of this chapter is to expand the concept of P-E Matching from institution to community environment, so as to understand the impact of community environment on the residential satisfaction and health of the elderly. We believe that the personal characteristics, behavioral characteristics and environmental characteristics of the elderly living in the community are important predictors of residential satisfaction. Understanding these three different but interdependent impacts should better optimize the outdoor environment of the community to meet the needs of the elderly, and ultimately affect the health of old age.

Lawton applies the behavioral environment theory to adapt to the elderly population, and constructs the relationship model between the environment and the elderly behavior, that is, $B=f(P, E)$, where B represents Behavior; f is Function; P represents Person, including individuals and groups; E represents for Environment, which refers to the space environment that affects the behavior of the elderly. This model shows that the interaction between people and the environment leads to the behavior of people in the space environment (Li D Z.,1999) On this basis, this paper has built a model for determining whether individual and community outdoor site are aging-friendly.

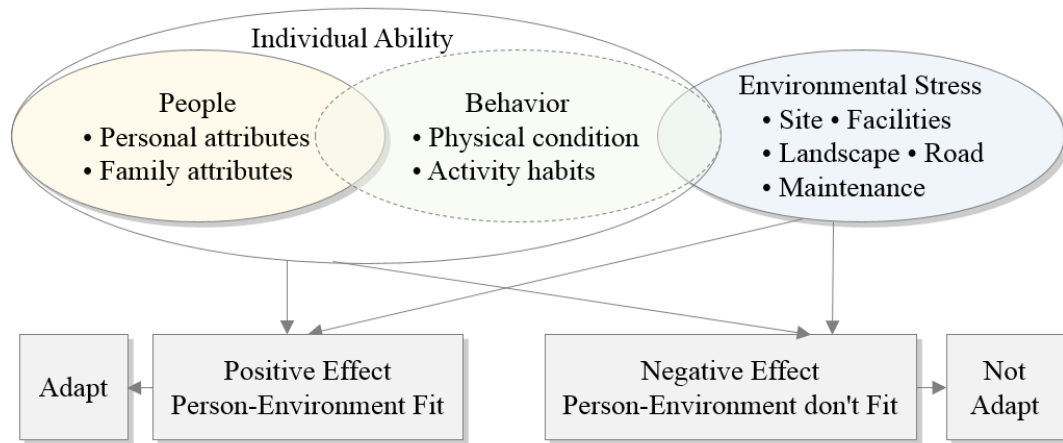


Figure 6-2. Model for determining whether individual and community outdoor sites are aging-friendly

As shown in Figure 6-2,

- ① The interaction between individual ability and environment has produced positive effects, indicating that people are matched with the environment. The environment is in the adaptable behavior area of the elderly.
- ② The interaction between individual ability and environment has produced negative effects, indicating that people do not match with the environment. The environment is located in the area of inadaptable behavior of the elderly.

The Ecological Model of Aging assumes that "people with strong abilities can withstand high pressure environments, and only those who can withstand pressure can adapt to the environment", explaining the balance between the needs caused by increasing environmental pressure and the ability of individuals to cope with such needs, and how the elderly constantly adjust themselves by changing individual behaviors (Lawton MP., 1977).

The model can be used to explain the mechanism of the elderly's selective use of the community outdoor activity site environment. Different site environments have different effects on the elderly. The elderly enter the site through site selection and self selection. After a period of time, the elderly have the habit of using some sites more than others. According to this principle, it can be distinguished which objective environment determines the number of elderly people in the site. These objective environments reflect the preference of the elderly. When the objective environment matches the preference of the elderly, the evaluation results point to aging-friendly environment, which can further explain the site characteristics of those sites that are highly aging-friendly, and vice versa.

6.1.2 P-E matching theory

P-E matching theory can be defined as the degree of matching between individual and environmental characteristics(French J R P.et al.,1982), which was born in management science. In 1909, Parsons proposed the Model of Person Environment Fit (Parsons F.,1909). In 1938, Murray proposed the Needs Press Model. This model points out that the combination of specific pressures and corresponding demands plays a crucial role in individuals and their behaviors (Murray H A.,1938). In 1951, Lewin, a representative of humanism and social psychology, pointed out that, behavior is not determined by individual or the environment alone, but is the result of the interaction between individual and the environment. He proposed the Ecological Model that integrates environment and behavior (Lewin,K.,1951). In 1987, Schneider put forward the famous Attraction-Selection-Attrition model, which was called A-S-A model for short. This theoretical model provides an explanation mechanism for the matching effect of people and the environment. Because of the A-S-A model, the matching between people and the environment has received more extensive attention.

According to the elderly ecological model (Lawton MP. et al.,1973; 1977) proposed by Lawton, when the individual ability of the elderly and the environmental pressure reach a certain balance, the elderly will have adaptive behaviors, which will have a positive impact on the elderly. If the "elderly ecological model"(Figure 6-3)is applied to the environmental design, more consideration should be given to the impact of environmental pressure on the elderly. The elderly, as a typical applicable population, can be applied to the model, but their individual abilities vary greatly, it needs to be considered according to different situations.

Based on the assumption of environmental compliance, the ecological model of aging believes that people with weak abilities are more vulnerable to the impact of the environment, while people with strong abilities can withstand greater environmental pressure. Individual behavior is a function of the dynamic balance between the pressure imposed by the environment and the ability of individuals to meet their own needs. The model consists of two parts: individual capacity and environmental pressure. Environmental pressure refers to the degree of response to environmental needs and it is the requirement of the environment for residents. Individual ability refers to the ability to make adaptive responses in the aspects of physical function health, social role, sensory function, perceptual function and cognition, which represents a person's greatest internal potential. Individual ability is from low to high, environmental pressure is from weak to strong, individual ability will change due to disease and health, and environmental pressure is also characterized by fluctuations(Lawton MP. et al.,1973).

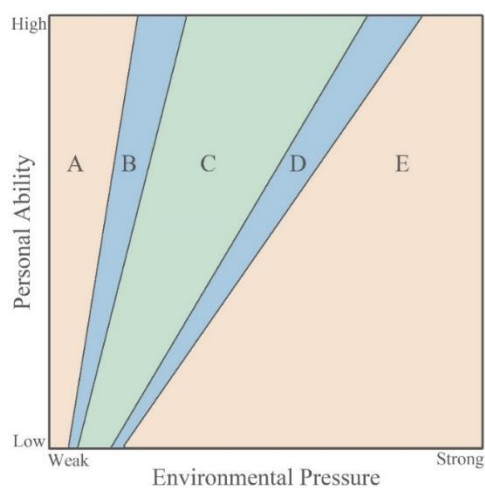


Figure 6-3.The model of old adults' physical ability and environmental stress (Source: author)

Model analysis is shown in Figure 6-3,

Region A: Negative effect–maladaptive behavior.

Personal Ability >> Environmental Pressure.

When the individual ability of the elderly is significantly greater than the environmental pressure, it indicates that the potential demand for the environment of these elderly has far exceeded the existing environmental pressure. However, this part of the elderly is not satisfied with the community environment with low environmental pressure, so as to have a negative impact on them. For the elderly with weak personal ability, very low environmental pressure cannot stimulate their ability level, but may cause dependence and accelerate the decline of their personal ability, which also brings negative effects.

Region B: Tolerable effect–marginally adaptive behavior.

Personal Ability > Environmental Pressure.

When the personal ability of the elderly is greater than the pressure brought by their environment. When the personal ability of the elderly is higher, it is tolerable that the

personal ability to a certain extent exceeds the pressure of the community environment in which they live. When the personal ability of the elderly is lower, the lower environmental pressure is also acceptable compared to their personal ability. Although the personal ability of the elderly enables them to live in a community environment with higher environmental pressure, they can also adapt to this relatively low environmental pressure to a certain extent, which is called mild adaptive behavior.

Region C: Positive effect–adaptive behavior.

Personal Ability = Environmental Pressure.

There is a balance between the elderly's individual ability and environmental pressure. At this time, regardless of the level of individual ability, the elderly can easily cope with environmental pressure by their own ability, and can quickly adapt to environmental pressure. Therefore, when the relative value of individual ability and environmental pressure is in the maximum comfort zone, the elderly have adaptive behaviors, which bring positive effects to their lives.

Region D: Tolerable effect–marginally adaptive behavior.

Personal Ability < Environmental Pressure.

When the individual ability of the elderly is less than the environmental pressure. At this time, the elderly have some difficulties in adapting to the relatively high environmental pressure, but through their own efforts and external help, they can also tolerate and accept the living environment. This living environment has a certain negative impact on the life of the elderly, affecting their quality of life. But the elderly will adjust slowly according to the actual situation and adapt to the space environment.

Region E: Negative effect–maladaptive behavior.

Personal Ability << Environmental Pressure.

When the individual ability of the elderly is obviously less than the environmental pressure, at this time, the elderly will be unable to bear living in this high-pressure environment, cannot rely on their individual ability to complete daily activities, severely limit their own scope of activities, and cause serious impact on their quality of life.

6.2 P-E matching of the elderly with different physical conditions

From the perspective of the use of community outdoor site, there are differences among different elderly groups. According to the elderly ecological model, the changes in the relationship between the elderly's individual ability and environmental pressure will have different impacts on the elderly. In this section, we will use One-way Analysis of Variance and post hoc test to study the differences in the needs of the elderly at different ages, with different physical conditions, as well as device-aided elderly and nursing-cared elderly.

6.2.1 The differences of the elderly in different age groups

According to 4.2.5 above, based on the frequency analysis of social demography, the age distribution results are: 194 people "60-69 years old", 73 people "70-79 years old", 36 people "80-89 years old", and 7 people "Over 90 years old". There are fewer people Over 90 years old. By referring to 2.3.4 above and combining with China's national conditions, "60-69 years old" is young-old (194), "70-79 years old" is old-old (73) and "80-89 years old" and "Over 90 years old" are oldest-old (43).

Analysis of variance and post hoc test are used to compare the differences in personal attributes, physical condition, outdoor activity habits and outdoor environment satisfaction and demand degree of the elderly at different ages.

① There are significant differences in personal attributes and physical conditions of the elderly at different ages, including 6 items ($p < 0.05$), which means that there are significant differences in 6 items among the samples of different 3 subgroups (Table6-1).

Table 6-1. Age and Sociodemographic statistical information, results of Physical Condition ANOVA

	Age (Mean \pm standard deviation)			<i>F</i>	<i>p</i>	Post Hoc tests
	Young -old (n=194)	Old -old (n=73)	Oldest -old (n=43)			
Education level	2.95 \pm 1.17	2.34 \pm 1.04	2.44 \pm 1.58	8.302	0.000**	1>2;1>3
Period of residence	2.41 \pm 1.12	2.71 \pm 1.14	3.14 \pm 1.15	8.103	0.000**	2>1;3>1;3>2
Floor of home	1.82 \pm 0.73	1.70 \pm 0.62	1.49 \pm 0.77	4.147	0.017*	1>3
Elevator condition	1.55 \pm 0.50	1.58 \pm 0.50	1.77 \pm 0.43	3.454	0.033*	3>1;3>2
physical condition	4.00 \pm 0.93	3.59 \pm 0.93	3.56 \pm 0.80	7.774	0.001**	1>2;1>3
Assistance you need for outdoor activities	3.90 \pm 0.53	3.74 \pm 0.73	3.44 \pm 0.98	8.797	0.000**	1>3;2>3

* $p < 0.05$ ** $p < 0.01$

As can be seen from the table, young-old (60-69): generally have a high level of education, live on higher floors and do not need equipment such as walkers for outdoor activities. Oldest-old (80+): generally have lived in their original place of residence for many years. They also live on lower floors and most buildings do not have lifts. Most outdoor activities require a walker or someone to accompany them.

② There are significant differences in outdoor activity habits of the elderly at different ages, including 13 items ($p < 0.05$), which means that there are significant differences in 13 items among the samples of different 3 subgroups (Table6-2).

Table 6-2. Results of ANOVA of age and Outdoor Activities Habits

	Age (Mean ± standard deviation)			F	p	Post Hoc tests
	Young -old (n=194)	Old -old (n=73)	Oldest -old (n=43)			
6-8 a.m	0.45±0.50	0.40±0.49	0.21±0.41	4.265	0.015*	1>3;2>3
12-14 p.m	0.10±0.30	0.26±0.44	0.28±0.45	7.423	0.001**	2>1;3>1
15-17 p.m	0.26±0.44	0.49±0.50	0.35±0.48	6.991	0.001**	2>1
18-20 p.m	0.44±0.50	0.29±0.46	0.23±0.43	5.077	0.007**	1>2;1>3
Unit doorway	0.15±0.36	0.27±0.45	0.37±0.49	6.212	0.002**	2>1;3>1
Small square between buildings	0.30±0.46	0.44±0.50	0.51±0.51	4.777	0.009**	2>2;3>1
Street outside the residential area	0.14±0.35	0.33±0.47	0.14±0.35	6.913	0.001**	2>1;2>3
Sit still	0.20±0.40	0.38±0.49	0.60±0.49	16.738	0.000**	2>1;3>1;3>2
Chat	0.26±0.44	0.44±0.50	0.35±0.48	4.248	0.015*	2>1
Bask	0.38±0.49	0.66±0.48	0.60±0.49	10.273	0.000**	2>1;3>1
Chess and cards	0.12±0.32	0.14±0.35	0.28±0.45	3.733	0.025*	3>1;3>2
The activity place is too small	0.44±0.50	0.34±0.48	0.26±0.44	3.147	0.044*	1>3
Few community activities	0.36±0.48	0.41±0.50	0.19±0.39	3.189	0.043*	1>3;2>3

* $p < 0.05$ ** $p < 0.01$

Young-old (60-69): outdoor activities tend to take place in the early morning from 6-8am and in the evening from 18-20pm. Outdoor activities are less likely to take place in front of flats or in small squares between buildings. They are less likely to engage in static outdoor activities such as sitting, chatting, sunbathing, chess and cards. Often feel that the outdoor area is too small for most people.

Old-old (70-79): Most of the time spent outdoors is between 15-17pm. Outdoor activities are more likely to take place in the streets outside the neighbourhood. Outdoor activities are more likely to be chatting and sunbathing. Often feel that there are fewer community activities, fewer older people and fewer acquaintances.

Oldest-old (80+): Most outdoor activities are between 12-14pm. Outdoor activities are more likely to take place in front of the flat or in the small square between buildings. Most outdoor activities are meditation, chess and cards.

③ There are significant differences in satisfaction and demand degree of outdoor environment among the elderly in different age groups, including 6 items ($p < 0.05$), which means that there are significant differences in 6 items among the samples of different 3 subgroups (Table6-3).

Table 6-3. Age and satisfaction, demand degree ANOVA results

	Age (Mean ± standard deviation)			F	p	Post Hoc tests
	Young -old (n=194)	Old -old (n=73)	Oldest -old (n=43)			
Sculptures	2.93±1.42	3.33±1.23	3.49±1.16	4.466	0.012*	2>1;3>1
Recreation and fitness facilities	3.79±1.31	3.85±1.32	4.35±0.87	3.508	0.031*	3>1;3>2
Lighting facilities	3.83±1.30	4.10±1.11	4.33±1.02	3.485	0.032*	3>1
Rest facilities	3.73±1.35	4.01±1.21	4.26±1.03	3.651	0.027*	3>1
Ramp and step	3.70±1.47	3.05±1.62	2.35±1.65	15.433	0.000**	1>2;1>3; 2>3
Garbage bin facilities	4.27±1.06	4.10±1.02	3.56±1.10	8.1	0.000**	1>3;2>3

* $p < 0.05$ ** $p < 0.01$

Young-old (60-69): In the outdoor environment needs are more important in terms of sanitary conditions and want more ample litter bins. There is no concern for the provision of sculptural objects in the environment. There is less demand for outdoor lighting and rest facilities.

Oldest-old (80+): Desire for an outdoor environment with more sculptural vignettes and fitness facilities to meet their needs. Adequate outdoor lighting and rest facilities are considered necessary. Would like to see fewer steps and ramps in the outdoor environment.

④ In summary, the differences among the elderly in different age groups are summarized as follows.

The characteristics of sites that meet the needs of young-old.

Most of young-old are in good health. They are satisfied with the existing outdoor environment. Most of young-old take care of their grandchildren, and have more outdoor activities in the morning and evening. In addition to self exercise, part of the reason is that they pick up and send their grandchildren to school, and in addition, they also take charge of family shopping, so outdoor activities cover a wide range. They pay more attention to the sanitation of the environment and hope to increase the number of garbage cans. It is hoped that outdoor areas will be enlarged to accommodate more people.

The characteristics of sites that meet the needs of old-old.

Old-old are more concentrated in 15-17 PM activities. The middle aged have more free time as they withdraw from caring for their grandchildren. Because they will feel less community activities, less elderly people, less acquaintances, often go to the neighborhood outside the streets to chat and bask in the sun. It is hoped that community outdoor environments should be able to accommodate more diverse functions to meet the needs of their daily lives.

The characteristics of sites that meet the needs of oldest-old.

Due to poor mobility, most people live in low-rise buildings without elevators for a long

time. Most of the time is noon sun maximum time for outdoor activities. Most of them focus on the small square near the door of the unit or the building, sitting or playing chess and cards. I often feel that the function of the community outdoor environment is relatively simple, and I hope to add more ornamental sculpture pieces outdoors to play a role in pleasing the body and mind. Because outdoor activities require a walker or someone to accompany you, it is desirable to have fewer steps and ramps. Adequate lighting and rest facilities are necessary for outdoor activities, as well as appropriate fitness equipment.

6.2.2 Differences in the elderly with different physical conditions

The results of the frequency analysis of the assessment of self-physical condition were 85 "very good", 116 "good", 88 "general", "poor" 17 and "very poor" 4. The number of older people assessed as 'very poor' was low. To facilitate comparison of differences, the definitions were recoded, with 'poor' and 'very poor' being 'worse' (21 people). Differences in personal attributes, outdoor activity habits and satisfaction with and need for the outdoor environment were compared between older people with different health conditions using ANOVA and post-hoc tests.

① There are significant differences in personal attributes among the elderly with different physical conditions (Table 6-5), including 9 items ($p < 0.05$), which means that there are significant differences in 9 items among the samples of different 4 subgroups (Table 6-4).

Table 6-4. Physical condition and Sociodemographic statistical information, Physical capacity ANOVA results

	Physical condition (Mean \pm standard deviation)				F	p	Post Hoc tests
	very good (n=85)	good (n=116)	general (n=88)	worse (n=21)			
Age	1.22 \pm 0.56	1.64 \pm 0.81	1.65 \pm 0.82	1.76 \pm 1.00	6.64	0.000**	2>1;3>1; 4>1
Education level	3.00 \pm 1.29	2.80 \pm 1.21	2.56 \pm 1.14	2.10 \pm 1.26	4.02	0.008**	1>3;1>4; 2>4
Employment condition	1.82 \pm 0.38	1.86 \pm 0.35	1.95 \pm 0.21	1.95 \pm 0.22	2.98	0.032*	3>1;3>2
Monthly income	3.81 \pm 1.58	3.84 \pm 1.60	3.24 \pm 1.32	3.14 \pm 1.49	3.8	0.011*	1>3;2>3
Floor of home	1.94 \pm 0.82	1.67 \pm 0.64	1.66 \pm 0.68	1.76 \pm 0.77	2.97	0.032*	1>2;1>3
Elevator condition	1.49 \pm 0.50	1.56 \pm 0.50	1.66 \pm 0.48	1.81 \pm 0.40	3.24	0.022*	3>1;4>1; 4>2
Use of assistive devices	3.99 \pm 0.11	3.89 \pm 0.45	3.69 \pm 0.82	2.95 \pm 1.36	17	0.000**	1>3;1>4; 2>3;2>4; 3>4
Number of trips per day	2.36 \pm 0.63	2.41 \pm 0.66	2.10 \pm 0.57	2.24 \pm 0.62	4.58	0.004**	1>3;2>3
Total length of stay per day	2.12 \pm 0.79	2.27 \pm 0.82	2.00 \pm 0.79	1.76 \pm 0.89	3.31	0.020*	2>3;2>4

* $p < 0.05$ ** $p < 0.01$

The elderly in very good health: generally of a lower age. Have a high level of education, live on a high floor and have a lift in more buildings. Outdoor activities do

not require equipment such as mobility aids.

The elderly in good health: have a high personal monthly income. Go out most often each day. They also spend the most time outdoors each day.

The elderly in general health: Most are retired. They go out less frequently each day.

The elderly in worse health: generally of a higher age. Lower educational level. Lower monthly personal income. Shorter length of stay outdoors per day. Needs a walker or someone to accompany them during outdoor activities.

② There are significant differences in outdoor activity habits among the elderly with different physical conditions (Table 6-5), including 12 items ($p < 0.05$), which means that there are significant differences in 12 items among the samples of different 4 subgroups (Table 6-5).

Table 6-5. Physical condition and Outdoor Activities Habits ANOVA results

	Physical condition (Mean \pm standard deviation)				<i>F</i>	<i>p</i>	Post Hoc tests
	very good (<i>n</i> =85)	good (<i>n</i> =116)	general (<i>n</i> =88)	worse (<i>n</i> =21)			
9-11 a.m.	0.41 \pm 0.50	0.61 \pm 0.49	0.51 \pm 0.50	0.33 \pm 0.48	3.66	0.013 *	2>1;2>4
12-14 p.m.	0.07 \pm 0.26	0.21 \pm 0.41	0.20 \pm 0.41	0.14 \pm 0.36	2.73	0.044 *	2>1;3>1
Small square between buildings	0.32 \pm 0.47	0.48 \pm 0.50	0.28 \pm 0.45	0.19 \pm 0.40	4.48	0.004 **	2>1;2>3;2>4
Central square of the residential area	0.29 \pm 0.46	0.38 \pm 0.49	0.26 \pm 0.44	0.10 \pm 0.30	2.79	0.041 *	2>4
Keep-fit exercises	0.52 \pm 0.50	0.47 \pm 0.50	0.28 \pm 0.45	0.33 \pm 0.48	4.11	0.007 **	1>3;2>3
Dance and sing	0.13 \pm 0.34	0.20 \pm 0.40	0.03 \pm 0.18	0.05 \pm 0.22	4.72	0.003 **	2>3;2>4
The activity place is too small	0.51 \pm 0.50	0.30 \pm 0.46	0.36 \pm 0.48	0.57 \pm 0.51	4	0.008 **	1>2;4>2
The fitness facilities are old	0.34 \pm 0.48	0.45 \pm 0.50	0.59 \pm 0.49	0.62 \pm 0.50	4.43	0.005 **	3>1;4>1;3>2
Poor greening landscape, no sunshade	0.32 \pm 0.47	0.40 \pm 0.49	0.36 \pm 0.48	0.67 \pm 0.48	3.02	0.030 *	4>1;4>2;4>3
Poor sanitation conditions	0.25 \pm 0.43	0.20 \pm 0.40	0.28 \pm 0.45	0.57 \pm 0.51	4.53	0.004 **	4>1;4>2;4>3
Which type of activity do you prefer	2.39 \pm 0.98	2.46 \pm 0.91	2.81 \pm 0.95	3.00 \pm 0.95	4.94	0.002 **	3>1;4>1;3>2;4>2
Tolerable distance between your home and outdoor activities	2.22 \pm 1.00	2.34 \pm 0.95	2.30 \pm 1.05	1.67 \pm 0.86	2.81	0.040 *	1>4;2>4;3>4

* $p < 0.05$ ** $p < 0.01$

The elderly in very good health: more of the outdoor activities are fitness exercises. Often find outdoor fitness facilities outdated, with no resting benches, poor landscaping and no shade.

