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Innovation of housing model in smart senior living communities: a study on the integration of age-adapted housing design and smart technology application

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Abstract The aggravating trend of population aging has contributed to the growing demand for ageing-friendly housing design, and traditional housing environments are difficult to meet the physiological and psychological needs of the elderly. Existing senior housing has significant deficiencies in heat and humidity environment, sound and light environment, and air quality, and lacks scientific prediction models to guide design decisions. The rapid development of intelligent technology provides new ideas to solve this problem, and building smart senior living communities by combining artificial intelligence with age-appropriate design has become an important way to meet the challenges of aging. This study analyzes the influencing factors of aging-friendly residential design comfort through the field measurements of senior living buildings in five cities, namely Dalian, Dezhou, Yulin, Xinyang, and Wuhan, and constructs an aging-friendly residential design demand prediction model based on BP neural network. The study adopts the neural network algorithm with 25 evaluation indexes as the input layer neurons and the comprehensive expectation value as the output layer neurons, and the model is trained and validated by 328 valid questionnaire data. The results show that the average indoor temperatures in northern cities with heating range from 22.98°C to 25.12°C, which are significantly higher than those in southern cities without heating, which range from 11.49°C to 11.62°C. The average indoor PM2.5 concentration in rural dwellings is 156.9 μg/m³, which is well above the design limit of 75 μg/m³; the relative error of the prediction model is controlled within 5%, and the absolute error is maximum 0.333 It is concluded that the BP neural network model can effectively predict the design needs of ageing homes, provide a scientific basis for the design of homes in smart elderly communities, and promote the optimization and improvement of the environment of ageing homes.

Index Terms neural network, aging residence, smart senior living community, prediction model, residential design, senior living building

I. Introduction

In today's Chinese society, the phenomenon of population aging is becoming more and more prominent, and the ensuing problem of elderly care is also attracting more and more attention [1]. The limited number of senior living communities and the inadequate senior living facilities are lagging far behind the wishes of the elderly to enjoy their twilight years, and the current situation of senior living is not optimistic [2], [3].

For the elderly, the lowering of economic status, the rapid change of functional roles, and the deterioration of physical functions have affected the physiological and psychological adaptability of the elderly to varying degrees [4], [5]. In this situation, the concept of "ageing-friendly housing" has been proposed in recent years [6]. The design of ageing-friendly housing is a systematic task, which mainly includes the planning and site selection, indoor and outdoor environments, ancillary facilities, spatial layout, and other aspects to ensure that the designed housing highlights the "adaptability", and provides a comfortable, convenient, and safe aging environment for the elderly [7].

However, at present, China's living space is unable to meet the living needs of the elderly, the lack of service resources, and the design of ageing-adapted housing is unable to meet the psychological and physiological needs of the elderly, which makes the community-based elderly care model and ageing-adapted housing design unable to organically connect, and restricts the harmonious development of the society to a certain extent [8]-[11]. In this context, the integration of intelligent technology into the innovative design of the housing model of community aging, and the construction of a systematic design system of ageing-adapted housing, in order to provide a convenient and comfortable living space for the elderly, will effectively improve the quality of elderly services and service efficiency [12]-[15].

The phenomenon of global population aging is becoming more and more prominent, and the continuous rise of the proportion of elderly population has brought unprecedented challenges to the society. The elderly population presents unique characteristics in physiological function, cognitive ability and social interaction, which put forward higher requirements for the living environment. Traditional residential design often neglects the special needs of the elderly, and there are obvious deficiencies in terms of barrier-free facilities, safety and security, and environmental comfort. At the same time, the satisfaction of the elderly with the residential environment directly affects their quality of life and physical and mental health, so it has become imperative to build a quality environment suitable for the elderly to live in. In recent years, the booming development of artificial intelligence, Internet of Things, big data and other emerging technologies has provided a new opportunity to solve this problem. These technologies can realize real-time monitoring of the living status of the elderly, intelligent adjustment of environmental parameters and accurate provision of personalized services, thus significantly improving the quality and efficiency of elderly services. However, there are still many theoretical and practical challenges in how to integrate smart technologies with ageing-friendly housing design to build a smart elderly community that truly meets the needs of the elderly.