The elderly in good health: Most of the time spent outdoors is between 9-11am and 12-14pm. Most of these activities take place in the small squares between buildings and in the large squares in the centre of residential areas. There is a lot of dancing and singing outdoors. They often feel that the outdoor areas are too small and not enough for most people and that the sanitary conditions are poor.

The elderly in general health: they are less likely to choose outdoor activities such as exercise, dancing and singing.

The elderly in worse health: less likely to choose small squares between buildings or large squares in residential areas. They often feel that outdoor activities are too small and not enough for most people, that fitness facilities are outdated, that there are no resting benches, that the landscape is poorly landscaped, that there is no shade, and that environmental hygiene conditions are poor.

③ There are significant differences in satisfaction with outdoor environment of current residence among the elderly with different physical conditions (Table 6-6) , including 25 items ($p < 0.05$), which means that there are significant differences in 25 items among the samples of different 4 subgroups (Table6-6).

Table 6-6. Results of ANOVA of Physical condition and community outdoor sites satisfaction

	Physical condition (Mean \pm standard deviation)				<i>F</i>	<i>p</i>	Post Hoc tests
	very good (<i>n</i> =85)	good (<i>n</i> =116)	general (<i>n</i> =88)	worse (<i>n</i> =21)			
Area of activity site	3.65 \pm 1.44	3.38 \pm 1.31	3.19 \pm 1.42	2.38 \pm 1.43	5.1	0.002**	1>3;1>4;2>4;3>4
Fluctuation degree of activity site	3.75 \pm 1.37	3.32 \pm 1.28	3.16 \pm 1.29	2.86 \pm 1.53	4.2	0.006**	1>2;1>3;1>4
Openness of activity site	3.89 \pm 1.38	3.49 \pm 1.27	3.36 \pm 1.37	2.81 \pm 1.60	4.52	0.004**	1>2;1>3;1>4;2>4
Parent-child activity space	3.72 \pm 1.46	3.26 \pm 1.27	3.09 \pm 1.41	2.95 \pm 1.50	3.73	0.012*	1>2;1>3;1>4
Exclusive space for the elderly	3.48 \pm 1.50	2.78 \pm 1.42	2.50 \pm 1.36	2.10 \pm 1.51	9.29	0.000**	1>2;1>3;1>4;2>4
Recreation and fitness facilities	3.65 \pm 1.45	2.97 \pm 1.44	2.75 \pm 1.42	2.90 \pm 1.61	6.21	0.000**	1>2;1>3;1>4
Sun/rain shelter	3.35 \pm 1.50	2.72 \pm 1.34	2.43 \pm 1.36	2.29 \pm 1.45	7.48	0.000**	1>2;1>3;1>4
Lighting facilities	3.62 \pm 1.42	2.73 \pm 1.42	2.70 \pm 1.44	2.29 \pm 1.49	9.52	0.000**	1>2;1>3;1>4
Barrier-free design	3.53 \pm 1.44	2.77 \pm 1.37	2.59 \pm 1.33	2.29 \pm 1.31	9.19	0.000**	1>2;1>3;1>4
Rest facilities	3.84 \pm 1.27	3.00 \pm 1.42	2.72 \pm 1.37	2.67 \pm 1.59	11.2	0.000**	1>2;1>3;1>4
Public toilet	3.32 \pm 1.54	2.60 \pm 1.34	2.31 \pm 1.38	2.52 \pm 1.36	8.03	0.000**	1>2;1>3;1>4
Signage facilities	3.56 \pm 1.45	2.95 \pm 1.30	2.92 \pm 1.31	2.57 \pm 1.36	5.42	0.001**	1>2;1>3;1>4
Sculptures	3.49 \pm 1.39	3.14 \pm 1.33	2.77 \pm 1.23	2.67 \pm 1.49	5.04	0.002**	1>3;1>4

Water&Scape	3.46±1.43	3.03±1.44	2.50±1.30	2.33±1.56	8.15	0.000**	1>2;1>3;1>4;2>3;2>4
Green planting	3.81±1.31	3.44±1.31	3.02±1.41	2.67±1.53	6.92	0.000**	1>3;1>4;2>3;2>4
Flowers and plants	3.67±1.39	3.39±1.37	2.88±1.37	2.67±1.53	6.35	0.000**	1>3;1>4;2>3;2>4
Cicadas and birds singing	3.85±1.29	3.32±1.28	2.97±1.25	3.19±1.33	7.12	0.000**	1>2;1>3;1>4
Road smoothness	3.88±1.25	3.41±1.31	3.24±1.33	3.29±1.38	3.98	0.008**	1>2;1>3
Road safety	3.79±1.35	3.39±1.38	3.08±1.34	3.19±1.50	4.05	0.008**	1>2;1>3
Separation of passengers and vehicles	3.80±1.36	3.20±1.44	2.97±1.45	2.71±1.55	6.38	0.000**	1>2;1>3;1>4
Road parking	3.58±1.43	2.84±1.34	2.86±1.47	2.33±1.43	7.07	0.000**	1>2;1>3;1>4
Ramp and step	3.61±1.44	3.24±1.32	3.00±1.34	2.43±1.50	5.42	0.001**	1>3;1>4;2>4
Environmental facility maintenance	3.69±1.41	3.28±1.31	2.89±1.38	2.33±1.46	8.15	0.000**	1>2;1>3;1>4;2>3;2>4
Garbage bin facilities	3.75±1.37	3.44±1.28	2.98±1.36	3.05±1.40	5.36	0.001**	1>3;1>4;2>3
Environmental sanitation	3.78±1.33	3.52±1.30	3.06±1.40	3.00±1.61	4.9	0.002**	1>3;1>4;2>3

* $p<0.05$ ** $p<0.01$

In general, the satisfaction with the elderly in good health is high, while the satisfaction with the elderly in poor health is low.

There were differences in six environmental factors of satisfaction with the elderly in good health and the elderly in general health.

There were 25 environmental factors in satisfaction with the elderly in good health and those in poor health.

④ There are significant differences in ideal community outdoor environment demand degree among the elderly with different physical conditions (Table 6-5), including 4 items ($p<0.05$), which means that there are significant differences in 4 items among the samples of different 4 subgroups (Table6-7).

Table 6-7. Results of variance analysis of Physical condition and community outdoor sites demand degree

	Physical condition (Mean ± standard deviation)				F	p	Post Hoc tests
	very good (n=85)	good (n=116)	general (n=88)	worse (n=21)			
Signage facilities	3.98±1.26	3.92±1.17	3.47±1.42	3.48±1.40	3.3	0.022*	1>3;2>3
Water &Scape	4.09±1.11	3.83±1.11	3.60±1.34	3.62±1.16	2.7	0.045*	1>3
Cicadas and birds singing	4.21±1.05	3.79±1.22	3.63±1.39	3.86±1.15	3.5	0.015*	1>2;1>3
Ramp and step	4.01±1.32	3.03±1.59	3.19±1.67	3.19±1.75	7.1	0.000**	1>2;1>3;1>4

* $p<0.05$ ** $p<0.01$

The elderly in good health have high demand, while the elderly in general health has low demand.

There were differences in 1 environmental factor of the degree of demand for the elderly in very good health and the elderly in good health.

There are differences in 3 environmental factors of the degree of demand for the elderly in good health and the elderly in general health.

⑤ In summary, the differences of the elderly with different physical conditions are as follows:

The characteristics of sites that meet need of the elderly in very good health.

The elderly who are in good health are generally younger elderly. Because they often exercise outdoors, they hope to improve the fitness facilities and rest facilities in the environment. They also have higher requirements for outdoor landscape settings, and they hope to have sunshade and rain shelter facilities to meet the use of different climates and seasons.

The characteristics of sites that meet need of the elderly in good health.

The elderly in good health have a high monthly income. Go out more times and stay outdoors for a long time. Outdoor activities are mostly concentrated in the morning, in the small square between the buildings or the central square of the residential area, with singing and dancing activities. Therefore, we hope to increase the activity area to accommodate more elderly people to participate in activities. Due to the large number of people gathered, more attention to the surrounding health conditions.

The characteristics of sites that meet need of the elderly in general health.

The elderly in general health. After retirement, most people go out less often due to physical reasons. Outdoor activities are less likely to choose fitness exercise or dancing and singing.

The characteristics of sites that meet need of the elderly in worse health.

The elderly in worse health are generally elderly people of advanced age. Lower education and lower monthly income. Because outdoor activities require a walker or someone to accompany them, the length of stay is short. Most factors limit their outdoor activities.

6.2.3 The difference between device-aided elderly and nursing-cared elderly

In 2.3.4 above, older people are classified into three categories based on their living status and abilities: Self-care elderly are those who can take care of themselves and are not dependent on others for activities; Device-aided elderly are semi-disabled older people who are able to move around with the help of assistive devices such as handrails, crutches and wheelchairs; and nursing-cared elderly are mentally and physically disabled older people who require care.

The frequency analysis result of evaluating "Assistance you need for outdoor activities"

is: "No assistance is required" 278, "Walking aid or crutches" 15 people, "the Wheelchair" 3, "Escort is required" 14 people. In order to facilitate the difference comparison, the definition of "No assistance is required" for self-care elderly will be re-coded and the difference comparison in this section will not be carried out. "Walking aid or crutches" and "the Wheelchair" is defined as a Device - aided elderly (18), "Escort is required" is defined as a nursing - cared elderly (14). We used bar graphs to compare the differences in outdoor activity habits between Device-aided elderly and nursing-cared elderly. The line chart was used to compare the differences of outdoor environment satisfaction between Device-aided elderly and nursing-cared elderly.

① Differences in outdoor activity habits between device-aided elderly and nursing-cared elderly (Figure 6-4).

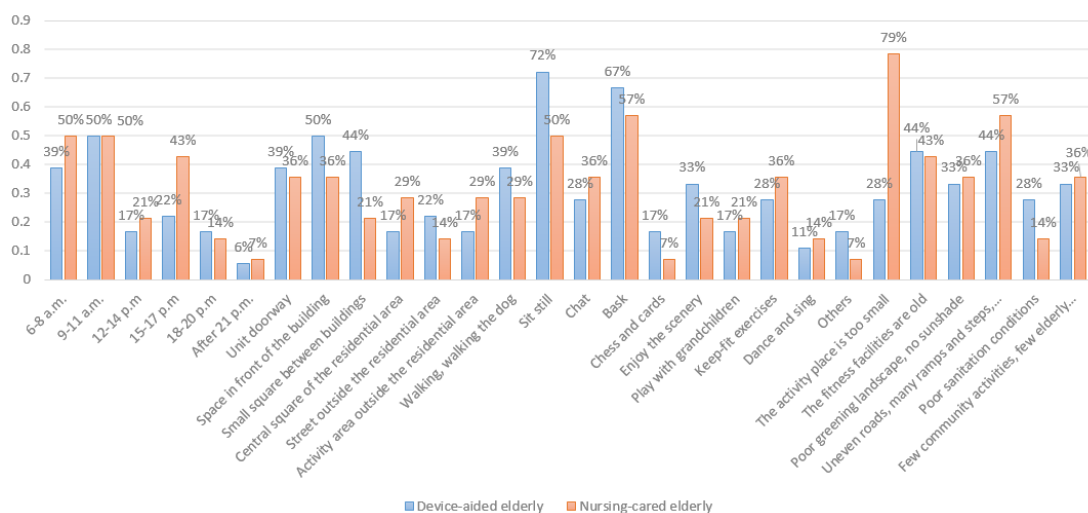


Figure 6-4. Differences in outdoor activity habits between device-aided elderly and nursing-cared elderly

As can be seen from the figure, there are some differences between device-aided elderly and nursing-cared elderly in terms of outdoor activity habits, and they also share some common features.

Device-aided elderly activity time is mostly in the morning. The activities are mainly located at the gate of the unit, the open space in front of the building, and the small square between the buildings. The main types of activities are sitting and basking. The main reasons that hinders outdoor activities are old fitness facilities, no rest seats, poor landscaping, no shading, uneven roads, ramps and steps, and parking.

Nursing-cared elderly are also mostly in the morning. But it's also more popular with 15 and 17 p.m. In addition to the gate of the unit and the open space in front of the building, the activity scope also includes the central square of the residential area and the activity area outside the community. The main types of activities are sitting and basking. The main reason for impeding outdoor activities are that activity places are too small for most people. And the road is uneven, ramp steps, parking occupied.

② Differences in satisfaction of community outdoor environment between device-aided elderly and nursing-cared elderly (Figure 6-5).

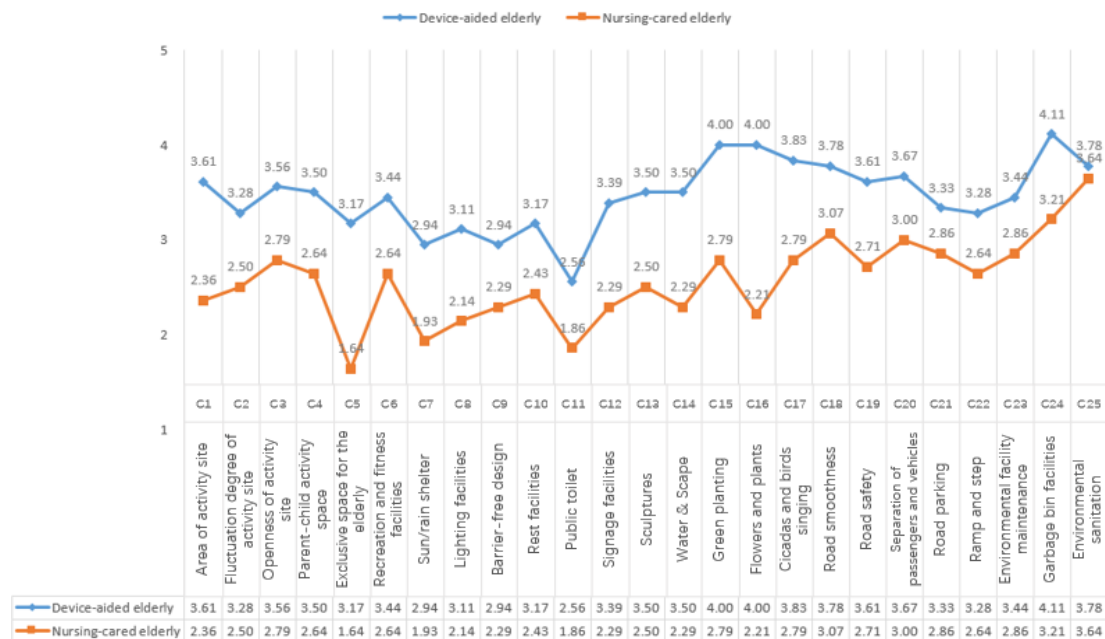


Figure 6-5. Differences in satisfaction of community outdoor environment between device-aided elderly and nursing-cared elderly

A comparative analysis of satisfaction with the outdoor environment in the communities where device-aided elderly and nursing-cared elderly currently live was carried out using the Likert scale method. The scale consists of five responses: dissatisfied, somewhat dissatisfied, unimportant, somewhat satisfied and satisfied, and is rated on a five-point scale (1, 2, 3, 4 and 5, with higher scores being better). With 3 as the reference level, >3 is a good rating and <3 is a poor rating.

As can be seen from the table, the device-aided elderly studied were more satisfied with the overall environment of the community they live in than the nursing-cared elderly. the device-aided elderly were more satisfied with the environment as a factor. In addition to low satisfaction with the C11 public toilets, they also expressed low satisfaction with the C7 shade and rain shelter and C9 accessibility design of the environment.

Nursing-cared elderly had more factors of dissatisfaction with the environment. Only C24 and C25 were relatively satisfied with the sanitary aspects of the environment. Among the road factors C18 accessibility and C20 separation of pedestrian and vehicle traffic reached the baseline. Satisfaction with the existing environment was the lowest in C5 the setting of exclusive grounds for the elderly.

③In summary, the differences between device-aided elderly and nursing-cared elderly are as follows:

Characteristics of the sites that meet the need of device-aided elderly.

The outdoor activities for the device-aided elderly are mostly concentrated in the morning. They sit quietly and bask in the sun at the doorway of the unit, the open space in front of the building, and the small square between buildings. They are relatively satisfied with the outdoor environment. If the road is uneven, more ramps and steps will seriously affect their travel. Therefore, the barrier free design in the environment is highly required. If expecting to extend the outdoor activity time, also expect to increase the rest seats and improve the sun shading and rain shelter facilities.

Characteristics of the sites that meet the need of nursing-cared elderly.

Nursing-cared elderly outdoor activities are mostly concentrated in the morning. There are also more outdoor activities in the afternoon from 15-17pm. Most of the activities are meditation and sunbathing. The range of activities is relatively large because they are accompanied by someone. Satisfaction with the outdoor environment is low. If the roads are uneven and there are many ramps and steps, this limits their mobility. However, they are relatively satisfied with the smoothness of the roads around the residential area and the separation of pedestrian and vehicle traffic. I would like to have an exclusive space for the elderly. And a larger area for activities, so that more people can be seen moving around, increasing the willingness to do so.

6.3 Path analysis

Path analysis is used to study the influence relationship between multiple potential variables and verify the model assumptions (Figure 6-6). This section uses path analysis to measure personal attributes, family attributes, physical conditions, activity habits and satisfaction, demand and the relationship among several variables, and analyze how they affect the activities and characteristics of the elderly in the outdoor community environment.

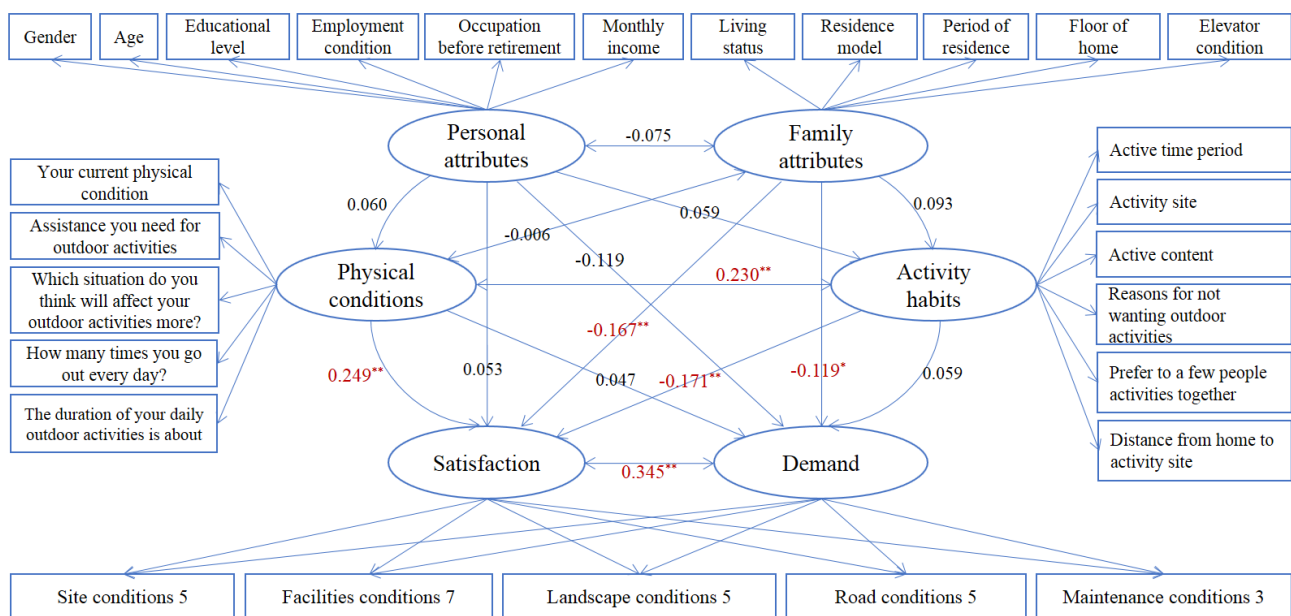


Figure 6-6. Path analyzes the influence relationship between multiple latent variables

6.3.1 Test of degree of model fit

Before analyzing its path coefficient, it is necessary to first perform a fit test, that is, to test the matching degree of the hypothesis model to the sample data. Use spss23 AMOS software to establish path analysis and make statistics, and use GFI, CFI, NFI, IFI, SRMR and other information standards to evaluate the model. The fitting index of the model is: GFI=0.986(>0.9), CFI=0.937(>0.9), NFI=0.929(>0.9), IFI=0.945(>0.9), SRMR=0.044 (<0.1) . The measured value is within the acceptable range of the fitting index, indicating that the model data is well fitted (Table6-8).

Table 6-8. Model fitting index

Commonly used indicators	χ^2	df	p	Chi-square	GFI	RMSEA	RMR	CFI	NFI	NNFI
				freedom ratio						
Judgment criteria	-	-	>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
Value	8.499	2	0.014	4.249	0.986	0.103	27.732	0.937	0.929	0.945
Other indicators	TLI	AGFI	IFI	PGFI	PNFI	SRMR	RMSEA 90% CI			
Judgment criteria	>0.9	>0.9	>0.9	>0.9	>0.9	<0.1	-			
Value	0.461	0.857	0.945	0.094	0.109	0.044	0.039 ~ 0.178			

Default Model: $\chi^2(17)=119.498, p=1.000$

6.3.2 Research hypothesis test

Table 6-9. Summary table of model regression coefficients

X	→	Y	Unnormalized path coefficients	SE	z (CR Value)	p	Normalized path coefficient
Personal attributes	→	Demand	-1.191	3.481	-0.342	0.732	-0.019
Family attributes	→	Demand	-6.012	2.866	-2.098	0.036	-0.119
Activity habits	→	Demand	0.337	0.331	1.020	0.308	0.059
Physical conditions	→	Demand	0.540	0.661	0.817	0.414	0.047
Personal attributes	→	Activity habits	0.634	0.613	1.035	0.301	0.059
Family attributes	→	Activity habits	0.830	0.504	1.648	0.099	0.093
Personal attributes	→	Satisfaction	3.849	3.886	0.990	0.322	0.053
Family attributes	→	Satisfaction	-9.905	3.199	-3.096	0.002	-0.167
Activity habits	→	Satisfaction	-1.139	0.369	-3.088	0.002	-0.171
Physical conditions	→	Satisfaction	3.325	0.738	4.503	0.000	0.249
Personal attributes	→	Physical conditions	0.322	0.306	1.052	0.293	0.060
Family attributes	→	Physical conditions	-0.025	0.252	-0.101	0.919	-0.006

Note: → Indicates the path influence relationship

It can be seen from the above table (Table 6-9) that by comparing the revised path analysis with the research hypothesis, 4 hypotheses have passed the test.

When the family attributes affect demand, the standardized path coefficient value is $-0.119 < 0$, and this path shows a significance of 0.05 levels ($z = -2.098$, $p = 0.036 < 0.05$). Therefore, it indicates that the family attributes will have a significant negative impact on demand. The hypothesis holds.

When family attributes affect satisfaction, the coefficient value of standardized path is $-0.167 < 0$, and this path shows significance of 0.01 levels ($z = -3.096$, $p = 0.002 < 0.01$). Therefore, it indicates that family attributes will have a significant negative impact on satisfaction. The hypothesis holds.

When activity habits affect satisfaction, the standardized path coefficient value is $-0.171 < 0$, and this path shows significance of 0.01 levels ($z = -3.088$, $p = 0.002 < 0.01$). Therefore, activity habits will have a significant negative impact on satisfaction. The hypothesis holds.

When physical conditions affect satisfaction, the coefficient value of standardized path is $0.249 > 0$, and this path shows significance of 0.01 levels ($z = 4.503$, $p = 0.000 < 0.01$). Therefore, it indicates that physical conditions have a significant positive impact on satisfaction. The hypothesis holds.

Table 6-10. Covariance table

X	Y	Non-standard estimation coefficients (Coef.)	Std. Error	z	p	Std. Estimate
Personal attributes	Family attributes	-0.012	0.009	-1.326	0.185	-0.075
Satisfaction	Demand	201.192	32.949	6.106	0.000	0.345
Physical conditions	Activity habits	1.761	0.443	3.974	0.000	0.230

As can be seen from the above table (Table6-10):

As for the covariance relationship (correlation) between satisfaction and demand, the standardized path coefficient value is $201.192 > 0$, and this path shows a significance of 0.01 levels ($z = 6.106$, $p = 0.000 < 0.01$), which indicates that there is a significant positive covariance correlation between satisfaction and demand.

As for the covariance relationship (correlation) between physical conditions and activity habits, the standardized path coefficient value is $1.761 > 0$, and this path shows a significance of 0.01 levels ($z = 3.974$, $p = 0.000 < 0.01$), which indicates that there is a significant positive covariance correlation between physical conditions and activity habits.

6.3.3 Comprehensive analysis

① Family attributes are significantly associated with satisfaction. Family attributes are significantly associated with demand. And both are negatively impacted.

Community outdoor environments are built with a certain periodicity (Jiang C.X.,2001). As time passes, urban community outdoor environments are bound to age. The longer the age of residence in a household property, the higher the degree and rate of aging of

the community environment and facilities. Both satisfaction and demand as assessed by older people will decrease as a result.

② Activity habits are significantly associated with satisfaction. They are negatively impacted.

Outdoor activity time periods, activity sites and activity types are all associated with satisfaction. As older people's need for outdoor activities increases, the more they demand more of the outdoor venue environment, and the less satisfied they are with it.

③ Physical conditions are significantly associated with satisfaction. They are positively impacted.

The better the physical condition of the older person, the more able they are to cope with the stresses of the outdoor environment on their own. The more adaptable they are to their environment. Satisfaction with a stress-free environment is higher.

④ Satisfaction is significantly associated with demand. They are positively covariance correlated.

The correlation between satisfaction and neediness was significant. The environment preferred by older people may also be influenced by the characteristics of the environment they live in. Older people who live in a beautiful and scenic environment also pay more attention to the aesthetic elements of buildings and landscapes. This is why satisfaction with the outdoor environment of the community is high and the need for an ideal community is also higher.

⑤ Physical conditions are significantly associated with activity habits. They are positively covariance correlated.

Physical condition and activity habits correlate significantly. The type of activity was related to the physical activity level of older people. Outdoor activities also tended to be more restricted and hindered for those older people that had significant mobility limitations or were less able to take care of themselves. There is a direct impact on their activities time, location and type of activity.

6.4 Summary

The P-E Matching theory elaborates the mechanism of the elderly matching with the environment from the perspective of space, emphasizing the corresponding relationship between environmental pressure and internal needs. Environmental pressure plays an important role in promoting or hindering the satisfaction of needs. The high satisfaction of the community's outdoor environment indicates that individuals have no pressure in the environment, and can judge people and environment match with each other, and the environment is aging-friendly (Kahana E.,1974;1983; Lawton M P. et al.,1979). And vice versa.

The outdoor environment should meet the needs of different types of elderly activities.

The higher the matching degree, the higher the adaptability of the elderly. The elderly outdoor activities are mainly affected by the two dimensions including facility configuration and site space. Among them, the elderly with low individual ability are more stressed by the environment and pay more attention to the basic service ability of the environment, the reasonable allocation of seats, the shelter facilities and the accessibility of the sites are the main factors that affect whether such elderly people can adapt to the outdoor environment; Elderly people with high individual ability have a weak perception of the existing environmental pressure, and most of them think that the environment is simple and boring. They pay more attention to the entertainment function of the facilities and the fun of the activity space for their environmental needs. Various environmental factors form environmental pressure on the elderly's individual adaptability to varying degrees.

From the perspective of the use of community outdoor site, there are differences among the elderly groups with different aging degrees, health conditions and living conditions. According to the elderly ecological model, changes in the relationship between the elderly's individual ability and environmental pressure have different impacts on the elderly.

① Individuals with a high level of personal competence. Individuals who can adapt fully to the environment of the community in which they live, thus maintaining good health and a high quality of life.

② Individuals with a high level of individual ability. When environmental stressors are appropriately beyond their individual capabilities, i.e. in the "zone of maximum performance potential", they can stimulate older people to a certain extent. It should not be taken for granted that all environmental barriers are always detrimental to health. There is a small body of research that suggests that certain environmental barriers may act as a form of exercise and help or maintain physical function. By encouraging older people to overcome environmental stress, the individual abilities of older people are gradually improved to some extent.

③ Individuals with lower personal capabilities. Older people that have a slight disability or a slight mobility impairment has difficulty adapting to higher levels of environmental stress. Complementary support can be provided to help reduce the stress of their environment.

④ Individuals with very low personal capacity. For older people that have significant mobility limitations or who are less able to care for themselves, even small environmental stresses can be very stressful. Very low environmental demands may therefore be appropriate for this group of older people. The principles mentioned earlier also apply to this lower level.

⑤ Device-aided elderly and nursing-cared elderly are unable to participate in most outdoor activities due to declining physical functions Limited by the terrain conditions of Dalian, the slope of the terrain is large, and it is not possible to go to further places.

Sitting around, talking, watching or listening to other people's activities is the only way to "fit in". Places with monotonous or fixed functions are "boring and uninteresting" according to the elderly. They are more willing to choose functional places for activities. Their types of outdoor activities tend to be monotonous due to the limitation of physical health reasons, which leads to the unavailability of some activities facilities. It is hoped that relevant rehabilitation training facilities can be configured in the community.

We also found that the outdoor activities of the elderly are mainly determined by the interaction and influence of personal attributes, family attributes, physical conditions, activity habits and satisfaction, demand and several variables. The elderly in good health often feel that the community environment is free of pressure, so they are more satisfied with the community outdoor sites. Such elderly can participate in various outdoor activities due to their good physical conditions, which are also not restricted by the activity site. However, since the environment will not change dynamically due to aging, the environmental pressure will increase when the individual ability decreases. Long-term residence can lead to a decrease in satisfaction with the area's environment. In conclusion, social ecological model shows that the complex and dynamic interrelationship among individual, social and environmental factors shapes physical activities and behaviors. The demand for outdoor activities of the elderly is also formed by these factors.

Chapter 7.

Outdoor environment evaluation system of elderly livable communities

The research purpose of this chapter is to establish a relatively complete outdoor environment evaluation system of elderly livable communities. Through the application of this evaluation system, we can find a short board for the outdoor environment of the community that affects the activities of the elderly, and provide strategies in the actual renovation and construction of the community.

Step1:Model construction and connotation analysis. Use grounded theory to collect data and code. Determine the criterion layer environmental factors and sub-category environmental factors.

Step2:Weight calculation of the evaluation index system. The index weighting follows the principle of the superiority chart method. The hierarchical structure of the evaluation system is constructed. First, the weight of the criterion layer is calculated, then the weight of each index layer is summarized, and finally the total ranking weight of the hierarchy is calculated.

Step3:Comparison of index scores of sample communities. Determine the scoring criteria and scoring methods of the evaluation system. Comprehensively calculate the index scores of each community through subjective and objective indicators. Weigh and accumulate all scores to finally obtain the final score of each sample community.

Step4:The evaluation results are compared and analyzed, and targeted strategies for improving the outdoor environment of each community are proposed.

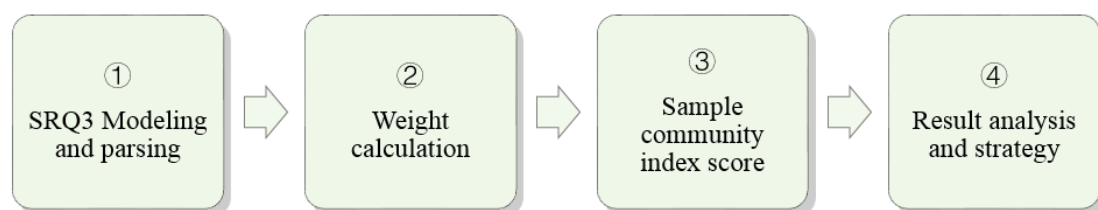


Figure 7-1. Chapter 7 Research steps

7.1 Model construction and theoretical analysis

7.1.1 Model construction

The research of relevant institutions and scholars at home and abroad has laid a solid foundation for the subsequent research and provided a useful reference for the development of the research in this chapter. Based on China's national conditions and new practical requirements, this paper proposes an outdoor environment evaluation system of elderly livable communities through literature review and objective analysis. The key to building the outdoor environment evaluation system of elderly livable communities is to determine the construction method of the indicator system and its weighting method. The rationality, scientificity and accuracy of the indicator weight directly affect the reliability of the evaluation system. Therefore, the selection of the system construction method is the most important part of the overall comprehensive evaluation system.

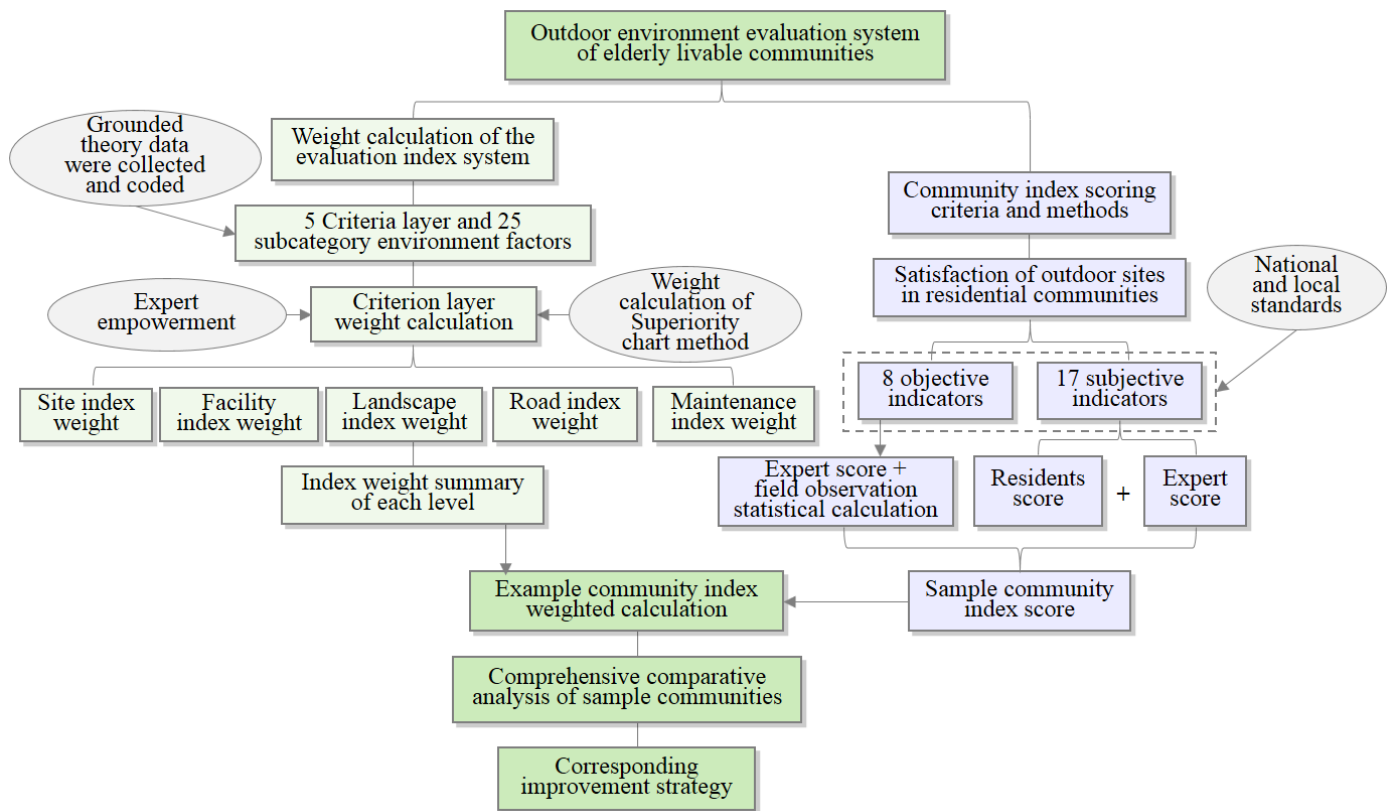


Figure 7-2. Model of outdoor environment evaluation system of elderly livable communities

Green hierarchy is the index system weighting method. Experts participate in the weighting of specific indicators. The superiority chart method is used to calculate the weight of the criterion layer first, and then calculate the weight of specific indicators under each criterion layer. Finally, the weights of indicators at all levels are summarized

and the total ranking weights of indicators at all levels are calculated. The three-level hierarchical structure of the evaluation system with scientificity and stability and the accurately quantified indicator weights are obtained. All indicators have the characteristics that can be specifically quantified.

Purple hierarchy is the scoring criteria and methods for the indicators of the sample community. First, the outdoor satisfaction evaluation of the current residential community in the questionnaire is divided into 8 objective indicators and 17 subjective indicators in combination with the relevant national and local standards. Then, the experts score the objective indicators in combination with the statistical results of field observation. The elderly and experts participating in the survey score the subjective indicators respectively. Finally, according to the scoring method, calculate the index scores of the outdoor sites in the sample community.

Finally, the scores of each index of the outdoor site in the sample community are weighted, the results are analyzed and compared, and the corresponding improvement strategies are given.

7.1.2 Grounded theory

Grounded theory is an important qualitative research theory jointly proposed by sociologists Barney Glaser and Anselm Strauss in 1967 (Glaser B.G. et al., 1967). After decades of research verification by scholars, grounded theory is considered as a practical and effective research method, and its main purpose is to establish theory on the basis of empirical data (Xie T.P., 2018). Generally speaking, before starting the grounded theory research, there is no and there is no need for theoretical assumptions, instead, open interviews, literature analysis, participatory observation and other methods are used to systematically collect data, and then the data are classified and coded, their core concepts are extracted, and relevant theories are generated by revealing the connections between concepts (Xie T.P., 2018; Li Y.P. et al., 2018)

In this study, grounded theory is used to obtain data through semi-structured interview, literature review and field observation, and normative steps are used for qualitative analysis of data. The process is illustrated in Figure 7-3.

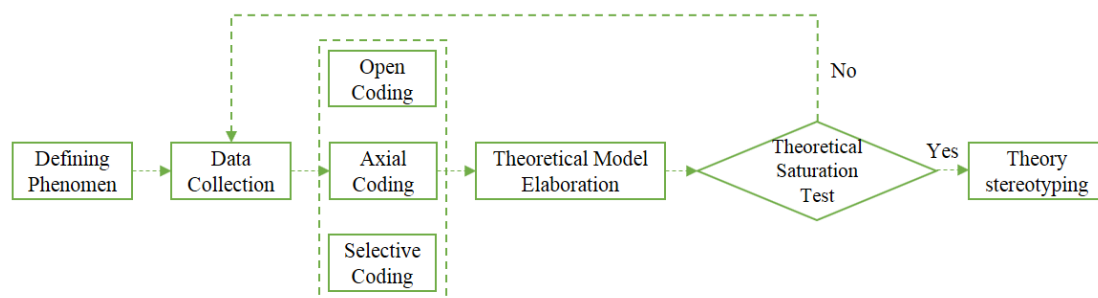


Figure 7-3. The research paradigm of programmed grounded theory (Source: author)

The basic data of the grounded theory can generally be derived from the extant texts such as policy documents and literatures, and the elicited texts such as questionnaires and interviews.

7.1.3 Preliminary screening of site environmental factors based on literature.

Based on the literature, the research is conducted on the outdoor environment of the community and the quality of life of the elderly. The site environmental factors potentially affecting outdoor activities are screened out (Table 7-1). Through the literature quality assessment, the research quality is determined to be good, and the research conclusions can be adopted. Most of the research has been done through these factors: Area, Vegetation, Related to travel motivation, Traffic stations, Parking, Seat, Activity facilities, Public toilets, Garbage collection facilities, Lighting, Shelter facilities, Waterscape, Sculpture, Bird, Site maintenance, Accessibility.

Table 7-1. Summary of site attraction factors for potential impact activities (Source: author)

Elements	Reasons for potential impact on site use	Source	Elements	Reasons for potential impact on site use	Source
Area	Provide the necessary area of activity	Shi Yingfang (2009) ; xie Yamei (2015)	Garbage collection facilities	Collect all kinds of wastes discharged during activities to ensure clean environment	Turel et al. (2007); Zhang Yunji (2009)
Vegetation	Provide viewing objects and social space	Humpel et al. (2002) ; kaczynski, Henderson (2007) ; aspinall et al. (2010) ; kemperman, Timmermans (2014)	Lighting	Replenish light for outdoor activities at night	Kwok, Ng (2008) ; Woo et al. (2010)
Related to travel motivation	①Related to travel motivation, including banks, supermarkets, drug shops, educational facilities, etc. ②Related to social needs, such as cafes	①Xie Yamei (2015) ; sun Cui Cui etc (2016) ②Aspinall et al. (2010)	Shelter facilities	Provide sun shading and rain protection services	Lin Wenjie et al. (2011); Sun Cuicui et al. (2016)
Traffic stations	Provide public transport services	Aspinall et al. (2010) ; Yung et al. (2016)	Waterscape	Provide viewable objects	Thompson et al. 2008; Kwok and ng (2008)
Parking	Provision of motor vehicle travel services	Clarke and Nieuwenhuijsen (2009a, 2009b) ; Labus (2011)	Sculpture	Provide viewable objects	Turel et al. (2007)
Seat	①Conventional seats, meeting the needs of rest; ②Auxiliary seats, flower bed edge, steps, etc., to meet the needs of rest ;	①Whyte (1980) ; Aspinall et al. (2010) ②Kwok, Ng (2008) ; Day (2008)	Bird	Provide viewable objects	Corti et al. (2005); Chen et al. (2016)
Activity facilities	①Equipment required for exercise and rehabilitation training, such as outdoor fitness equipment ②Provision of equipment required for chess and card activities, such as chess and card facilities, usually in conjunction with fitness facilities ③Provide facilities needed for vigorous sports, such as gate courts and table tennis courts	①Lin Yongqiang, Shi Yi (2002); Chow (2013) ②Lin Wenjie et al. (2011); Xie Yamei (2015) ③Xie Yamei (2015); He Liyu (2017)	Site maintenance	If the site and facilities are damaged or unsanitary, it will cause a sense of insecurity and affect the use	Aspinall et al. (2010); Kemperman, Timmermans (2014)
Public toilets	Meet physiological needs	Thompson et al. (2008) ; temelova, Dvorakova (2012) ; sun Cui Cui et al. (2016)	Accessibility	Fall prevention	Lin Yongqiang, Shi Yi (2002); Luo Yimin (2018)

7.1.4 The site environmental elements were preliminarily screened based on in-depth interviews

Scholar Charmaz pointed out that grounded theory method and in-depth interview are method both open and directional, both formed and naturally generated, both step-by-step and flexible, and in-depth interview is particularly suitable for grounded theory

method (Charmaz K.,2006). Therefore, this study uses the form of in-depth interviews with elderly people in community outdoor activities to ensure data availability, reliability and accuracy.

① Before the interview, the content of the interview was set: firstly, basic information about the older person and secondly, the older person's perception of the community environment they live in (Appendix 2). Two main objectives were achieved: firstly, to investigate which environmental factors of the activity venue are of concern to older people's needs when they are outdoors in the community? What are the environmental factors that affect the visit of older people? And to make a brief evaluation of the current environmental quality. The second is to preview the satisfaction with the availability of sites and the measurement of the demand for older people's activities.

② In the interview, 13elderly people were interviewed face-to-face from April 4-6, 2022. The face-to-face interviews were suspended due to the global coronavirus pandemic. Then 35older adults were interviewed on the telephone. Among them, 18 (37.5%) were male and 30 (62.5%) were female(Appendix 2).



Figure 7-4. The researchers conducted in-depth interviews with the elderly (Source: author)

Respondents were informed before the conversation that the call would be recorded. And guide the interviewees to conduct a free style interview. No specific environmental factors were set for the respondents, so as to fully understand the environmental characteristics of the elderly's outdoor activity demand, so as to scientifically determine the data needed for research. It should be emphasized that the investigators avoided the use of academic vocabulary when collecting materials, and both the elderly interviewed and the investigators communicated orally.

③ After the interview, the investigator summarized the contents of the call records. After Open Coding, the collected interview data were preliminarily processed. To Axial Coding constant comparative analysis, the main category are found. Selective Coding was used to cluster the main categories at the system level.

A total of 465 phrases were mentioned by the elderly when they paid attention to

environmental characteristics during outdoor activities (Appendix 3). Five types of environmental factors, including site, facility, landscape, road and maintenance, are obtained (Table 7-2).

Table 7-2. Index system of environmental factors of outdoor sites in livable community for the elderly

5 Criteria layer environmental factors	25 Sub-category environmental factors	Code
Site conditions	Area of activity site	C1
	Fluctuation degree of activity site	C2
	Openness of activity site	C3
	Parent-child activity space	C4
	Exclusive space for the elderly	C5
Facilities conditions	Recreation and fitness facilities	C6
	Sun/rain shelter	C7
	Lighting facilities	C8
	Barrier-free design	C9
	Rest facilities	C10
	Public toilet	C11
	Signage facilities	C12
Landscape conditions	Sculptures	C13
	Water &Scape	C14
	Green planting	C15
	Flowers and plants	C16
	Cicadas and birds singing	C17
Road conditions	Road smoothness	C18
	Road safety	C19
	Separation of passengers and vehicles	C20
	Road parking	C21
	Ramp and step	C22
Maintenance conditions	Environmental facility maintenance	C23
	Garbage bin facilities	C24
	Environmental sanitation	C25

On the basis of comprehensive literature review and in-depth interview information, 5 categories of environment are taken as criterion layer factors, and the environmental factors mentioned frequently in the survey are selected for classification and sorting. The influencing factors are screened according to 26 experts in urban and rural planning and design and students in environmental design. The factors that the experts have doubts about and think have little impact are discussed and summarized. At the same time, the community design specifications are compared, 1 first-class index (target layer), 5 second-class indexes (criterion layer) and 25 third-class indexes (index layer) of environmental factors were established. The constructed environmental factors are scientific, comprehensive, clear and universal.