This study adopts a combination of field research and data analysis, firstly, through the actual survey of senior living buildings in several cities, we analyze the key factors affecting the comfort of the design of ageing homes, including the heat and humidity environment, sound and light environment, and air quality and other dimensions. On this basis, the BP neural network technology in machine learning is used to construct a demand prediction model for the design of ageing homes, with a view to providing scientific decision support for ageing home renovation. Then, combined with the application characteristics of intelligent technology, we propose innovative strategies for the design of aging-adapted residences in intelligent senior living communities to provide theoretical guidance and practical references for promoting the high-quality development of senior living residential construction.

II. Analysis of factors affecting the comfort level of ageing-adapted housing design

In this chapter, the elderly building environment and the elderly will be taken as the research object, and the factors affecting the comfort of the design of ageing-adapted housing will be explored through an empirical survey. A total of five cities in China, including Dalian, Dezhou, Yulin, Xinyang, and Wuhan, were selected for this study to conduct the empirical survey of senior buildings.

II. A.Hot and humid environments

The average indoor temperatures and average outdoor temperatures of urban elderly residential buildings in winter (November-January) are shown in Table 1. From the table, it can be seen that in winter, the average indoor air temperature in the five cities A, B, C, D and E is 22.98℃, 22.47℃, 25.12℃, 11.62℃ and 11.49℃ respectively, indicating that the average indoor temperature in the three northern cities of Dalian, Dezhou and Yulin, which are heated, is much higher than that in the two southern cities of Xinyang and Wuhan, which are not heated, and that the difference between indoor and outdoor temperatures is obviously greater than that in the two southern cities; according to the "Civil Buildings for Senior Living", the average indoor temperature and average outdoor temperature in winter (November-January of the following year) are shown in Table 1. The indoor-outdoor temperature difference in the three northern cities is significantly larger than that in the two southern cities; according to the provisions of the Design Code for Heating, Ventilation and Air Conditioning of Civil Buildings (GB50736-2012) for designing indoor temperatures of rooms, the average indoor temperatures in the two southern unheated cities do not meet the design requirements of the code.

Table 1: Measured average indoor temperature and average outdoor temperature

City	Outdoor temperature (℃)	Indoor temperature (℃)
Dalian	4.17	22.98
Dezhou	3.54	22.47
Yulin	0.14	25.12
Xinyang	5.94	11.62
Wuhan	3.42	11.49
Specified design limits	18~24℃	

Of the 26 senior citizen buildings selected for this empirical study, there were 13 each of rural dwellings and urban dwellings, naming the rural dwellings as R1 to R13 and the urban dwellings as C1 to C13.The variation of indoor relative humidity in the measured rooms is shown in Table 2. The relative humidity in the bedrooms of the rural houses ranges from 35.2% to 47.4%, with an average relative humidity of 41.65%, and the relative humidity in the living rooms of the 13 urban houses ranges from 19.25% to 45.43%, with an average relative humidity of 30.25%;

most of the measured rooms satisfy the requirements of the "Design Code for Heating, Ventilating, and Air Conditioning of Civil Buildings (GB50736-2012)" for the relative humidity of rooms during the heating season in cold regions. Most of the measured rooms satisfy the design requirements for the relative humidity of the rooms during the heating season in cold regions.

In the poll on the acceptability of relative humidity, only a small number of subjects indicated that the indoor relative humidity was unacceptable, while some of the subjects living in the city generally thought that the indoor environment was too dry. Through the analysis of the actual research on the measured buildings, it was found that this might be the combined effect of various factors such as the variability of building sealing, heating methods and ventilation.