7.2 Weight calculation of evaluation index system

Indicator assignment followed the principles of Superiority chart method. The distribution and return to the expert questionnaire for the evaluation indicator system in this paper were focused on 18 May 2022. It was distributed among 26 experts,

scholars, designers and students in the field of environmental design to obtain professional opinions and insights. After the opinions were combined and tallied, the final indicator weights were calculated and tested for consistency.

7.2.1 Basic principles and steps of Superiority chart method

The superiority chart method is a method proposed by P.E. Moody in 1983. It analyzes the importance of each factor to the target by means of a matrix diagram to provide a basis for management decisions. The superiority chart method sets n as the comparison object to rank separately, and scores each serial number separately to obtain the priority number. Then it conducts a comprehensive evaluation, calculate the total priority number of each evaluation index separately. Evaluate according to the value of the total priority number. The superiority chart method is simple in application, which can handle both quantitative and qualitative problems, so it is more convenient to promote (S.Isaac,2016).

The specific operation method is as follows: multiple experts rank specific evaluation schemes, establish a judgment matrix by comparing two schemes, and use "0" and "1" to represent the advantages and disadvantages of the schemes: "1" represents the more "excellent" and "important" schemes in the comparison between two schemes; "0" represents "inferior" and "unimportant"; If the comparison between the two is equivalent, a score of 0.5 (Table 7-3) can be used. The specific steps are as follows:

- ① Experts compare the comparison targets and fill in "0", "1" and "0.5" for identification;
- ② Add together the lines of each comparison target to get the total priority number of the target;
- ③ Comprehensively calculate the total priority number of all comparison targets to obtain the sum of total priority number;

Table 7-3 Superiority chart method Table for calculating the weights

Mean	Item	Maintenance conditions	Facilities conditions	Road conditions	Landscape conditions	Site conditions	TTL (Index score)	weight
1.885	Maintenance conditions	0.5	0	0	0	0	0.5	4.00%
2.577	Facilities conditions	1	0.5	0	1	0	2.5	20.00%
3.462	Road conditions	1	1	0.5	1	0	3.5	28.00%
3.115	Landscape conditions	1	0	0	0.5	0	1.5	12.00%
3.962	Site conditions	1	1	1	1	0.5	4.5	36.00%

7.2.2 Criterion layer and index layer weight calculation

The weight values of each criterion layer are obtained by comparing the data onto the criterion layer in the questionnaire with the judgement of the The superiority chart method. And after the calculation of the consistency test of the judgment matrix. It is concluded that the judgment matrix meets the requirements and there is no contradiction between the data. The specific data can be seen in the following table (Table 7-4).

According to Table 7-4, the weights of the five environmental factors are Site, Road, Facilities, Landscape, and Maintenance. Site (36%) has the highest weight and Maintenance (4%) has the lowest weight. Therefore, experts in the field of environmental design mainly focus on the site, road and facilities for community outdoor aging, and pay relatively little attention to the landscape, and the lowest attention to the maintenance.

Table 7-4. Weight Calculation of Priority Graph

critierion layer	mean	TTL (Index score)	Weight value
Maintenance	1.885	0.5	4.00%
Landscape	2.577	1.5	12.00%
Facilities	3.115	2.5	20.00%
Road	3.462	3.5	28.00%
Site	3.962	4.5	36.00%

① Table 7-5. shows that the weight order for the five types of site factors is Elderly exclusive sites, Activity area size, Openness of activity sites, Parent-child activity space, and risk of sites. Fluctuation degree of activity site. In terms of site factors, experts pay more attention to the Elderly exclusive sites (36%), and the Fluctuation degree of activity sites (4%) show the least attention.

Table 7-5. Weight calculation results of site

Item	mean	TTL (Index score)	Weight value
Area of activity site	4.154	3.5	28.00%
Fluctuation degree of activity site	3.654	0.5	4.00%
Openness of activity site	4.077	2.5	20.00%
Parent-child activity space	3.846	1.5	12.00%
Exclusive space for the elderly	4.231	4.5	36.00%

② Table 7-6 can be obtained, seven factors weight sorting facilities for Barrier - free design, Lighting facilities, Rest facilities, Public toilets, Fitness facilities, Guide marking facilities, Shading/Rain shelter facilities, among site factors, experts pay more attention to the Barrier free design (26.53%). Shading/Rain shelter facilities (2.04%) scored the least.

Table 7-6. Weight calculation results of Facilities

Item	mean	TTL (Index score)	Weight value
Recreation and fitness facilities	4.385	2	8.16%
Sun/rain shelter	4.308	0.5	2.04%
Lighting facilities	4.538	5	20.41%
Barrier-free design	4.577	6.5	26.53%
Rest facilities	4.538	5	20.41%
Public toilet	4.462	3.5	14.29%
Signage facilities	4.385	2	8.16%

③ Table 7-7 can be obtained, 5 factors weight sorting into The Green landscape planting, Flower ornamental, Waterscape, The cicada sings The bird, its sketches, Among the site factors, the experts focused more on Green planting (36%), Sculpture sketches (4%) got the least attention.

Table 7-7. Weight calculation results of Landscape

Item	mean	TTL (Index score)	Weight value
Sculptures	3.731	0.5	4.00%
Water & Scape	3.808	2.5	20.00%
Green planting	4.538	4.5	36.00%
Flowers and plants	4.269	3.5	28.00%
Cicadas and birds singing	3.769	1.5	12.00%

④ According to Table 7-8, the weights of the five types of Road factors are Road safety, Road patency, Traffic diversion, Slopes, steps, Road parking. Among the site factors, experts pay more attention to road safety (36%). Road parking (4%) received the lowest attention.

Table 7-8. Weight calculation results of Road

Item	mean	TTL (Index score)	Weight value
Road smoothness	4.5	3.5	28.00%
Road safety	4.692	4.5	36.00%
Separation of passengers and vehicles	4.308	2.5	20.00%
Road parking	4.038	0.5	4.00%
Ramp and step	4.192	1.5	12.00%

⑤ According to Table 7-9, the weights of the three maintenance factors are Environmental facilities maintenance and Garbage bin facilities, among which Hygiene Situation (11.11%) receives the least attention.

Table 7-9. Weight calculation results of Maintenance

Item	mean	TTL (Index score)	Weight value
Environmental facility maintenance	4.385	2	44.44%
Garbage bin facilities	4.385	2	44.44%
Environmental sanitation	4.346	0.5	11.11%

7.2.3 Summary of indicator weights at each level

After comprehensive summary of the weights of indicators at all levels calculated in the above table, the summary table of weight indicators (Table 7-10) are obtained. The summary table can visually see the weight proportion of each criterion layer and the weight proportion of each criterion layer within the criterion layer.

Table 7-10. Index weight summary of each level

Criterion layer	Weight A-B	Index layer	Weight B-C
B1 Site	0.36	Area of activity site	C1 0.28
		Fluctuation degree of activity site	C2 0.04
		Openness of activity site	C3 0.20
		Parent-child activity space	C4 0.12
		Exclusive space for the elderly	C5 0.36
		Recreation and fitness facilities	C6 0.08
B2 Facilities	0.20	Sun/rain shelter	C7 0.03
		Lighting facilities	C8 0.20
		Barrier-free design	C9 0.27
		Rest facilities	C10 0.20
		Public toilet	C11 0.14
		Signage facilities	C12 0.08

			Sculptures	C13	0.04
			Water &Scape	C14	0.20
B3 Landscape	0.12		Green planting	C15	0.36
			Flowers and plants	C16	0.28
			Cicadas and birds singing	C17	0.12
			Road smoothness	C18	0.28
			Road safety	C19	0.36
B4 Road	0.28		Separation of passengers and vehicles	C20	0.20
			Road parking	C21	0.04
			Ramp and step	C22	0.12
			Environmental facility maintenance	C23	0.44
B5 Maintenance	0.04		Garbage bin facilities	C24	0.44
			Environmental sanitation	C25	0.12

7.2.4 Calculate the total ranking weight of indicators at all levels

After calculating the respective weights of indicators at all levels, it is necessary to calculate the weight of the total ranking of the levels, that is, to calculate the proportion of each of the 25 indicators in this evaluation system. The calculation method is as follows:

Weight of index $C_i = (\text{Weight}_{A-B}: \text{the criterion layer weight of index } C_i) * (\text{Weight}_{B-C}: \text{the proportion of index } C_i \text{ in the criterion layer weight})$

For specific values of Weight_{A-B} and Weight_{B-C} , see Table 7-10 above.

After the calculation of the total ranking weight of the hierarchy, the following Table 7-11 is obtained, where the weight column of index C_i is the final index weight value (reserved to 3 decimal places).

Table 7-11. Weight Calculation of Hierarchical Total Ranking

		Weight _{A-B}					Weight of indicator C_i
		Site	Facilities	Landscape	Road	Maintenance	
Weight _{B-C}							$\sum WAB*WBC$
C1	Area of activity site	0.36	0.20	0.12	0.28	0.04	0.100
C2	Fluctuation degree of activity site	0.28					0.014
C3	Openness of activity site	0.04					0.072
C4	Parent-child activity space	0.20					0.043
C5	Exclusive space for the elderly	0.12					0.130
C6	Recreation and fitness facilities	0.36	0.08				0.016
C7	Sun/rain shelter		0.03				0.006
C8	Lighting facilities		0.20				0.040
C9	Barrier-free design		0.27				0.054
C10	Rest facilities		0.20				0.040
C11	Public toilet		0.14				0.028
C12	Signage facilities		0.08				0.016
C13	Sculptures			0.04			0.005
C14	Water& Scape			0.20			0.024
C15	Green planting			0.36			0.043
C16	Flowers and plants			0.28			0.034

C17	Cicadas and birds singing	0.12	0.014
C18	Road smoothness	0.28	0.078
C19	Road safety	0.36	0.100
C20	Separation of passengers and vehicles	0.20	0.056
C21	Road parking	0.04	0.011
C22	Ramp and step	0.12	0.037
C23	Environmental facility maintenance	0.44	0.017
C24	Garbage bin facilities	0.44	0.017
C25	Environmental sanitation	0.12	0.005

By ranking the weights of all the indicators (Figure 7-5), it can be found that after a comprehensive rating by 26 experts and scholars, the three indicators with the highest comprehensive weights among all the indicators of the outdoor environment evaluation system of elderly livable communities are the exclusive space for the elderly (13%), area of activity site (10%) and road safety (10%), while the three indicators with the lowest comprehensive weights are sun/rain shelter (0.6%), sculptures (0.5%) and environmental sanitation (0.5%).

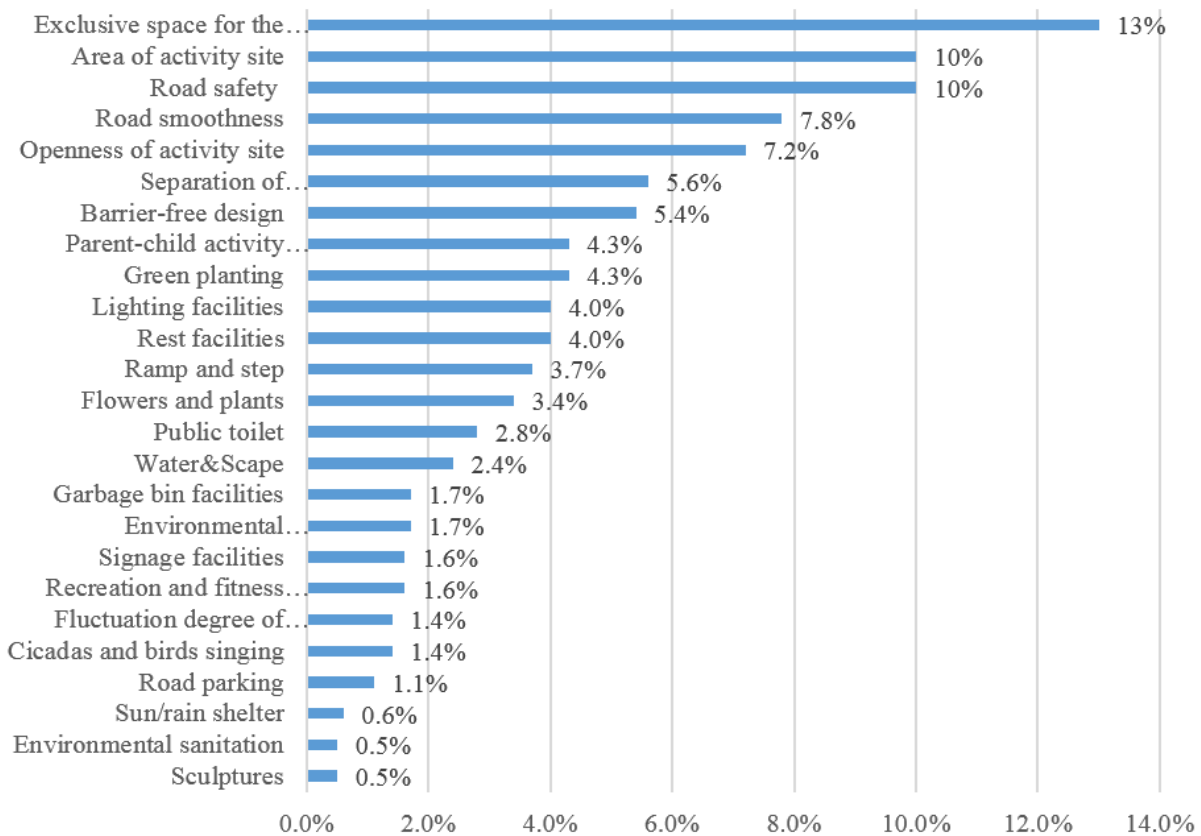


Figure 7-5. Total ranking weight distribution diagram of indicators

The complete Outdoor environment evaluation system of elderly livable communities hierarchy and weight distribution can be seen in Table 7-12 below., which can serve as a reference for the system and weights in the specific research and calculation process.

Table 7-12. Outdoor environment evaluation system of elderly livable communities hierarchy and weight distribution

Target layer	Criterion layer	Criterion layer weight	Index layer weight
Outdoor environment evaluation system of elderly livable communities	Site conditions	0.36	Area of activity site (0.100); Fluctuation degree of activity site (0.014); Openness of activity site (0.072); Parent-child activity space (0.043); Exclusive space for the elderly (0.130)
	Facilities conditions	0.20	Recreation and fitness facilities (0.016); Sun/rain shelter (0.006); Lighting facilities (0.040); Barrier-free design (0.054); Rest facilities (0.040); Public toilet (0.028); Signage facilities (0.016)
	Landscape conditions	0.12	Sculptures (0.005); Water& Scape (0.024); Green planting (0.043); Flowers and plants (0.034); Cicadas and birds singing (0.014)
	Road conditions	0.28	Road smoothness (0.078); Road safety (0.100); Separation of passengers and vehicles (0.056); Road parking (0.011); Ramp and step (0.037)
	Maintenance conditions	0.04	Environmental facility maintenance (0.017); Garbage bin facilities (0.017); Environmental sanitation (0.005)

Weight of the highest three indicators in green, said of the lowest weight three indicators in red

7.3 Comparison of index scores of each community

7.3.1 Evaluation System Scoring Criteria

After obtaining the weights of various indicators of the community outdoor sites aging-friendly evaluation system, the next step is to use the evaluation system to score the elderly livability of the sample communities. The scoring criteria is reference document formed to help researchers score based on the understanding of the evaluation indicators after consulting the relevant national and local standards. The rating ranges are satisfied (9-10), somewhat satisfied (7-8), general (5-6), somewhat dissatisfied (3-4) or not satisfied (1-2).

7.3.2 Evaluation system Scoring method

When scoring the sample communities, 25 indicators are divided into 8 objective indicators and 17 subjective indicators. Among them, experts give scores for objective indicators. Objective indicators refer to indicators that can directly obtain specific values through statistical calculation. For example, C1 Area of activity site, C6 Recreation and fitness facilities, C7 Sun/rain shelter, C10 Rest facilities, C11 Public toilet, C20 Separation of passengers and vehicles, C21 Road parking, C24 Garbage bin facilities can be quantified indicators. After obtaining specific values, objective indicators are converted into corresponding community scores according to the scoring criteria.

Subjective indicators are indicators that cannot be obtained through direct calculation and need to be evaluated subjectively through field research and interviews by

researchers. In order to prevent the biased and random scoring of subjective indicators from affecting the reality of the actual application of the entire evaluation system, the final score of subjective indicators needs to integrate the scores of experts and elderly residents. The specific calculation method is as follows:

$$X_{\text{subjective indicator}} = \frac{\text{Arithmetic mean of elderly residents' scores} + \text{experts' scores}}{2}$$

Table 7-13 lists the specific application cases. C1 is the objective index, and the final score is the score given by experts A. C2 is the subjective index, and the final score is (mean score of elderly residents B + score given by experts C)/2.

Table 7-13. Scoring method

Evaluating indicator	Score value (0-10 points)		
	Community X		
	Elderly resident score	Expert score	Total score
C1 (Objective indicators)	/	A	A
C2 (Subjective indicators)	B	C	(B+C)/2

Once all the indicators have been combined, the scores are weighted according to the weighting of each indicator to calculate the final score. By adding up the scores for all 25 indicators, a final community score (between 0 and 10) is obtained. This score is based on the following criteria: Elderly livability is good (9-10), Elderly livability is better (7-8), Elderly livability is average (5-6), Elderly livability is poor (3-4), Elderly livability is bad (1-2). The final community scores can be applied to evaluate not only the livability of the community itself in terms of older people, but also for cross-sectional comparisons between different communities.

7.3.3 An Empirical study on sample community evaluation system

An empirical study is carried out on the theoretical model of the evaluation system for the elderly livable community. Through the aging-friendly evaluation of community outdoor site of four different types, namely, closed communities, closed cluster communities and mixed open communities (renovated and not renovated), the reliability and operability of the evaluation system are tested to find the weaknesses in different types of communities, at the same time, it can also find out to a greater extent whether the operability of the evaluation system and indicator selection are insufficient. After statistical calculation, the index scores calculation table of each community is obtained. Then, according to the specific scoring values calculated, the 25 indicators were classified into categories of Elderly livability is good (9-10) and Elderly livability is better (7-8). Elderly livability is average (5-6), Elderly livability is poor (3-4), Elderly livability is bad (1-2) The specific content of elderly livability was shown in the distribution table for more intuitive analysis and comparison.

① XH community index score calculation (Table 7-14) and index score distribution (Table 7-15).

XH community was built in 2002. It is located at the intersection of Zhongshan Road and Fuguo Street in Shahekou District, adjacent to Heping Square and Xinghai Square, and the most famous "Golden Tourism Coast" Xinghai Bay in southern Liaoning is nearby in the south. It has superior geographical location and excellent matching of living and business services. Xinghai Renjia's buildings are mainly multi-layer, and gardens, trees, ponds and squares in the community can be seen everywhere, it is natural, with a greening rate of 51%, and is known as "garden house".

Table 7-14. XH community index score calculation

Code	The evaluation index	Rating value (0-10 points)		
		Mean score of elderly residents	expert score	Total score
C1	Area of activity site	/	9	9.0
C2	Fluctuation degree of activity site	6.7	9	7.9
C3	Openness of activity site	7.5	8.5	8.0
C4	Parent-child activity space	7.5	7	7.3
C5	Exclusive space for the elderly	6.7	6	6.4
C6	Recreation and fitness facilities	/	7.5	7.5
C7	Sun/rain shelter	/	5	5.0
C8	Lighting facilities	4.5	3.5	4.0
C9	Barrier-free design	5.2	2.5	3.9
C10	Rest facilities	/	6.5	6.5
C11	Public toilet	/	1	1.0
C12	Signage facilities	6.1	3.5	4.8
C13	Sculptures	8.5	7	7.8
C14	Water&Scape	8.5	7	7.8
C15	Green planting	8.6	8	8.3
C16	Flowers and plants	8.9	7.5	8.2
C17	Cicadas and birds singing	8.6	7.5	8.1
C18	Road smoothness	6.2	7	6.6
C19	Road safety	6.6	4.5	5.6
C20	Separation of passengers and vehicles	/	3.5	3.5
C21	Road parking	/	1.5	1.5
C22	Ramp and step	6.8	3.5	5.2
C23	Environmental facility maintenance	7.2	5.5	6.4
C24	Garbage bin facilities	/	7.5	7.5
C25	Environmental sanitation	8.6	7.5	8.1

Table 7-15. XH community index score distribution

Classification	Elderly livability is good (9-10)	Elderly livability is better (7-8)	Elderly livability is average (5-6)	Elderly livability is poor (3-4)	Elderly livability is bad (1-2)
Site conditions	C1	C2, C3, C4	C5		
Facilities conditions		C6	C7, C10	C8, C9, C12	C11
Landscape conditions		C13, C14, C15, C16, C17			
Road conditions			C18, C19, C22	C20	C21
Maintenance conditions		C24, C25	C23		

On the whole, the outdoor site of XH community is suitable for aging. Among the 25 related indicators, 12 were good and 6 were poor. Among them, C1 activity area size (9.0) has the highest score. C11 public toilets had the lowest rating (1.0).

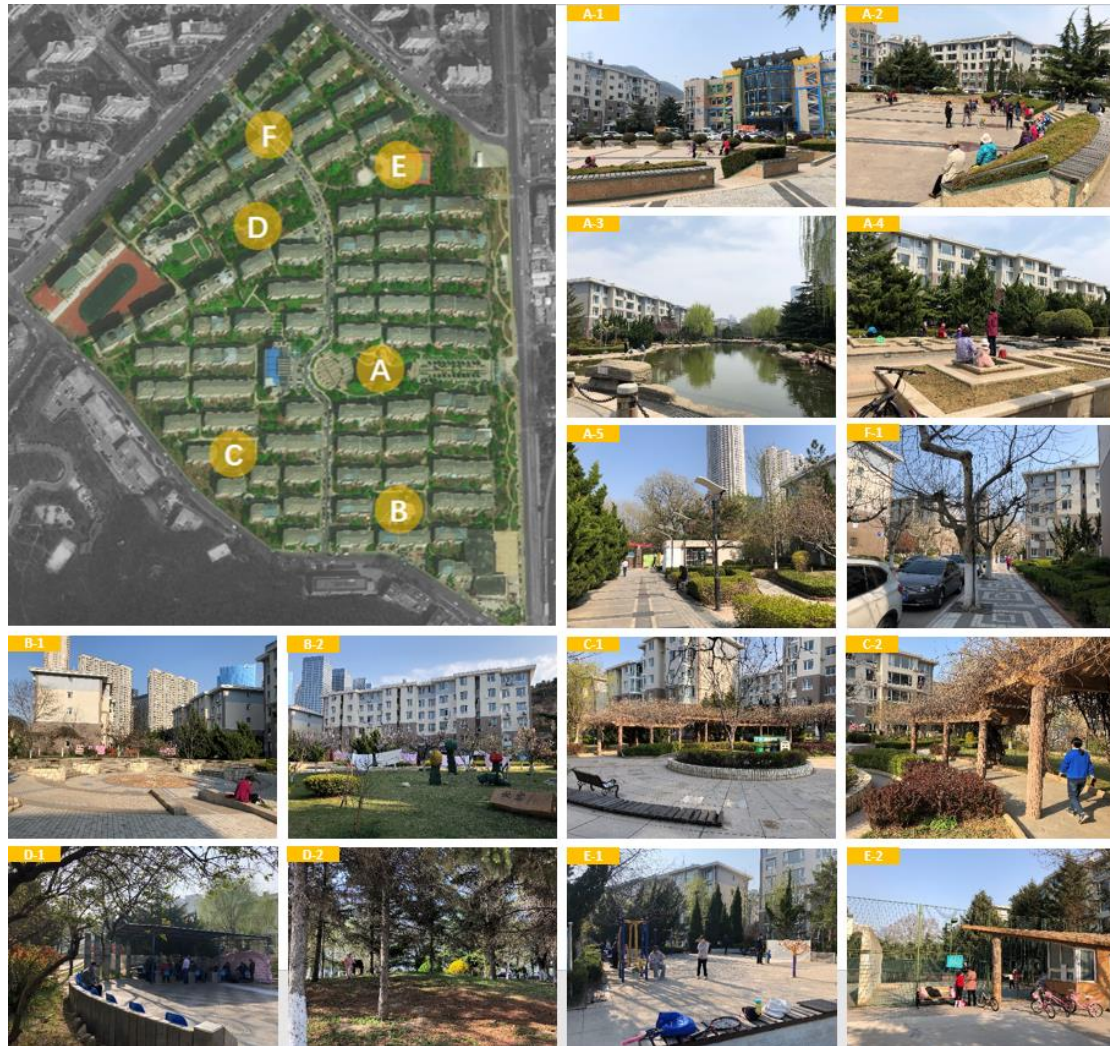


Figure 7-6. XH community outdoor sites status (Map Source: <https://map.qq.com/>, Photo Source: author)

As can be seen from the figure (Figure 7-6), there is A large central activity site (A-1,2,3,4,5) in the residential area. The area of site A is close to 10,000 square meters, which is composed of a community center (swimming pool and fitness center in the building),A circular square, a pond with corridors and rest areas on both sides, and a rectangular landscape sculpture gallery. Rest facilities are adequate. It is the main gathering place for community residents. There are also medium-sized sites B,C,D,F and many smaller sites scattered throughout the community. Site D (D-1,2) has very rich vegetation and landscape. The undulating micro-terrain changes attract many children to play here. Field E (E-1,2) is an outdoor space dominated by sports. There are 2 tennis courts and 3 practice courts. 1 table tennis table and multiple sets of exercise equipment.

The outdoor environment of the community is generally good. Complete supporting service facilities. The site setting is rich and diverse, with Spaces for children and the elderly. More perfect facilities, fitness rest facilities sufficient. There are ramps, blind lanes and handrails and other accessible design. The community landscape is rich and diverse, with sculptures, water features and insects and birds singing to meet the spiritual needs of residents. High plant coverage, trees, shrubs and grass mix. Colorful

and varied flowers can be seen everywhere. The outdoor environment of the community is in good condition. Road masonry can be maintained in a timely manner.

The main road of the community can not be separated between people and vehicles, and the roadside parking phenomenon is very prominent, which can not to ensure the smooth passage, and brings safety risks to the residents. Although the terrain in the community is relatively flat, in some areas, the landscape stone, point steppe stone and steps cause obstacles for the elderly to walk. There are few guidance signs of the community. Not enough lighting at night. There are no public toilets outdoors.

② XF community index score calculation (Table 7-16) and index score distribution (Table 7-17) .

XF Community was built in 2009. It is adjacent to Malan River in the north and Xinghai Bay in the south. You can walk 1 km to the largest Xinghai Square in Asia. It is built leaning the Yuanbao Mountain, and you can walk 200 meters to Fuguo Park. The location is superior, and the transportation is very convenient. The Xingfu e-Home project is the first natural building in Dalian's "Valley of Wind" planned and designed by Japanese Master Riken Yamamoto. Taking the sense of Valley of Wind, the architectural layout adopts free and smooth spatial modeling, and the residence and street view business are integrated organically.

The community is composed of six areas with similar forms. Each area is equipped with an independent butler house. The building area of each area is about 35,000 m². The outdoor space of each cluster is composed of several scattered small activity sites. However, the settings of the six cluster sites are different.

Table 7-16. XF community index score calculation

Code	The evaluation index	Rating value (0-10 points)		
		Mean score of elderly residents	expert score	Total score
C1	Area of activity site	/	7.5	7.5
C2	Fluctuation degree of activity site	8.1	9	8.6
C3	Openness of activity site	7.4	6.5	7.0
C4	Parent-child activity space	6.4	6.5	6.5
C5	Exclusive space for the elderly	4.1	3.5	3.8
C6	Recreation and fitness facilities	/	3.5	3.5
C7	Sun/rain shelter	/	4	4.0
C8	Lighting facilities	4.6	3.5	4.1
C9	Barrier-free design	6.7	2.5	4.6
C10	Rest facilities	/	5.5	5.5
C11	Public toilet	/	1	1.0
C12	Signage facilities	6.7	2	4.4
C13	Sculptures	7.5	3.5	5.5
C14	Water &Scape	6.2	2	4.1
C15	Green planting	8.5	6.5	7.5
C16	Flowers and plants	7.3	4.5	5.9
C17	Cicadas and birds singing	8.6	7.5	8.1
C18	Road smoothness	9.5	8.5	9.0
C19	Road safety	8.9	8.5	8.7
C20	Separation of passengers and vehicles	/	9	9.0
C21	Road parking	/	7.5	7.5
C22	Ramp and step	7.8	6	6.9
C23	Environmental facility maintenance	6.4	5	5.7
C24	Garbage bin facilities	/	5.5	5.5
C25	Environmental sanitation	8.1	8.5	8.3

Table 7-17. XF community index score distribution

Classification	Elderly livability is good (9-10)	Elderly livability is better (7-8)	Elderly livability is average (5-6)	Elderly livability is poor (3-4)	Elderly livability is bad (1-2)
Site conditions		C1,C3	C4	C5	
Facilities conditions			C10	C6,C7,C8,C9,C12	C11
Landscape conditions		C15,C17	C13,C16	C14	
Road conditions	C18, C20	C19 ,C21	C22		
Maintenance conditions		C25	C23,C24		

On the whole, XF community has a good degree of aging suitability for community outdoor sites. Among 25 related indicators, 10 are good and 7 are poor. Among them, C18 road patency (9.0) and C20 traffic diversion (9.0) scored the highest. C11 has the lowest rating for the setting of public toilets (1.0).



Figure 7-7. XF community outdoor sites status (Map Source: <https://map.qq.com/>, Photo Source: author)

As can be seen from the figure (Figure 7-7), the community consists of six areas with similar forms. Each area has its own butler's room. The construction area of each area is about 35,000 square meters. Each group outdoor space consists of several scattered small activity areas. But the six groups have different Settings.

The outdoor environment of the community is generally good. The landscape planning and design of the six regions has their own characteristics and are rich, which can meet the spiritual and material needs of residents. Although the activity areas are small and scattered, each area has a place for children's activities. Plant coverage rate is higher, more trees, shrubs, grassland is relatively less. More diverse flower varieties. The outdoor environment of the community is in good condition. As each group is managed separately, each group has its own underground parking lot. The outdoor grounds are fully used by residents, with no motor vehicles crossing. The activities and safety of residents are guaranteed.

Community facilities are relatively perfect, but lack of place environment for the elderly, fitness facilities are not enough. Shade and shelter facilities to cope with different weather conditions are not sufficient. Due to the lack of timely maintenance of road masonry in some areas, it is easy to cause obstacles for the elderly to walk. There are few guidance signs in the community. Not enough lighting at night. There are no public toilets outdoors.

③ NHS community index score calculation (Table 7-18) and index score distribution (Table 7-19).

HS Community is a mixed open community. It was built in 1990. It is located in Nansha, Shahekou, Dalian. It is mainly the family dormitory building of Dalian Heavy Machinery Processing Factory, which is a multi-storey building. It is near to market, bus stops, and the transportation and life are relatively convenient. Among them, the NHS area has completed the reconstruction project of old residential areas in Dalian.

Table 7-18. NHS community index score calculation

Code	The evaluation index	Rating value (0-10 points)		
		Mean score of elderly residents	expert score	Total score
C1	Area of activity site	/	6.5	6.5
C2	Fluctuation degree of activity site	6.3	4.5	5.4
C3	Openness of activity site	8.6	6.5	7.6
C4	Parent-child activity space	8.3	5.5	6.9
C5	Exclusive space for the elderly	6.6	4	5.3
C6	Recreation and fitness facilities	/	6	6.0
C7	Sun/rain shelter	/	2.5	2.5
C8	Lighting facilities	5.1	3.5	4.3
C9	Barrier-free design	6.0	2.5	4.3
C10	Rest facilities	/	6	6.0
C11	Public toilet	/	1	1.0
C12	Signage facilities	6.3	2.5	4.4
C13	Sculptures	5.1	1	3.1
C14	Water&Scape	4.9	1	3.0
C15	Green planting	6.0	2.5	4.3
C16	Flowers and plants	6.6	1	3.8
C17	Cicadas and birds singing	6.6	5	5.8
C18	Road smoothness	5.7	6	5.9
C19	Road safety	8.3	5.5	6.9

C20	Separation of passengers and vehicles	/	3	3.0
C21	Road parking	/	3	3.0
C22	Ramp and step	3.1	4	3.6
C23	Environmental facility maintenance	7.4	6	6.7
C24	Garbage bin facilities	/	5.5	5.5
C25	Environmental sanitation	6.9	6.5	6.7

Table 7-19. NHS community index score distribution

Classification	Elderly livability is good (9-10)	Elderly livability is better (7-8)	Elderly livability is average (5-6)	Elderly livability is poor (3-4)	Elderly livability is bad (1-2)
Site conditions		C3	C1,C2,C4,C5		
Facilities conditions			C6,C10	C8,C9,C12	C7,C11
Landscape conditions			C17	C13,C14,C15,C16	
Road conditions			C18,C19	C20,C21,C22	
Maintenance conditions			C23,C24,C25		

Overall, the degree of aging suitability of outdoor sites in NHS community was general. Among the 25 related indicators, 1 was good and 12 were poor. Among them, the opening degree of C3 activity site (7.6) has the highest score. C11 has the lowest rating for the setting of public toilets (1.0). The C7 shade/shelter (2.5) score is also low.



Figure 7-8. NHS community outdoor sites status (Map Source: <https://map.qq.com/>, Photo Source: author)

The renovated NHS community has an overall improved outdoor environment (Figure 7-8). Exclusive children's activity space, fitness equipment and rest facilities are relatively sufficient. Area D (D-1,2, 3) is the community health plaza. The original facilities are groups of fitness equipment and rest gallery, and the government has added 4 table tennis tables and rest chairs after renovation. It is the only outdoor public fitness area in the mixed community. It has become the main gathering place for the surrounding residents.

Although the plant green has been updated and improved, but the vegetation coverage rate is still low. In this area, there are parking and road occupation in front of and between residential buildings, which brings hidden dangers to residents' travel and safety. Because there is a general elevation difference and more steps in this area, it brings inconvenience to the elderly to travel. Sun and rain shelter facilities are not sufficient. There are few guidance signs in the community. Not enough lighting at night. There are no public toilets outdoors.

④ OHS community index score calculation (Table 7-20) and index score distribution (Table 7-21).

OHS is an unrenovated HS community. Due to years of disrepair, the environment is aging and damaged seriously.

Table 7-20. OHS community index score calculation

Code	The evaluation index	Rating value (0-10 points)		
		Mean score of elderly residents	expert score	Total score
C1	Area of activity site	/	1.5	1.5
C2	Fluctuation degree of activity site	4.2	2	3.1
C3	Openness of activity site	5.6	3.5	4.6
C4	Parent-child activity space	4.4	1	2.7
C5	Exclusive space for the elderly	2.9	1	2.0
C6	Recreation and fitness facilities	/	1	1.0
C7	Sun/rain shelter	/	1	1.0
C8	Lighting facilities	2.7	1	1.9
C9	Barrier-free design	2.9	1	2.0
C10	Rest facilities	/	1	1.0
C11	Public toilet	/	1	1.0
C12	Signage facilities	5.3	1	3.2
C13	Sculptures	5.1	1	3.1
C14	Water &Scape	4.4	1	2.7
C15	Green planting	4.4	1.5	3.0
C16	Flowers and plants	4.9	1.5	3.2
C17	Cicadas and birds singing	5.6	5	5.3
C18	Road smoothness	3.6	5	4.3
C19	Road safety	3.1	1.5	2.3
C20	Separation of passengers and vehicles	/	2	2.0
C21	Road parking	/	1	1.0
C22	Ramp and step	3.1	1	2.1
C23	Environmental facility maintenance	3.8	2	2.9
C24	Garbage bin facilities	/	2	2.0
C25	Environmental sanitation	5.1	2	3.6

Table 7-21. OHS community index score distribution

Classification	Elderly livability is good (9-10)	Elderly livability is better (7-8)	Elderly livability is average (5-6)	Elderly livability is poor (3-4)	Elderly livability is bad (1-2)
Site conditions				C2,C3	C1,C4,C5
Facilities conditions				C12	C6,C7,C8,C9,C10,C11
Landscape conditions			C17	C13,C15,C16	C14;
Road conditions				C18;	C19,C20,C21,C22
Maintenance conditions				C25	C23,C24

On the whole, the aging suitability of outdoor sites for OHS community was poor. Among 25 related indicators, 1 were general and 24 were poor. Among them, C17 cicada songbird (5.3) scores was the highest. C6 sports and fitness facilities, C7 sun/rain shelter facilities, C10 rest facilities, C21 road parking, and C11 public toilets all had the lowest score (1.0).

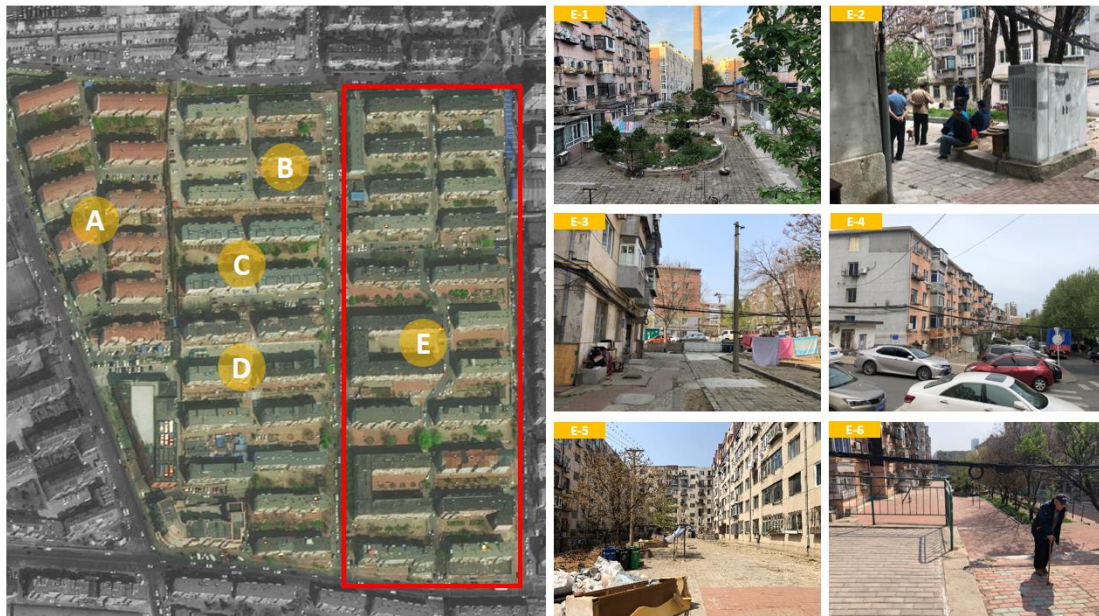


Figure 7-9. OHS community outdoor sites status (Map Source: <https://map.qq.com/>, Photo Source: author)

Area E (E-1-6) is the unrenovated OHS community (Figure 7-9). Due to disrepair, the environment is seriously damaged. There is no playground with fitness facilities and no children's playground. Old people can only take their own seats and cushions to rest in front and back onto the building. There are flower beds in the ground between the buildings, but they are badly damaged. The interior vegetation is wilted and overgrown with weeds. In some areas, people and vehicles are mixed and the roadside parking situation is serious, which brings great safety risks to residents. Pavement tiles turned uneven, many sites appeared water, serious damage. Building aging wall falling, very dangerous. The sanitary environment is poor, the garbage is piled up at will, the lack of maintenance. In urgent need of renovation.

7.3.4 Weighting calculation and analysis of sample communities

According to the scoring method of 7.3.2, as well as the scores of various indexes of each community obtained in Tables 7-14, 7-16, 7-18 and 7-20 above. By weighting all the scores and adding them up, a final score (between 0 and 10) is obtained for each case community. The detailed calculation is shown in Table 7-22:

Table 7-22. Weighted calculation table of outdoor environment evaluation system of elderly livable communities

Aging evaluation of community outdoor sites		XH (Gated community)		XF (Group type gated community)		NHS (New open community)		OHS (Old open community)	
Evaluating indicator	Weight	Score value	Weighted score	Score value	Weighted score	Score value	Weighted score	Score value	Weighted score
Area of activity site	0.100	9.0	0.90	7.5	0.75	6.5	0.65	1.5	0.15
Fluctuation degree of activity site	0.014	7.9	0.11	8.6	0.12	5.4	0.08	3.1	0.04
Openness of activity site	0.072	8.0	0.58	7.0	0.50	7.6	0.55	4.6	0.33
Parent-child activity space	0.043	7.3	0.31	6.5	0.28	6.9	0.30	2.7	0.12
Exclusive space for the elderly	0.130	6.4	0.83	3.8	0.49	5.3	0.69	2.0	0.26
Recreation and fitness facilities	0.016	7.5	0.12	3.5	0.06	6.0	0.10	1.0	0.02
Sun/rain shelter	0.006	5.0	0.03	4.0	0.02	2.5	0.02	1.0	0.01
Lighting facilities	0.040	4.0	0.16	4.1	0.16	4.3	0.17	1.9	0.08
Barrier-free design	0.054	3.9	0.21	4.6	0.25	4.3	0.23	2.0	0.11
Rest facilities	0.040	6.5	0.26	5.5	0.22	6.0	0.24	1.0	0.04
Public toilet	0.028	1.0	0.03	1.0	0.03	1.0	0.03	1.0	0.03
Signage facilities	0.016	4.8	0.08	4.4	0.07	4.4	0.07	3.2	0.05
Sculptures	0.005	7.8	0.04	5.5	0.03	3.1	0.02	3.1	0.02
Water&Scape	0.024	7.8	0.19	4.1	0.10	3.0	0.07	2.7	0.06
Green planting	0.043	8.3	0.36	7.5	0.32	4.3	0.18	3.0	0.13
Flowers and plants	0.034	8.2	0.28	5.9	0.20	3.8	0.13	3.2	0.11
Cicadas and birds singing	0.014	8.1	0.11	8.1	0.11	5.8	0.08	5.3	0.07
Road smoothness	0.078	6.6	0.51	9.0	0.70	5.9	0.46	4.3	0.34
Road safety	0.100	5.6	0.56	8.7	0.87	6.9	0.69	2.3	0.23
Separation of passengers and vehicles	0.056	3.5	0.20	9.0	0.50	3.0	0.17	2.0	0.11
Road parking	0.011	1.5	0.02	7.5	0.08	3.0	0.03	1.0	0.01
Ramp and step	0.037	5.2	0.19	6.9	0.26	3.6	0.13	2.1	0.08
Environmental facility maintenance	0.017	6.4	0.11	5.7	0.10	6.7	0.11	2.9	0.05
Garbage bin facilities	0.017	7.5	0.13	5.5	0.09	5.5	0.09	2.0	0.03
Environmental sanitation	0.005	8.1	0.04	8.3	0.04	6.7	0.03	3.6	0.02
Total score		6.35		6.37		5.32		2.49	

According to Table 7-22, a comprehensive comparative analysis of sample communities is conducted. The group gated community XF community (6.37) was slightly better than the gated community XH community (6.35). Both have advantages and disadvantages, the score is relatively close. The evaluation result of open community was lower than that of gated community, and the score of renovated NHS community (5.32) was significantly higher than that of unrenovated OHS community

(2.49). It reflects that different types of communities have different characteristics in the livability degree of the elderly.

XH gated community has a large area, rich and diverse internal sites, and rich activity sites and contents for the elderly. So overall satisfaction is relatively high. However, due to the large area of the community, the site accessibility is weak. In particular, the intermingling of people and vehicles and the phenomenon of roadside parking have become the focus of problems in the community environment.

XF group gated community, belonging to the key school district housing. The residents are mainly families with children, and the parent-child space in the community is rich. As most of the elderly residents take care of their grandchildren, their focus is on family and children, so they are relatively satisfied with the community environment. The main problem in the community is the lack of consideration of the activity needs of the elderly. Lack of fitness and rehabilitation facilities and sites for the elderly. The sun and rain shelter facilities are not fully considered.

Mixed community outdoor environment is uneven. In general, the renovated outdoor environment and areas of the NHS have been greatly improved in terms of site, facilities, roads and maintenance. The elderly are also relatively satisfied with the outdoor environment. Although the outdoor environment as a whole has been improved, but also improve environmental quality. The landscape and road elements in the community context need to be focused on, and their quality can be improved. It provides a new and perfect strategy for the government to renovate old communities in the future.

The outdoor environment in the unrenovated area of OHS has serious problems. In this area, the satisfaction evaluation of the elderly in the site, facilities, landscape, roads and maintenance is low. The community does not have dedicated recreational activities and landscape areas. The main gathering place for the elderly living here is at the gate of the unit or beside the community road. Through the interview survey, the elderly are emotional, have many opinions, and have a strong willingness to reform.

Although the elderly have high and low evaluation on the suitability of outdoor sites for aging in the sample community. But there are common problems. For example, there are few guidance signs in the community. Not enough lighting at night. There are no public toilets outdoors. We need to pay attention to the above environmental factors, focus on improving.

7.4 Design strategies for the sample community

7.4.1 Design strategies for common problems in sample communities

The common problems of sample communities can be obtained from the above table. First of all, the majority of the elderly surveyed are younger elderly who are in good

health and can take care of themselves. Such elderly groups prefer activities with a large number of people singing and dancing. The demand for outdoor activities in the community is mainly to increase the area of the activity sites. Second, based on the data analysis of the supply and demand model and the evaluation system, the common environmental problem reflected by the sample community is the problem of outdoor facilities in the community. Planning and design strategies unrelated to the evaluation model are not described in this paper. The strategy is as follows:

① **Area of activity site**

The total area of the site correspond to the activity. When the elderly community outdoor activities occur, there are not only main activity behaviors, but also a series of related activities. It is not perfect if the site space is designed only for the main activities. Elderly people in the activity venue, sometimes play the role of performers, sometimes play the role of onlookers. Both methods can get a good sense of social participation and reflect personal value. Therefore, the activity site should include at least two main functional Spaces: one is the main activity area, that is, the main place where activities take place; The second is related activity area, including watching, sitting and external traffic and other functional places. In addition, related public service facilities can also be configured, such as article storage, water dispenser, jack, audio equipment and so on, to form an auxiliary function area (Figure 7-10).

The setting of the field area can refer to "Technical Requirements for Urban Community Sports Facilities" (JG/T 191-2006). The area of the site can be estimated by multiplying the size of the space in which the elderly individual stretches by the number of participants (see 4.1.4). According to the different combination of professional sports sites, the area of the main and related activity areas are different. The area of the activity areas can be inferred by adding the lowest values of all kinds of activity areas. If auxiliary facilities, landscape facilities such as sculptures, as well as isolated vegetation outside the site are needed, the area should be further expanded.

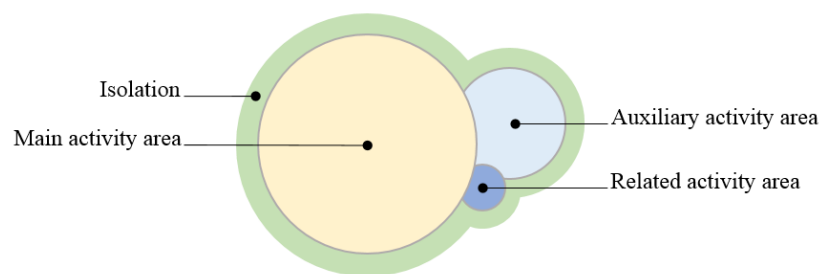


Figure 7-10. Activity site space organization (Source: author)

② **Sun/rain shelter**

The practical benefit of having sun/rain shelter in the site is to extend the time that the elderly can spend outdoors and to maintain the activities in the site. Many elderly people have the habit of basking in the sun. More basking in the sun can promote the body to synthesize more vitamin D, which is conducive to the absorption of calcium, and is very beneficial to health or rehabilitation after illness. But exposure to the sun for too long can damage the skin, especially in hot summer months. If the shelter facility is set up in the site, the rest activities of the elderly can be alternated with basking activities,

so as to protect the physical health of the elderly. At the same time, if it rains, the activity will not be stopped immediately, so that the elderly can continue their activities in the venue more confidently.

In the planning of sun/rain shelter facilities, in addition to landscaping considerations. But also to make the setting of sunshade/rain shelter facilities more user-friendlier, more practical, can be combined with the seat table and other facilities. It is also necessary to provide wheelchair space to the elderly in consideration of their leisure needs. (as shown in figure)

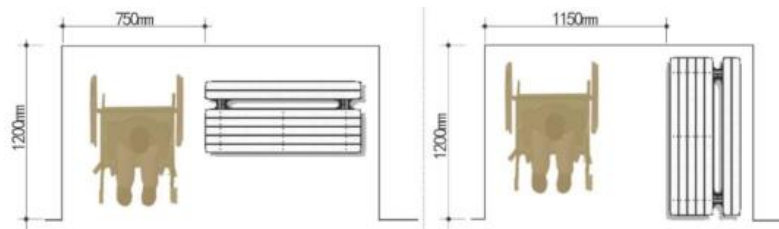


Figure 7-11. Diagram of seat and wheelchair position (Source: author)

③ Lighting facilities

Lighting facilities are the focus on attention to the elderly. Most of the elderly said that they do not do outdoor activities after dark at around 8 PM, which is caused by the mismatch between the decline in individual attributes such as sensory and activity ability of the elderly and the greater environmental pressure. In particular, poor lighting of outdoor sites for communities can be difficult and even dangerous for the elderly. If the lighting is perfect, the activity will not end immediately even when it gets dark.

We should pay attention to the building entrance and exit, road turns, up and down steps or ramps, waterfront space, space with obvious terrain changes, signs and other places to set up corresponding lighting facilities. Good outdoor lighting will make the elderly safer, more assured and longer stay.

④ Barrier-free design

According to the evaluation results, the construction of barrier-free facilities is the soft spot in the construction of community outdoor sites, which needs to be strengthened urgently. At present, the elderly are the main users of accessibility facilities in the community. However, with the increasing of the elderly population, the gap between the accessibility facilities of the community and the needs of the elderly population has also increased significantly.

Focus on the residential edge ramps, wheelchair ramps, pedestrian passages, public entrances and exits, public walkways, floors, stairs, elevator waiting hall and car and other facilities and parts of the barrier-free transformation. To provide a healthy, safe and comfortable community environment for the elderly.

⑤ Public toilet

Because the physical characteristics of the elderly, the elderly to the Public toilets

demand is very high. But in addition to the part of the community center has a Public toilet, community outdoor environment almost no Public toilets, the outdoor activities caused great inconvenience to the elderly. Through the depth interview, we learned that the sample community perceptions of Public toilets in the elderly and needs. Most old people think it is necessary to set up Public toilets, not only for the elderly physiological characteristics to consider, also to children's physiological needs to consider the outdoors. However, some elderly people expressed their understanding that there is no Public toilet in the community. Considering its sanitation maintenance and location setting, it will cause trouble to the community health management and nearby residents. But we believe that the community planning and design staff should put outdoor Public toilets as the focus of the community planning and decision making into consideration in the future.

⑥ **Signage facilities**

The elderly due to memory and spatial recognition ability decline. It not only needs the strong orientation recognition of the space itself, but also needs the assistance of the identification system to recognize and remember the space. So as to carry out all kinds of activities in it safely and freely. At the same time, as a kind of facilities, signage has a certain landscape decoration, so a perfect signage system is indispensable in the community outdoor environment.

The signage system is composed of all kinds of signage facilities, mainly including apartment building signs, signs, warning signs and markers. The main function of signs are to guide and warn. Therefore, clear signs are required at the entrances and exits of buildings and walking paths, road intersections or turning points, places with obvious elevation changes in the terrain, waterfront Spaces, and near equipment rooms that are not accessible.

7.4.2 Design strategies for different types of communities

According to the calculation results from Table 7-22, the highest score is 6.37 for XF, 6.35 for XH, 5.32 for NHS and 2.49 for OHS. In general, the later the residential area is built, the more complete the design and related supporting facilities for aging. The community like Houshan community has been built for more than 30 years. The realistic problem is that our country has not entered the aging population at that time. At the beginning of community design, the demand for activities of the elderly is very little considered. In the following, the corresponding countermeasures are given for the specific problems reflected by each community.

① **XH community** is gated community. The Elderly livability of outdoor sites in this community was better. The vast majority of environmental indicators are above 5 points. In addition to the common problems, the corresponding countermeasures are given for the human-vehicle diversion and road parking problems.

In recent years, with the rapid growth of the number of private cars in China, the

phenomenon of parking cars around and inside communities occupying sidewalks has become increasingly prominent. Residents have less space to travel. Because the elderly are inconvenienced, slow to react, walking is more restricted. In the outdoor environment of the community, we should separate the traffic from the pedestrian as far as possible to reduce the hidden danger of traffic.

Conditionally, it is best to use underground parking to avoid the interference of the ground. When there is no condition to carry out the human-vehicle branch, the crossing of motor traffic and pedestrian traffic should be minimized. Motor vehicles shall have lower speed limits, and speed bumps shall be set at certain distance intervals. Sidewalks shall be set separately beside motor vehicle lanes, and isolation piles shall be appropriately added at intersections and other facilities.

② **XF community** is group gated community. The Elderly livability of outdoor sites in this community was better. The vast majority of environmental indicators are above 5 points. In addition to the common problems, corresponding countermeasures is given for the problems of exclusive sites for the elderly, recreation and fitness facilities, and waterscape viewing.

It is known above that XF community belongs to the school district housing of key schools, and the residents are mainly families with children. The environment and facilities of community outdoor sites are well equipped, but there are not enough facilities to meet the needs of the elderly to carry out various activities.

The exclusive venue for the elderly should have enough effective activity area and more fitness facilities to support various activities such as fitness activities and community activities for the elderly. The types and quantities of facilities in the site represent the usability and senility of outdoor activity space to a certain extent. At the same time, shade and rain shelter facilities should be set up to ensure that the elderly can enjoy outdoor activities for a longer time. The elderly are generally able to take the initiative to select the site design that suits them. The site designs that meets their physical condition and outdoor activity habit preference has stronger adaptability.

Field observation XF community planning to design has a water feature, but now it is dry state. After understanding with the community property, we know that the maintenance cost of running it is high, and its setting also has certain security risks. The water is not an effective place to play, but watching the water will bring a sense of calm to the elderly. Low-cost operation methods such as waterscape circulation can be referred to (Li CZ.et al,2010). In addition, reinforce, add the balustrade beside the waterscape, and improve the anti-slip property of the floor tiles around the waterscape, and improve its unsafe factors.

③ **NHS community** is a renovated open community, and the Elderly livability of the community outdoor site is average. Some environmental indicators score 5-6. In addition to the common problems, the countermeasures are given for landscape factors

and road factors.

A good natural environment can bring people a kind of "pleasure", and "pleasure" refers to the embodiment of the personalized and emotional psychological needs of the elderly when the basic functional needs of outdoor activities are met. The government's existing renovation policy first meets the basic functional needs of residents in terms of site, facilities and environmental maintenance. The next step is to make the activity venue more interesting. Sculptures, waterscape appreciation, plants and flowers in the environment can not only meet the basic aesthetic of vision, but also play a variety of roles such as space limitation, enhanced identification, enhanced guidance, and healing (Wang D.H.,2007). The collocation and combination of plants can be used to separate the landscape greening space, and add open, semi-open or closed space on the basis of the original space, so as to achieve the effect of enriching the spatial level and meet the different communication needs of the elderly (Wang Y. et al,2016).

The disorganized form of transportation in old neighborhoods often makes the elderly feel insecure, which is one of the most significant problems of old neighborhoods. However, it is difficult to completely separate people from cars in existing communities. Therefore, the mutual interference in people and vehicles should be reduced as much as possible, and the living needs of elderly residents should be given priority to the basis of meeting the basic transportation functions. The speed can be controlled by adding speed bumps, setting signs and other methods. Warning should be made in parts of turns, blind areas and other dangerous places, so as to reduce the flow of people and traffic together as much as possible to ensure smooth road.

There are many mountains and hills in Dalian. In the gentle slope section with large elevation difference, a ramp in accordance with the standard should be set up, generally with a slope of less than 8%. A rest platform should be set in the middle of an excessively long ramp with handrails on both sides to avoid inconvenience to people using wheelchairs and walkers.

④ **OHS community** is an unrenovated open community, and the Elderly livability in the outdoor field of the community is poor.

The vast majority of environmental indicators are below 4 points. In addition to the common problems, almost all items in the evaluation index need to be improved countermeasures. The elderly living in the OHS area are eager to reform. A refurbishment strategy can learn from the experience of NHS areas that have been refurbished and reject their shortcomings. It is suggested that the government should focus on the willingness and demand of the elderly to transform the landscape and roads. Make the transformation of old communities suitable for aging more comprehensive and accurate.

7.5 Summary

Integrated literature review and in-depth interviews, this chapter constructs an outdoor environment evaluation system model for elderly livable communities based on relevant norms of community aging-friendly reform in China. The evaluation system can comprehensively, accurately and objectively evaluate the aging-friendly level of outdoor site in the sample community. The evaluation process consists of weight calculation of evaluation index system, index score comparison of each community and coping strategies.

① Follow the principles of scientificity, systematicness and operability. Finally, 5 criteria level environmental factors and 25 sub-category environmental factors were extracted. After judging and calculating the superiority chart method, the weights of five environmental factors in the criterion layer are ranked as Site, Road, Facilities, Landscape and Maintenance. Among them, Site (36%) has the highest weight, Maintenance (4%) has the lowest weight. It can be seen that experts in the field of environmental design mainly focus on the site, road and facilities for community outdoor site aging, and pay relatively little attention to landscape, and the lowest attention to maintenance.

② Through the comprehensive score of 26 experts and scholars, in outdoor environment evaluation system of elderly livable communities, comprehensive weighting of the highest three indicators are: C5 exclusive space for the elderly (13%), area of activity site (10%), C19 road safety (10%), low comprehensive weights of three indexes are: C7 sun/rain shelter (0.6%), C13 sculpture (0.5%), C25 environmental sanitation (0.5%). The three indexes with the highest comprehensive weight are consistent with the outdoor activity needs of the elderly. The three indexes with the lowest comprehensive weight are different from the outdoor activity needs of the elderly. In particular, C7 sun/rain shelter are not satisfied with the existing sun/rain shelter in the community, both from the perspective of supply and demand and from the evaluation system, and are the focus of attention of the elderly. This indicates that there are differences in the cognition of needs between planners and residents. It also shows the importance of empirical research, which can provide a powerful supplement for planners' designs and government's transformation strategy.

③ After determining the weight of each index, an empirical study was conducted on the theoretical model of the outdoor environment evaluation system of elderly livable communities. First determine the scoring criteria and scoring method. All the scores are weighted and accumulated through the scores of each index of each community. Finally, the final score of each sample community are obtained. XF community (6.37) was the highest, slightly better than XH community (6.35). Renovated NHS community (5.32) were significantly higher than unrenovated OHS community (2.49). The evaluation of the sample community is not excellent, and the community environment still has great room for improvement. In general, the evaluation results of closed communities are

higher than those of open communities, and the evaluation results of renovated areas are higher than those of unrenovated areas. The government's policy of renovating the outdoor environment of the old community is effective and necessary. The evaluation results also reflect that different types of communities have different characteristics in the livability degree of the elderly.

④ There are some common problems of the construction of livable environment for the elderly in different communities, and the differences in different communities are also obvious. Combined with the characteristics of the community itself and the actual situation, from the common problems of the sample community and the individual problems of different types of communities, the targeted optimization strategies are put forward.

Chapter 8.

Conclusion

8.1 Summary and Discussion

Urban community outdoor site provide material space for the elderly's daily outdoor activities and social interaction. With the gradual deepening of aging, the elderly in China have an increasing demand for community outdoor site. Inadequate consideration of the needs of the elderly for outdoor activities is a prominent problem in the planning, construction and renovation of urban community outdoor site in China. This paper studies the adaptability of outdoor sites in urban communities to meet the needs of the elderly. The supply and demand model of outdoor sites in urban communities, the model for determining whether individual and community outdoor sites are aging-friendly, and the outdoor environment evaluation system of elderly livable communities have been constructed. Through information collection and screening, three sample communities in Shahekou District, where the elderly population is concentrated, have been obtained and empirical research has been carried out. The main conclusions of this paper are as follows:

8.1.1 Findings and contributions of SRQ 1

Based on the theory of supply and demand balance, the supply and demand model of outdoor sites in urban communities is constructed. The Likert scale Method and Semantic Differential Method (SD) are used to quantitatively and qualitatively study the matching relationship between supply and demand of outdoor sites in community, to reveal the different environmental influencing factors of different supply and demand matching results. The results show that,

① The matching of supply and demand was determined for the 5 major environmental factors and 25 sub-categories of environmental factors. 19 of the 25 sub-categories of environmental factors had a balanced supply and demand. There are 6 items in overdemand: C5 Exclusive space for the elderly, C7 Sun/rain shelter, C8 Lighting facilities, C9 Barrier-free design, C11 Public toilet, C14 Water &Scape. Overall, the facilities category is highlighted as an environmental factor in need of optimisation and improvement in the community outdoor environment. The balance of supply and demand for environmental factors in the grounds, landscape, roads and maintenance categories are factors that need to be maintained to the advantage of future community planning, design, maintenance and management.

② The matching results of supply and demand of environmental factors of various community outdoor sites are identified and summarized. The outdoor environment supply and demand results in XH community and XF community are close. Most environmental factors are in the balance with supply and demand. The outdoor environment of the renovated NHS community has been improved, but the environmental factors of overdemand, oversupply and zero point of supply and demand are more than those of XH and XF communities. Environmental factors that are in overdemand in unrenovated OHS community account for the vast majority. The outdoor environment of the community is in urgent need of improvement. In general, there is a good balance between supply and demand in gated and group gated communities. The phenomenon of overdemand in the open community is obvious, which has been improved significantly after renovation.

SRQ 1 Research contribution and value.

The supply and demand model of outdoor sites in urban communities provides a new perspective for the study of elderly livable communities. The concept of the site supply and demand matching model is proposed. The connotation of the supply and demand matching of outdoor sites in communities is discussed, which promotes the consensus between the supply and demand sides on the use of overall community outdoor resources.

With the aggravation of aging in China, the overall construction requirements of the aging-friendly system for outdoor environment in communities and various technical indicators have been gradually clarified. However, there is also a unilateral focus on the implementation of hard indicators, ignoring the actual needs of the elderly and the quality of the internal environment. These problems are directly related to the "quantity" based objective index assessment method and the concept of community design such as resource allocation modeling. As a result, the supply and demand of community outdoor site resource allocation is misplaced, and supply is contrary to the actual activity demand, which to some extent affects the healthy quality of life of the elderly. For example, excessive low-demand site environment will not only fail to meet the actual environmental needs of the elderly in the community, but also lead to negative deviation in the quality of outdoor activities, and even lead to constructive waste. On the contrary, proper resource allocation can not only meet the actual activity needs of the elderly, so that the elderly can get great satisfaction in emotional and environmental use, but also play the role of the government in improving the efficiency of community outdoor resource allocation.

By referring to the matching relationship between supply and demand in the "market mechanism", re-examine and deeply explore the significance of supply and demand of community outdoor space in the system of livable community for the elderly, pay attention to the improvement of environmental quality and service efficiency of community outdoor site, explore the environmental characteristics of community outdoor site that truly meet the needs of the elderly, so as to provide targeted and

implementable optimization strategies for planning, landscape and other environmental design and government renovation policies.

8.1.2 Findings and contributions of SRQ 2

On the basis of P-E Matching theory, the model for determining whether individual and community outdoor sites are aging-friendly is constructed. One way Analysis of Variance and post hoc test are used to study the differences in the needs of the elderly at different ages, with different physical conditions, device-aided elderly and nursing-cared elderly. And path analysis is used to analyze personal attributes, family attributes, physical conditions, outdoor activities habits, degree of satisfaction and demand, and the impact and relationship among several variables. The results show that ,

① Differences in the aged at different ages. Most of the young-old is in good physical condition. High satisfaction with the existing outdoor environment. The old-old may feel that there are few activities in the community, and the outdoor activities usually go to the streets outside the community. It is hoped that the community outdoor environment will add more diverse functions. Due to The mobility difficulties, The oldest-old has specific needs for functions, facilities, landscape and roads in the outdoor environment of the community.

② Differences in the elderly with different physical conditions. Older people that are in good health are less aware of the existing environmental pressure, and more think that the environment is monotonous and boring, and pay more attention to the entertainment function of facilities and the fun of activity space. The Older people in worse health are under more pressure in the environment and pay more attention to the basic service capacity of the environment. The rational allocation of chairs, shelter facilities and accessibility of the site are the main factors that affect whether the older people can adapt to the outdoor environment.

③ Differences between device-aided elderly and nursing-cared elderly. Most outdoor activities cannot be participated in due to the decline in physical function. Sitting around, talking, watching or listening to other people's activities is the only way to "fit in". More willing to choose functional places for activities. It is hoped that relevant rehabilitation training facilities can be configured in the community.

④ The path analyzes the influence relationship between multiple latent variables. The elderly in good physical condition often feel that the community environment is stress-free, so they are more satisfied with the community outdoor sites. Such elderly people can participate in all kinds of outdoor activities because of their good physical condition, and are not restricted by the location of activities. But because the environment does not change into matching dynamics as people age, environmental stress increases as individual abilities decline. Long-term residence can lead to a decrease in satisfaction with the area's environment. In conclusion, socio-ecological models suggest complex and dynamic interrelationships between individual, social, and environmental factors

that shape physical activity and behavior. The outdoor activity demand of the elderly is also formed by these factors.

SRQ 2 Research contribution and value.

The planning and design of community outdoor site should be able to better understand and consider the personal attributes and activity habits of the elderly. Meeting the elderly's activity preferences can effectively improve the use efficiency of the site. The elderly can actively screen out suitable site, and their preferences determine the use of the site.

Meeting the activity preferences of the elderly can make the designed site more adaptable. This adaptability comes from the stability of the preferences determined by the physical conditions and living habits of the elderly. From the perspective of physical functions, the elderly's degraded and vulnerable physical functions determine their heavy dependence on fitness equipment, shelter facilities and other site characteristics, and are highly sensitive to distance, road conditions and other factors. From the perspective of living habits, the elderly are keen to participate in community activities with a large number of people in order to seek more psychological identity, behavioral identity, value identity, etc. They also hope to have the opportunity to participate in outdoor activities while not affecting a number of housework, such as shopping for vegetables, taking care of children, etc. These preferences have an important impact on the final form of the site, such as the site area should be able to adapt to the needs of community activities, there are more functional facilities around the site, etc. Therefore, the site design meeting the elderly's activity preference adapts to the general needs of people's activities after aging, and is conducive to the long-term use of the site.

In the future, with the further growth of the elderly in China, more protection, more preferential treatment and more health help for the elderly will more and more permeate into life. The research on the aging-friendly community outdoor site in this paper has adapted to the needs of social development. In addition, the needs of the elderly on the space environment of the site are a higher level and more humanized needs for the quality and service level of the site, which is more conducive to meet people's needs of constantly improving space quality.

8.1.3 Findings and contributions of SRQ 3

On the basis of integrating literature review and in-depth interviews, and in combination with the requirements of the relevant specifications for aging-friendly reform in China, the model of outdoor environment evaluation system of elderly livable communities is constructed using the grounded theory. The evaluation model can comprehensively, accurately and objectively evaluate the aging-friendly level of outdoor site in the sample community. The evaluation process consists of weight calculation of evaluation index system, index score comparison of each community and coping strategies. The results show that,

① After the calculation of the superiority chart method, the weights of the five environmental factors of the criterion layer are ranked as Site, Road, Facilities, Landscape and Maintenance. Among them, Site (36%) has the highest weight, Maintenance (4%) has the lowest weight.

② Comprehensive scores of 26 experts and scholars. Among all 25 indicators, the three indicators with the highest comprehensive weight are C5 Exclusive space for the elderly (13%), C1 Area of activity site (10%), and C19 road safety (10%). The three indicators with the lowest comprehensive weight are: C7 Sun/rain shelter (0.6%), C13 Sculptures (0.5%), C25 Environmental sanitation (0.5%).

③ Empirical study on the theoretical model of outdoor environment evaluation system in livable community for the elderly. The final score are obtained for each sample community. XF community (6.37) was the highest, slightly better than XH community (6.35). The renovated NHS community (5.32) was significantly higher than the unrenovated OHS community (2.49). The evaluation results also reflect that different types of communities have different characteristics in the livability degree of the elderly.

④ There are some common problems of the construction of livable environment for the elderly in different communities, and the differences in different communities are also obvious. Combined with the characteristics of the community and the actual situation, put forward the targeted optimization strategy.

SRQ 3 Research contribution and value

The Outdoor environment evaluation system of elderly livable communities builds a set of objective, quantitative and effective evaluation methods for aging adaptability. The system is used to find the shortcomings that affect the outdoor activities of the elderly and to provide design strategies for renovating the outdoor environment in the community. This study combines the objective quantitative evaluation method of the overall community perspective of the commonly used subjective qualitative evaluation method. It deepens and expands the research methodology on aging-friendly issues. It is also an important addition to the field of aging-friendly research.

With the deepening of aging in China, the demand for the use of community outdoor activity sites by the elderly is growing. A comprehensive, accurate and objective evaluation of the aging level of the site is the key to the aging planning and design of the site. The evaluation results are objective and comprehensive by considering all objective characteristics affecting the activities of the elderly inside and outside the site from the perspective of the community as a whole. At the same time, compared with the qualitative analysis method based on experience, the quantitative evaluation method based on the objective characteristics inside and outside the site is more accurate.

This study uses an objective and quantitative evaluation method as a link to help the planners and designers understand more deeply the relationship between the objective conditions and outdoor activities of the elderly in the community. The planning and

design objectives and strategies developed on this basis can provide more scientific and targeted guidance for the ageing-friendly construction of community outdoor activity sites. And then provide reliable basis and scientific technical support for the aging construction of the community.

8.1.4 Findings and contributions of MRQ

The elderly livable environment is a complex giant system, and its influencing factors are also characterized by diversity and complexity. This study attempts to start from the overall perspective, from the perspective of community environment, and the needs of the elderly, comprehensively study the connotation and extension of the elderly livable community from the perspective of scientific evaluation. The supply and demand balance theory, P-E matching theory and grounded theory provide important guidance for the research of the aging-friendly outdoor activity sites in communities. This paper first discusses the environmental factors of different matching outdoor sites in urban communities through the supply and demand model. Then it judges the site adaptation of different elderly groups through the P-E matching model. Finally, the evaluation system was used to evaluate the livability of the outdoor environment of the sample community for the elderly. The comprehensive research results of the elderly livable community are integrated, and corresponding optimization strategies are given. This integration represents the scientific, comprehensive and quantitative consideration of all environmental factors affecting the elderly outdoor activities. Based on the national conditions, China still lacks such a comprehensive, quantitative and qualitative analysis and evaluation method.

Today, when the elderly group has become the main body of the population structure, we need to re-examine our community. The construction of a livable community for the elderly has a profound practical background and broad social needs. The starting point of the construction of a livable community for the elderly is to objectively understand the reality of the community. Therefore, this paper provides a set of practical evaluation index system to measure the construction status of the elderly livable community. It is necessary to propose targeted strategies based on the quantitative evaluation of the elderly livable environment in the community, so as to provide practical basis and theoretical guidance for the construction of the elderly livable community.

8.2 Contribution to Knowledge Science

8.2.1 SECI knowledge sharing

The concept of knowledge sharing transforms abstract ideas into feasible plans in a sustainable innovation cycle, which is the basis of the knowledge spiral of Nonaka and Takeuchi show how to generate, transfer and recreate knowledge in the organization. They describe the model as a spiral, not a circle, because it represents the continuous

progress of knowledge.

It has been 25 years since the SECI knowledge transformation model was proposed, and it has become the cornerstone of the theory of knowledge creation and transformation. Nowaka and Takeuchi put forward four ways in which knowledge types can be combined and transformed, showing how knowledge is shared and innovated in the organization. The model is based on explicit knowledge and tacit knowledge. SECI has four different knowledge transformation models (Figure 8-1).

- Socialization—— Tacit knowledge generates new tacit knowledge
- Externalization——Tacit knowledge generates new explicit knowledge
- Combination—— Explicit knowledge generates new explicit knowledge
- Internalization—— Explicit knowledge generates new Tacit knowledge

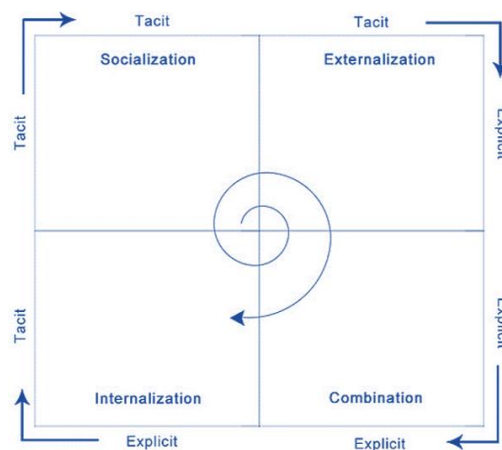


Figure 8-1 . SECI knowledge transformation model (Source: author)

8.2.2 The knowledge model constructed in this study

Based on the shared knowledge of SECI, a dynamic knowledge graph loop of livable communities for the elderly is constructed (Figure 8-2). Consider sustainability in the context of the whole environment by incorporating a deep emotional dimension. Identify the social motives of design in relation to nature (Nagai, Y., 2015). The necessary outdoor environment information and the activity needs of the elderly in urban communities are organized in order to evaluate and verify the effectiveness of community outdoor environment aging-friendly design. Designers can step in at any stage of the knowledge graph loop to research and analyze the activity needs of the elderly and output strategies and solutions. Identify core motivation for “advanced design thinking” through interdisciplinary co-creative design that goes beyond empathy to find a meaningful curriculum for group work in the future (Nagai, Y. et al., 2017 ; 2011; 2019).

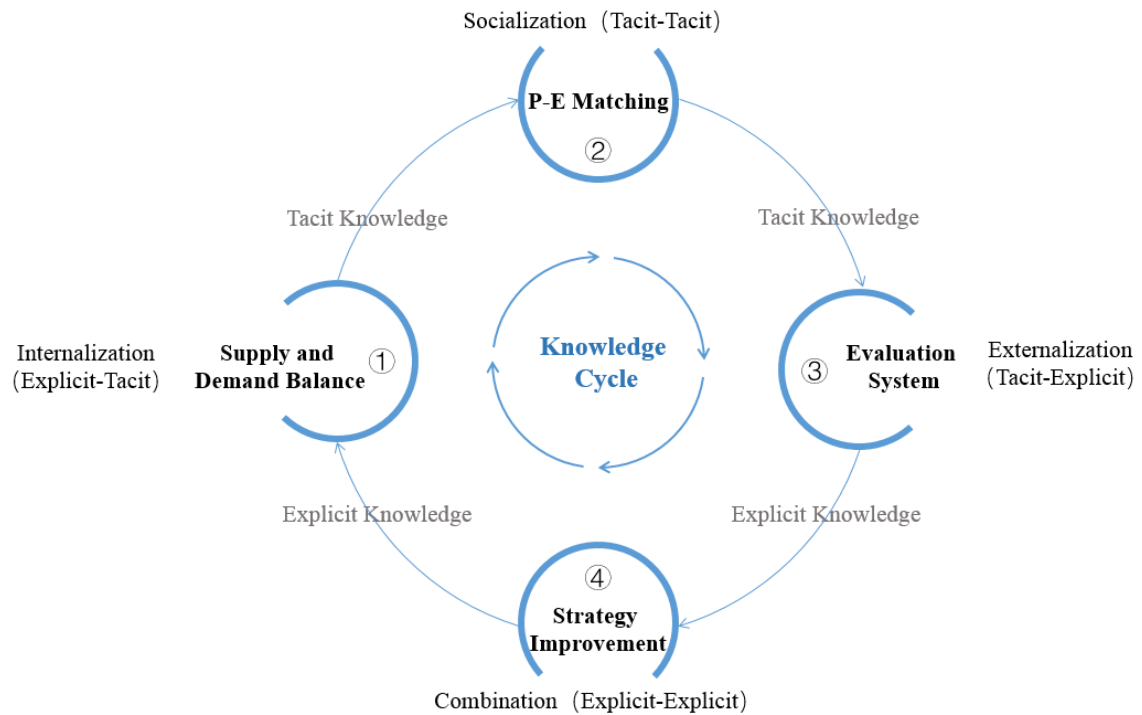


Figure 8-2 .Community outdoor environment aging knowledge map loop

Based on the knowledge graph loop, four stages are constructed:

① **Supply and demand balance (Internalization)**: The supply of community outdoor environment and the demand for elderly activities. Build a supply and demand model of outdoor sites in urban communities. On the basis of existing outdoor environment improvement measures, constantly add new improvement strategies. It becomes a part of the elderly's understanding of the existing environment. "Internalize" into their thinking and experience.

② **P-E matching (Socialization)**: Matching between the elderly and the environment. Build a model for determining whether individual and community outdoor site are aging-friendly. Conduct in-depth interviews with the elderly in outdoor activities. Make field observation records of the community's outdoor environment, activity groups, activity time, activity location and activity content. It is through sharing experience, observation and discussion that tacit knowledge is shared.

③ **Evaluation system (Externalization)**: Subjective and objective combination of community outdoor environment assessment. Construct the outdoor environment evaluation system of elderly livable communities and verify the satisfaction of the elderly with the environment. It is a means to express the tacit knowledge such as prior knowledge and intuitive cognition of the elderly into explicit data.

④ **Strategy Improvement (Combination)**: Give adjustment strategies for data analysis and evaluation reports. Classify, summarize and integrate the analysis results to create new decision-making knowledge. Apply it to the new knowledge cycle (internalization).

In this model, knowledge is constantly transformed and innovated with the observation, verification, induction and summary of community planners. This process should be regarded as a continuous, dynamic and knowledge vortex, rather than a static model, and it is basically a visual representation of overlapping and continuous processes that have occurred or should occur in an organization, making certain contributions to the research on livable communities for the elderly in the field of knowledge science.

8.2.3 Theoretical Implication

① Broaden the research horizon.

This paper is an important supplement to the research field of aging-friendly outdoor activity site in urban communities and contributes to the comprehensiveness of the existing theories of livable communities for the elderly by changing the research horizon from focusing on elderly care in elderly care communities, aging-friendly housing, community care and nursing facilities, etc. Focusing on satisfying the outdoor activities of the elderly, this study organically integrates relevant theories and cutting-edge achievements in urban and rural planning, geriatric sociology, environmental gerontology, geography and other fields, enriching the theoretical connotation of the aging problem.

② Study scale micromation.

The elderly livable community is a hot issue studied by many scholars in the context of aging. However, due to the limitations of data availability and other issues, scholars often conduct quantitative research on the elderly livable environment from macro scales such as cities. However, the research on the elderly livable environment at the micro scale of community is more conducive to solving the practical problems of the elderly. The research scale is micro and the research perspective is more specific, it provides reference for the research on the livable environment of Chinese communities in the context of aging, and provides theoretical basis and micro decision support for the construction of livable communities for the elderly adapted to local conditions.

③ Using multi-source data for evaluation and analysis.

Since it is difficult to obtain data at the community level in China, scholars usually use the data from the census. Therefore, the indicator system mostly focuses on the social attributes such as the age and registered residence of community residents, and rarely involves the physical living environment such as facilities and sites. There are problems such as incomplete indicators and insufficient explanatory power. This study is based on the data of micro environmental characteristics of urban communities. The data accuracy of Google Maps, Baidu Maps and other websites is not high, the information is incomplete, and it is impossible to obtain the space location, scale, environmental characteristics and other information of each community site. Therefore, it is very necessary to collect basic site data with sufficient accuracy by means of field investigation and camera extraction, which will help the relevant planning and design personnel to better understand the objective conditions related to the site in the community. The planning and design goals and strategies formulated on this basis can

more scientifically and specifically guide the construction of aging-friendly outdoor activity sites in urban communities, and thus provide a reliable theoretical basis for construction of aging-friendly community.

8.2.4 Practical Implication

① Combine the "top-down" and "bottom-up" research models.

As the aging trend intensifies, there is a strong "top-down" motivation for the decision-making of aging-friendly community outdoor site in China. All regions and departments throughout the country are trying to promote the process of aging-friendly communities. However, the "bottom-up" practice is obviously insufficient. Through research, we deeply feel that, the elderly have a strong desire and strong demand for the improvement of life and site environment in the old community. This is the fundamental source of bottom-up power. Through in-depth interviews and field observations, the needs and differences of the elderly on the outdoor environment are analyzed and summarized. This lays a theoretical and practical foundation for the future exploration of the "top-down and bottom-up combination of aging-friendly communities' transformation model".

② Enhance the fineness of aging-friendly research

The arrival of population aging has broken the original population structure and brought about unprecedented population changes. The number of the elderly population is on a par with the number of young people. According to the principle of intergenerational equity, the elderly population has gradually become the main body of the population structure, and the interests and needs of the elderly should be given sufficient attention. However, no matter in China or other countries, in the past community construction, the interests and needs of the elderly have not received much attention. This paper conducts research on the elderly based on the differences of the elderly group, forming a new understanding of "aging-friendly". To study the differences among the elderly is to effectively improve the use efficiency of the site, make the site more adaptable, which enhances the sophistication of the research on the aging-friendly.

③ Pay attention to the dynamic changes of aging-friendly.

During the research period, Dalian Municipal Government and local community management carried out the reconstruction of old residential areas in an all-round way. Among them, some areas of Houshan Community, a sample community, experienced this transformation. It just formed a comparison between the renovated areas and the unrenovated areas of the same community at the same time. Through literature review, it can be seen that longitudinal empirical studies in this field is very expensive and time-consuming, because this kind of experiment may have a long-term impact on the environment. Therefore, most of the relevant studies are horizontal studies and comparisons, and there is a lack of longitudinal studies on the impact of community outdoor environment renewal on the activity level and quality of life of the elderly. Little is known about what environmental factors lead to the increase of residents' activity level after the environmental transformation.

This research has seized this opportunity to study the impact and change of the dynamic changes of the community outdoor environment on residents, especially the elderly outdoor activities. The research data has made a strong supplement to the longitudinal empirical research in the aging-friendly field.

8. 3 Limitations and Developments

The aging of the population in China is severe and the problems are prominent. The outdoor environment research of the elderly livable community in this paper provides a positive and effective action path to solve many social problems caused by aging. It is of great significance to improve the theory of the elderly livable environment and guide the construction practice of the elderly livable community. On the one hand, the research reflects the differences in the construction of the elderly livable environment in urban communities. On the other hand, under the background of aging, it provides guidance for the community to adapt to the change of population age structure and create a suitable living environment for the elderly, which enriches the research content of human settlement environment science and aging geography. However, the following deficiencies still exist in the research:

① The supply and demand model of urban community outdoor site, the model for determining whether individual and community outdoor site are aging-friendly and the outdoor environment evaluation system of elderly livable communities constructed in this paper are the operationalization of the concept of elderly livable communities, and are comprehensive quantitative methods that reflect the needs of elderly groups for activities in community outdoor site. However, at present, no unified view has been formed on the monitoring and evaluation of the residential environment of the elderly livable community in both the practical field and the academic community. Further improvement of the model and indicator system will be the focus of subsequent research.

② The community selected in this empirical study is ideal typical communities. The sample community is very conducive to the basic data collection of the aging-friendly model in terms of spatial scale, facilities, abundance of activity sites, diversity of residential models, aging level, etc. The elderly livable community living environment is a complex giant system, and the universality and complexity of its problems need the support of a large number of data. In addition, the data are collected in sunny April and May. Therefore, it is uncertain whether our findings will be similar to the weather in other months. The construction of the comprehensive model is conducted under certain simplified conditions, excluding other interference factors. For example, the simplification of the activity habits of the elderly, the simplification of the individual differences of the elderly, and the simplification of the site supply and demand. In the subsequent research, the simplified conditions can be gradually reduced, the applicable scenarios of the model can be expanded, and the theoretical model can be more closely combined with the realistic scenario to further improve the practical value of the model.

③ The number of samples and the scope of research should be appropriately expanded. Due to time and manpower limitations, the sample size can only be limited to the acceptable error range. The quality of data will affect the research accuracy. The sample communities are not enough, and only three communities have been studied due to the availability of data. In the subsequent research, the number of samples and the scope of research should be expanded to enhance the scientific nature of the research and expand the availability of research results.

④ The samples were selected in cities, and rural areas were not taken into consideration, hence there is a lack of universality in the study sites. According to the statistics of the most recent population census of China, the population over 60 years old in rural areas accounts for up to 23.81% of people, which is higher than those in cities and towns by 7.99%. Future studies should pay more attention to the influence of environmental factors on ambulatory activities of older adults in rural areas.

⑤ Research tools and research methods should be further improved. Due to the limitation of professional background, the research methods and tools in this paper are still single. In further research, more effective research tools will be used to analyze and simulate the research content to enhance the scientific nature of the research.

⑥ Strengthen interdisciplinary research. The issue of livable community for the elderly involves multidisciplinary issues, and the knowledge base and theoretical support needed for research are also multi-disciplinary and multi-level. This paper only makes a preliminary exploration in interdisciplinary application, focusing on the perspective of urban planning discipline. In the future, it is necessary to further broaden the research horizon, learn from multidisciplinary theories and methods, and carry out interdisciplinary in-depth discussion to achieve complementary advantages.

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Appendix 1

Questionnaire Number () _____

Questionnaire on Community Outdoor Environment

Meeting the Needs of the Elderly

Dear elders,

The outdoor environment in the community is the most important place for your daily physical exercise, social and leisure activities. The outdoor environment in the community that meets your needs for daily activities can improve your health and quality of life. In order to understand the elderly's use of the community environment and activity venues, we hereby issue you a questionnaire. Please fill in according to your actual situation. Your information is only for academic research, and you can rest assured to answer.

Thank you for your cooperation and help. I wish you good health and a happy family!

Note: The participants in the questionnaire are the elderly over 60 years old.

I. Sociodemographic statistical information [Single choice] Please tick "√" on the appropriate options.

1. Gender

- Male Female

2. Age

- 60-69 years old 70-79 years old
 80-89 years old Over 90 years old

3. Education level

- Primary school and below Junior middle school High middle school and vocational study
 Junior college Bachelor's degree and above

4. Employment condition

- Employed Not employed

5. Occupation before retirement

- Civil servants and managers Employees of public institutions Enterprise staff
 Self-employed Farmer Others

6. Monthly income

- Less than 1000 CNY 1000 ~ 2000 CNY 2000 ~ 3000 CNY
 3000 ~4000 CNY 4000 ~5000 CNY Over5000 CNY

7. Living status

- Living alone Living together with Living together with

- Three generations under one roof
 - their spouses
 - their children
 - Others
- 8. Residence model**
- Gated community
 - Group gated communities
 - Mixed open community (Renovated)
 - Mixed open community (Unrenovated)

9. Period of residence

- 1-5 years
- 6-10 years
- 11-15 years
- Over 16 years

10. Floor of home

- 1st~3rd floors
- 4th~10th floors
- 11th~20th floors
- More than 21 floors

11. Elevator condition

- Yes
- No

II. Physical Condition [Single choice] Please tick "√" on the appropriate options.

1. Your current physical condition

- Very good
- Good
- Fair
- Not so good
- Poor

2. Assistance you need for outdoor activities

- No assistance is required
- Walking aid or crutches
- Wheelchair
- Escort is required

3. Which situation do you think will affect your outdoor activities more?

- Impaired vision
- Impaired hearing
- Poor mentality
- Poor flexibility
- Decreased upper body strength
- Decreased waist and leg ability

4. How many times you go out every day?

- 0 times
- 1-2 times
- 3-4 times
- 5 times or more

5. The duration of your daily outdoor activities is about

- Within half an hour
- 1-2 hours
- 2-3 hours
- More than 3 hours

III. Outdoor Activities Habits [Multiple Choices]

1. When do you usually have outdoor activities?

- 6-8 a.m.
- 9-11 a.m.
- 12-14 p.m.
- 15-17 p.m.
- 18-20 p.m.
- After 21 p.m.

2. Where do you usually have the most outdoor activities?

- Unit doorway
- Central square of the residential area
- Space in front of the building
- Street outside the residential area
- Small square between buildings
- Activity area outside the residential area

3. What are your frequent outdoor activities?

- Walking, walking the dog
- Sit still
- Chat
- Bask
- Chess and cards
- Enjoy the scenery
- Play with grandchildren
- Keep-fit exercises
- Dance and sing
- Others_____

4. What are the reasons why you don't want to go to the outdoor activities in the residential area?

- The activity place is too small
- Poor greening landscape, no sunshade
- Poor sanitation conditions
- The fitness facilities are old and there is no rest benches
- Uneven roads, many ramps and steps, parking occupied
- Few community activities, few elderly people and few acquaintances

5. Which of the following ways do you prefer when you are outdoors?

- Group activities with more than 5 people
- Small activities with groups of 3-5 people
- Two people together
- Alone

6. What is the distance from your home to the community outdoor activity site?

- 0-250m (0-5 minutes)
- 250-500m (5-10 minutes)
- 500-1000m (10-15 minutes)
- 1000-2000m (15-25 minutes)

IV. Please evaluate your satisfaction with the outdoor environment in your current residential area

Classification	No.	Outdoor environment of residential area	Dissatisfied	Somewhat dissatisfied	Irrelevant	Somewhat satisfied	Satisfied
			1	2	3	4	5
Site conditions	1	Area of activity site					
	2	Fluctuation degree of activity site					
	3	Openness of activity site					
	4	Parent-child activity space					
	5	Exclusive space for the elderly					
Facilities conditions	6	Recreation and fitness facilities					
	7	Sun/rain shelter					
	8	Lighting facilities					
	9	Barrier-free design					
	10	Rest facilities					
	11	Public toilet					
	12	Signage facilities					

Landscape conditions	13	Sculptures					
	14	Water&Scape					
	15	Green planting					
	16	Flowers and plants					
	17	Cicadas and birds singing					
Road conditions	18	Road smoothness					
	19	Road safety					
	20	Separation of passengers and vehicles					
	21	Road parking					
	22	Ramp and step					
Maintenance conditions	23	Environmental facility maintenance					
	24	Garbage bin facilities					
	25	Environmental sanitation					

V.What kind of community outdoor environment do you think can meet your activity needs? Please comment

Outdoor environment	No demand	Poor	Relatively Poor	Fair	Relatively Good	Good	In Demand
		1	2	3	4	5	
Area of activity site	Small						Large
Fluctuation degree of activity site	Ups and downs						Flat
Openness of activity site	Private						Open
Parent-child activity space	Single						Diverse
Exclusive space for the elderly	Unnecessary						Necessary
Recreation and fitness facilities	Single						Diverse
Sun/rain shelter	A few						Abundant
Lighting facilities	Deficient						Sufficient
Barrier-free design	Unnecessary						Necessary
Rest facilities	Insufficient						Abundant
Public toilet	Unrequited						Required
Signage facilities	Incomplete						Complete
Sculptures	Unnecessary						Necessary
Water&Scape	Unrequited						Required
Green planting	Deficient						Diverse
Flowers and plants	Monotonous						Abundant
Cicadas and birds singing	Deficient						Abundant
Road smoothness	Winding						Convenient
Road safety	Dangerous						Safe
Separation of passengers and vehicles	Unnecessary						Necessary
Road parking	Unordered						Ordered
Ramp and step	Less						More
Environmental facility maintenance	Unnecessary						Necessary
Garbage bin facilities	A few						Abundant
Environmental sanitation	Messy						Tidy

Appendix 2

In-depth interviews on ageing-friendly community outdoor sites

1. Basic information

1. Gender
2. Age
3. What is your physical condition?
4. Your occupation before retirement?
5. Who do you live with now?
6. How long have you lived in the community?
7. How many times do you go out every day? In what time period?

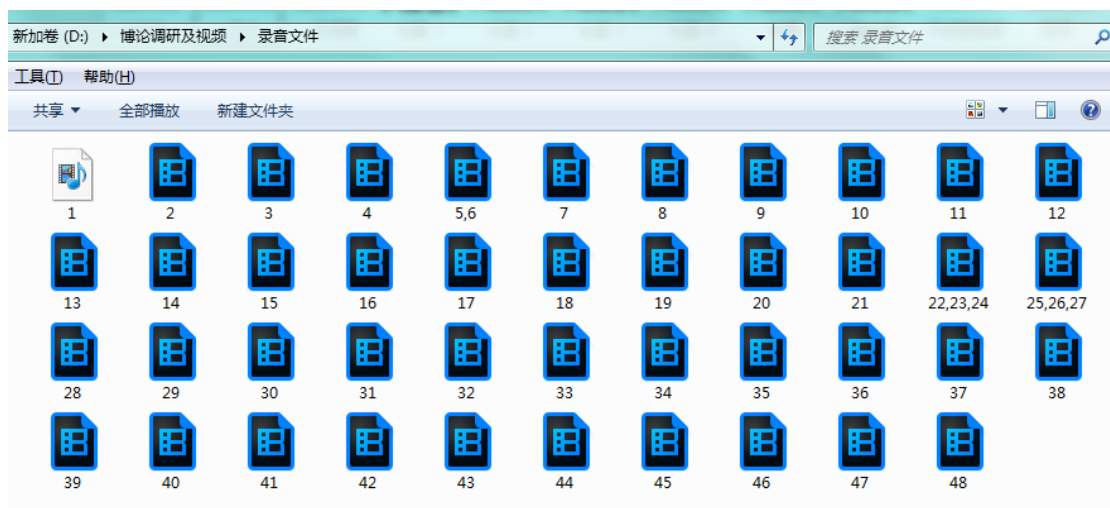
2. Views on community environment

1. What kind of community do you live in?
 2. Are you satisfied with your current community environment? What are you satisfied with? What are you not satisfied with?
 3. Where do you spend most of your time outdoors?
 4. What activities do you often do outdoors?
 5. Have you encountered any difficulties in your activities in the community?
 6. Do you think the community environment is helpful to your health?
 7. Do you think the community environment affects your communication with your neighbors?
 8. In what way do you think the current community environment has exerted the greatest influence on your life?
-

Basic information of in-depth interviewees

N o.	Gender	Age	Pre retirement occupation	Residence mode	Community type	Length of residence	The sample USES
1	Female	81	Farmer	Living with children	Work unit family building	Over 10 years	Code analysis
2	Male	64	Corporate director	Living with spouse	Commercial housing	6years	Code analysis
3	Male	65	Driver	Living with children	Commercial housing	5years	Code analysis
4	Female	63	Unemployed	Living with children	Commercial housing	5years	Code analysis
5	Male	73	Surveyor of Provincial Geological Team	Living with spouse	Commercial housing	one month	Code analysis
6	Female	78	Workshop director of cotton mill	Living with spouse	Commercial housing	one month	Code analysis
7	Male	65	Workers of state-owned enterprises	Living with spouse	Commercial housing	10 years	Code analysis
8	Female	63	Store sales	Living with spouse	Commercial housing	10 years	Code analysis
9	Female	72	High school teachers	Living with spouse	Commercial housing	3 years	Code analysis
10	Male	81	worker	Living with spouse	Commercial housing	10 years	Code analysis
11	Male	66	Individual work	Living with children	Commercial housing	3-4 years	Code analysis
12	Male	75	Individual work	Living with children	Commercial housing	3 years	Code analysis
13	Female	65	School staff	Living with children	Commercial housing	6 years	Code analysis
14	Female	67	School staff	Living with spouse	Commercial housing	Over 20 years	Code analysis
15	Female	60	Primary school teacher	Living with spouse	Work unit family building	Over 15 years	Code analysis
16	Female	71	Farmer	Living with spouse	Rural self built houses	10 years	Code analysis
17	Male	60	salesman	Cohabitation of three generations	Commercial housing	2 years	Code analysis
18	Female	62	cook	Living with children	Commercial housing	2 years	Code analysis
19	Male	68	Construction worker	Living with spouse	Commercial housing	12 years	Code analysis
20	Female	85	Businessman	Living with children	Military House Property	Over 10 years	Code analysis
21	Female	65	Businessman	Living with spouse	Commercial housing	5 years	Code analysis
22	Male	62	Railway worker	Living with spouse	Commercial housing	5 years	Code analysis
23	Female	60	Farmer	Living with spouse	Commercial housing	5 years	Code analysis
24	Female	89	Accounting	Others	Commercial housing	5 years	Code analysis
25	Male	93	Vice president of Sports School	Others	Commercial housing	5 years	Code analysis
26	Female	60	Unemployed	Cohabitation of three generations	Commercial housing	Over 10 years	Code analysis
27	Male	62	Businessman	Cohabitation of three generations	Commercial housing	Over 10 years	Code analysis
28	Female	65	Textile worker	Living with spouse	Commercial housing	Over 30 years	Code analysis

29	Female	75	Textile worker	Living with spouse	Commercial housing	4 years	Code analysis
30	Female	60	worker	Living with children	Commercial housing	Over 20 years	Code analysis
31	Female	68	medicine workers	Living with children	Commercial housing	Over 10 years	Code analysis
32	Male	85	office	Living with spouse	Commercial housing	2 years	Code analysis
33	Female	81	be unemployed	Living with spouse	Commercial housing	4 years	Code analysis
34	Female	60	artisan	Living with spouse	Commercial housing	12 years	Code analysis
35	Female	82	worker	Living with children	Commercial housing	23 years	Code analysis
36	Male	60	civil servant	Living with spouse	Commercial housing	5 years	Code analysis
37	Male	61	Enterprise employees	Living with spouse	Commercial housing	5 years	Code analysis
38	Female	78	Enterprise employees	Living with children	Commercial housing	16 years	Code analysis
39	Female	61	be in business	Living with spouse and children	Commercial housing	10 years	Code analysis
40	Female	84	Enterprise employees	Living with children	Commercial housing	25 years	Code analysis
41	Male	77	construction worker	Living with spouse	Commercial housing	20 years	Code analysis
42	Female	78	Guard	Living with spouse and children	Commercial housing	20 years	Saturation test
43	Male	79	farmer	Living with spouse	Commercial housing	Over 10 years	Saturation test
44	Female	81	teacher	Living with spouse	Commercial housing	11 years	Saturation test
45	Female	68	professional	Living alone	Commercial housing	Over 5 years	Saturation test
46	Female	65	Restaurant	Living with spouse	Commercial housing	10 years	Saturation test
47	Female	60	worker	Living with spouse	Commercial housing	Over 10 years	Saturation test
48	Male	60	management	Living with spouse	Commercial housing	10 years	Saturation test



Appendix 3

Word frequency statistics of environmental factors through in-depth interviews (N=465)

Five categories of environmental factors	Word frequency statistics (original data)
Site (167 times)	Activity site area (22 times)、Activity lawn (18 times)、The terrain changes slightly (8 times)、The site has slope (5 times)、Personal space privacy (18 times)、Space permeability (25 times)、Parent child fun space (6 times)、Children's play area (10 times)、Elderly activity area (33 times)、Square dance area (4 times)、Chess and Card area (18 times)
Facilities (81 times)	Fitness equipment and facilities (18 times)、Shading and rainproof facilities (8 times)、Night lighting (11 times)、Accessibility and other safety facilities (12 times)、Rest seat facilities (13 times)、Public toilet (9 times)、Guide sign (10 times)
Landscape (75 times)	Cultural landscape sketch (5 times)、Hydrophilic platform (6 times)、Water surface size (5 times)、Shrub variety richness (14 times)、Arbor variety richness (13 times)、Plant collocation (4 times)、Variety richness of flowers (15 times)、Bird calls (5 times)、Small animals (8 times)
Road (110 times)	Zigzag roads (12 times)、convenient walking (20 times)、No motor vehicles (15 times)、road safety (20 times)、Avoid the intersection of people and vehicles (10 times)、and park in the community (12 times)、Parking and road occupation (7 times)、Square steps (14 times)
maintenance (32 times)	Facility quality (11 times)、Trash can (10 times)、Site sanitation maintenance (11 times)

Appendix 4

Community outdoor field observations

Statistical table of XH community elderly people's outdoor activities

XH community / Survey Date: Apr.18 / Weather: Sunny 18°C

Activity group classification	Type of outdoor activities	Area A			Area B			Area C			Area D			Area E		
		9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00
Elderly	Walking, dogs	5	5	6	0	0	1	1	0	0	2	1	1	0	0	1
	Sit still	6	7	1	0	1	0	0	2	0	1	1	0	4	2	2
	Chat	6	4	2	0	0	0	0	0	0	0	2	0	4	3	0
	Bask in the sun	6	5	0	1	0	0	0	0	0	0	0	0	1	1	0
	Chess	0	0	0	0	0	0	0	0	0	10	15	13	4	5	0
	Views	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	Play with grandchildren	19	15	9	0	0	0	1	0	0	1	3	1	3	5	2
	Fitness exercise	0	1	0	0	0	0	0	0	0	0	0	0	5	8	4
	Dance and sing	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Total number of elderly people	45	39	18	1	1	1	2	2	0	14	21	15	27	24	9	
Number of Adults	7	33	14	0	1	0	1	0	4	2	2	4	2	13	11	
Number of Children	29	59	36	0	1	2	1	0	3	2	3	2	8	20	12	
Total number of people in each area	137			4			9			28			60			

Peak number of outdoor activities among different groups (filled in yellow)

Minimum size of outdoor activity venues for the elderly in each region of XH Community (calculated by peak number of people in each period)

Type of outdoor activities	Calculation standard	Area A	Area B	Area C	Area D	Area E
Walking, dogs	3 m ² /person	3×5	0	0	3×1	0
Sit still	5 m ² /sheet	5×6	0	5×2	5×1	5×4
Chat	3 m ² /person	3×6	0	0	3×2	3×4
Bask in the sun	3 m ² /person	3×6	3×1	0	0	3×1
Chess	10 m ² /group	0	0	0	15 (people) 10 x 3 groups	4 (people) 10 x 1 group
Views	3 m ² /person	3×3	0	0	0	0
Play with grandchildren	3 m ² /person	3×19	0	0	3×3	3×3
Fitness exercise	10 m ² /person	0	0	0	0	10×5
Dance and sing	10 m ² /person	0	0	0	0	10×6
Peak number of elderly		45	1	2	22	27
Area occupied by activities of the elderly		147 m ²	3 m ²	10 m ²	53 m ²	164 m ²
Area occupied by adult activities	3 m ² /person	3×33	3×1	3×4	3×4	3×13
Area occupied by children's activities	3 m ² /person	3×59	3×2	3×3	3×3	3×20
Total active area		423 m ²	12 m ²	31 m ²	74 m ²	263 m ²
Proportion of site demand for the elderly		34.8%	25%	31.2%	71.6%	62.4%

XH Community. Objective Status of Community Outdoor Space Usage Statistics Form						
Classification	Specific content	Area A	Area B	Area C	Area D	Area E
Site conditions	Whether the site topography is undulating	without	without	without	With	without
	Site openness / privacy density	Open	Private	Suitable	Private	Suitable
	Whether there is space for parent-child activities	With/ Sandpit/children's play facility	without	without	without	With
	Whether there is parking occupation	without	without	without	without	without
	Note	Hard cladding area 32%, grass/landscape area 68%	Hard cladding area 20%, grass/landscape area 80%	Hard cladding area 25%, grass/landscape area 75%	Hard cladding area 15%, grass/landscape area 85%	Hard cladding area 36%, grass/landscape area 64%
Facilities condition	Number of recreation and fitness facilities	0	0	0	chess tables and chairs 8	14 sets of fitness equipment, 1 chess table and chair, 1 table tennis table, 2 tennis courts, 3 practice courts
	Availability of shade/rain shelter facilities	without	without	With	With	With
	Availability of lighting facilities	With	less	less	less	With
	Accessibility design	With	Have a ramp	without	without	without
	Number of resting facilities	28 sets of wooden chairs	6 sets of wooden chairs	10 sets of wooden chairs	6 sets of plastic and stone seats	18 sets of wooden chairs
Common problems						
Facilities condition	Availability of public toilets	without				
	Guidance signage facilities	With				
Landscape conditions	Sculpture Landscape	With				
	Water Landscape	With				
	Bird activity	With				
	Shrub species	Rich				
	Tree Species	Rich				
Road conditions	Road accessibility	Short				
	Safety of the road	Unobstructed				
	Separation of pedestrian and vehicle traffic	Yes/ There's a main road for traffic				
	There is parking occupation	Yes/ More parking in front of main road and clubhouse				
	There are many ramps and steps	No				
Maintenance conditions	Trash cans	With				
	Site Maintenance	With/ Part of it needs maintenance				
	Site trash	without				

Statistical table of **XF community** elderly people's outdoor activities

XF community / Survey Date: Apr.21 / Weather: Cloudy 20°C

Activity group classification	Type of outdoor activities	Zone III A			Zone IV B			Zone V C			Zone VI D			Zone VII E		Zone VIII F			
		9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00			
		Elderly	Walking, dogs	1	1	1	3	0	2	3	4	3	2	0	2	2	2	1	2
	Sit still	3	2	2	2	3	1	4	2	0	1	1	0	1	1	0	0	1	0
	Chat	2	2	2	2	2	2	0	2	3	0	0	0	2	0	4	4	2	2
	Bask in the sun	1	0	0	2	2	0	0	0	0	0	0	0	0	1	0	1	1	0
	Chess	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Views	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Play with grandchildren	1	3	6	4	8	6	2	8	8	1	2	0	0	4	2	3	2	0
	Fitness exercise	1	0	0	0	0	0	0	0	2	1	0	0	1	0	1	0	0	0
	Dance and sing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total number of elderly people		9	8	11	13	15	11	9	16	16	5	3	2	6	8	8	10	7	3
Number of Adults		10	10	30	7	11	13	6	12	16	6	3	12	11	5	5	8	6	6
Number of Children		3	15	28	17	23	17	4	15	26	4	4	11	13	8	8	12	6	7
Total number of people in each area		69			51			58			28			32		30			

Peak number of outdoor activities among different groups (filled in yellow)

Minimum size of outdoor activity venues for the elderly in each region of **XF Community** (calculated by peak number of people in each period)

Type of outdoor activities	Calculation standard	Zone III A	Zone IV B	Zone V C	Zone VI D	Zone VII E	Zone VIII F
Walking, dogs	3 m ² /person	3×1	0	3×4	3×2	3×2	3×2
Sit still	5 m ² /sheet	5×2	5×3	5×2	5×1	5×1	0
Chat	3 m ² /person	3×2	3×2	3×2	0	0	3×4
Bask in the sun	3 m ² /person	0	3×2	0	0	3×1	3×1
Chess	10 m ² /group	0	0	0	0	0	0
Views	3 m ² /person	0	0	0	0	0	0
Play with grandchildren	3 m ² /person	3×6	3×8	3×8	3×1	3×4	3×3
Fitness exercise	10 m ² /person	0	0	0	10×1	0	0
Dance and sing	10 m ² /person	0	0	0	0	0	0
Peak number of elderly		11	15	16	5	8	10
Area occupied by activities of the elderly		46 m ²	51 m ²	52 m ²	24 m ²	26 m ²	30 m ²
Area occupied by adult activities	3 m ² /person	3×30	3×13	3×16	3×12	3×11	3×8
Area occupied by children's activities	3 m ² /person	3×28	3×23	3×26	3×11	3×13	3×12
Total active area		220 m ²	159 m ²	178 m ²	93 m ²	98 m ²	90 m ²
Proportion of site demand for the elderly		23%	32%	29.2%	25.8%	26.5%	33.3%

XF Community. Objective Status of Community Outdoor Space Usage Statistics Form							
Classification	Specific content	Zone III A	Zone IV B	Zone V C	Zone VI D	Zone VII E	Zone VIII F
Site conditions	Whether the site topography is undulating	without	without	without	without	without	without
	Site openness / privacy density	Open	Suitable	Suitable	Suitable	Suitable	Relatively private
	Whether there is space for parent-child activities	With	With	With	With	With	With
	Whether there is parking occupation	without	without	without	without	without	without
	Note	Hard cladding area 50%, grass/landscape area 50%	Hard cladding area 40%, grass/landscape area 60%	Hard cladding area 40%, grass/landscape area 60%	Hard cladding area 50%, grass/landscape area 50%	Hard cladding area 50%, grass/landscape area 50%	Hard cladding area 50%, grass/landscape area 50%
Facilities condition	Number of recreation and fitness facilities	2 fitness equipment	1 fitness equipment	1 fitness equipment, 1 basketball court	1 fitness equipment, 2 tennis courts	1 fitness equipment, 1 basketball court	1 fitness equipment
	Availability of shade/rain shelter facilities	With	With	With	With	With	With
	Availability of lighting facilities	With	With	With	With	With	With
	Accessibility design	With	With	With	With	With	With
	Number of resting facilities	14 sets of wooden or stone seats	7 sets of wooden chairs	11 sets of wooden chairs	20 sets of plastic and stone seats	8 sets of wooden chairs	8 sets of wooden chairs
	Availability of public toilets	without	without	without	without	without	without
	Guidance signage facilities	without	without	without	without	without	without
Landscape conditions	Sculpture Landscape	With	With	With	With	without	With
	Water Landscape	without	without	without	without	With	without
	Bird activity	With	With	With	With	With	With
	Shrub species	Rich	More abundant	Rich	Rich	Rich	Rich
	Tree Species	Rich	More abundant	Rich	Rich	Rich	Rich
Road conditions	Road accessibility	suitable	suitable	suitable	suitable	suitable	suitable
	Safety of the road	Unobstructed	Unobstructed	Unobstructed	Unobstructed	Unobstructed	Unobstructed
	Separation of pedestrian and vehicle traffic	Yes	Yes	Yes	Yes	Yes	Yes
	There is parking occupation	No	No	No	No	No	No
	There are many ramps and steps	No	No	No	No	No	No
Maintenance conditions	Trash cans	With	With	With	With	With	With
	Site Maintenance	Part of it needs maintenance	Part of it needs maintenance	Part of it needs maintenance	With	Part of it needs maintenance	Part of it needs maintenance
	Site trash	without	without	without	without	without	without

Statistical table of **Mixed community** elderly people's outdoor activities

Mixed community / Survey Date: Apr.19 / Weather: Sunny 20°C

Activity group classification	Type of outdoor activities	NP A			JX C			HS B			Health Plaza D			HS E		
								NHS						OHS		
		9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00	9:00-11:00	15:00-17:00	18:00-20:00
Elderly	Walking, dogs	5	4	2	2	3	5	14	15	2	3	4	7	17	8	5
	Sit still	0	1	0	2	1	1	17	9	5	6	2	2	19	3	0
	Chat	0	2	0	0	0	0	9	9	5	2	4	2	7	8	2
	Bask in the sun	1	0	0	0	1	0	1	3	0	2	2	0	11	5	0
	Chess	0	0	0	0	0	0	0	0	0	0	0	0	8	19	0
	Views	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Play with grandchildren	0	0	1	0	2	1	9	3	4	0	2	8	2	0	0
	Fitness exercise	0	0	0	0	0	0	4	0	3	4	0	4	0	0	0
	Dance and sing	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total number of elderly people	12	7	4	4	7	7	54	39	38	17	14	23	64	43	7	
Number of Adults	3	1	3	1	2	1	20	11	15	2	3	13	11	13	8	
Number of Children	1	0	1	0	2	0	19	12	9	0	6	17	2	3	0	
Total number of people in each area	16			11			93			53			80			
Peak number of outdoor activities among different groups (filled in yellow)																

Minimum size of outdoor activity venues for the elderly in each region of **Mixed Community** (calculated by peak number of people in each period)

Type of outdoor activities	Calculation standard	NP A	JX C	HS B	Health Plaza D	HS E
Walking, dogs	3 m ² /person	3×5	3×3	3×14	3×7	3×17
Sit still	5 m ² /sheet	0	5×1	5×17	5×2	5×19
Chat	3 m ² /person	0	0	3×9	3×2	3×7
Bask in the sun	3 m ² /person	3×1	3×1	3×1	0	3×11
Chess	10 m ² /group	0	0	0	0	10×1 (8)
Views	3 m ² /person	3×6	0	0	0	0
Play with grandchildren	3 m ² /person	0	3×2	3×9	3×8	3×2
Fitness exercise	10 m ² /person	0	0	10×4	10×4	0
Dance and sing	10 m ² /person	0	0	0	0	0
Peak number of elderly		12	7	54	23	64
Area occupied by activities of the elderly		36	23	224	101	216
Area occupied by adult activities	3 m ² /person	3×3	3×2	3×20	3×13	3×13
Area occupied by children's activities	3 m ² /person	3×1	3×2	3×19	3×17	3×3
Total active area		48	35	341	191	254
Proportion of site demand for the elderly		75%	65.7%	65.7%	52.9%	81.8%

Mixed community. Objective Status of Community Outdoor Space Usage Statistics Form					
Classification	Specific content	NP A	JX C	NHS B, D	OHS E
Site conditions	Whether the site topography is undulating	With	without	With	With
	Site openness / privacy density	Open	Open	Open	Open
	Whether there is space for parent-child activities	without	without	With	without
	Whether there is parking occupation	With	without	With	With
	Note	Hard cladding area 35%, grass/landscape area 65%	Hard cladding area 65%, grass/landscape area 35%	Hard cladding area 85%, grass/landscape area 15%	Hard cladding area 80%, grass/landscape area 20%
Facilities condition	Number of recreation and fitness facilities	0	0	5 chess and card tables and chairs, 6 table tennis tables	0
	Availability of shade/rain shelter facilities	without	With	With	without
	Availability of lighting facilities	With/ Poor	With	With/ Poor	without
	Accessibility design	without	without	Part of it has ramps	without
	Number of resting facilities	6 sets of stone seats	6 sets of wood or stone seats	44 sets of wooden chairs	5 sets of wooden chairs
	Availability of public toilets	without	without	without	without
	Guidance signage facilities	without	without	without	without
Landscape conditions	Sculpture Landscape	without	without	without	without
	Water Landscape	without	without	without	without
	Bird activity	With	With	With	With
	Shrub species	Very few	Dull	Very dull	Very few
	Tree Species	Very few	Dull	Very dull	Very few
Road conditions	Road accessibility	Short route	Short route	Short route	High difference, difficult to walk
	Safety of the road	Unobstructed/ Obstacles	Unobstructed	Unobstructed	Difficult to walk or have obstacles
	Separation of pedestrian and vehicle traffic	No	Yes	Yes	No
	There is parking occupation	Yes	No	Yes	Yes
	There are many ramps and steps	Yes	No	Yes	Yes
Maintenance conditions	Trash cans	With	With	With	Few trash cans
	Site Maintenance	Need to maintain	Part of it needs maintenance	With	Very poor, in urgent need of repair
	Site trash	With	without	without	Dirty