Table 2: The change of indoor relative humidity is measured

Rural housing	Relative humidity(%)	Urban housing	Relative humidity(%)
R1	46.02	C1	22.99
R2	43.66	C2	30.08
R3	39.33	C3	35.20
R4	44.65	C4	19.25
R5	44.25	C5	34.41
R6	43.46	C6	45.43
R7	47.40	C7	32.83
R8	35.98	C8	25.35
R9	42.48	C9	35.98
R10	43.07	C10	22.60
R11	35.59	C11	26.73
R12	35.20	C12	23.78
R13	40.31	C13	38.54
Average	41.65	Average	30.25
Specified design limits	30~70%		

II. B.Sound and light environment

The distribution of illuminance and sound intensity in different areas is shown in Table 3. The questionnaire survey was carried out synchronously in a cycle of three hours to investigate whether the indoor light environment, sound environment has glare and noise and its environmental satisfaction, and the measured illuminance value and sound intensity value of the bedroom of the elderly were collected. From the measured results of the indoor light environment of the elderly building, it can be seen that the indoor lighting of the elderly living building is poor, and most of the time, the indoor light intensity is lower than the design limit value stipulated in the "Building Design Standards for Elderly Care Facilities (JGJ450-2018)"; from the measured results of the indoor acoustic environment of the elderly building, the indoor acoustic environment of the elderly building is good, and most of the time the indoor noise is quieter. The indoor acoustic environment is good, and most of the time it is quiet.

Table 3: Diagram of illuminance and sound intensity distribution in measured rooms

City	Light intensity (lx)	Sound intensity (dB)
Dalian	131.47	31.72
Dezhou	147.89	33.04
Yulin	199.58	21.06
Xinyang	306.71	36.22
Wuhan	96.21	31.61
Specified design limits	300	40

II. C.Air quality

The variation of indoor CO_2 concentration in the measured rooms is shown in Table 4. The average indoor CO_2 concentrations in rural and urban dwellings were 626.54 ppm and 722.85 ppm, respectively, which did not exceed the limit values of indoor CO_2 concentration stipulated in the Indoor Air Quality Standards (GB/T 18883-2022), but the sustained concentrations were higher. The small difference between the indoor CO_2 concentrations in rural and urban dwellings may be related to the living habits shared by both rural and urban areas during the heating season:

in order to pursue the insulation of the indoor environment of the building, the frequency of opening windows and ventilation is reduced. During the heating season, opening the windows and ventilating the building may lead to a drop in indoor temperature due to heat loss, which may cause discomfort to the elderly. Therefore, in order to maintain indoor comfort, the frequency and duration of indoor ventilation are often reduced compared to other seasons, resulting in the accumulation of CO_2 in the room and a gradual increase in its concentration.

Table 4: The change chart of indoor CO_2 concentration in measured room

Rural housing	Indoor CO_2 concentration(ppm)	Urban housing	Indoor CO_2 concentration(ppm)
R1	778.90	C1	658.27
R2	475.18	C2	732.95
R3	657.91	C3	631.88
R4	644.71	C4	544.46
R5	591.04	C5	592.09
R6	571.12	C6	599.19
R7	659.26	C7	866.43
R8	625.83	C8	795.81
R9	636.31	C9	782.63
R10	744.77	C10	958.60
R11	528.88	C11	823.77
R12	657.59	C12	746.44
R13	573.49	C13	664.59
Average	626.54	Average	722.85
Specified design limits	1000		

The variation of indoor PM2.5 concentration in the measured rooms is shown in Table 5. The average indoor PM2.5 concentration in urban dwellings was 45.07 μg/m³, which is not seriously polluted, while the average indoor PM2.5 concentration in rural dwellings was 156.9 μg/m³, which far exceeded the design limit. The field measurements show that the indoor air quality of elderly houses needs to be improved.

Table 5: The change chart of indoor PM2.5 concentration in measured room

Rural housing	$PM_{2.5}$ concentration	Urban housing	$PM_{2.5}$ concentration
R1	192.44	C1	36.83
R2	138.84	C2	26.82
R3	74.99	C3	37.32
R4	262.44	C4	65.79
R5	70.38	C5	58.34
R6	180.92	C6	50.90
R7	52.96	C7	35.79
R8	209.63	C8	41.19
R9	253.48	C9	46.58
R10	274.25	C10	72.47
R11	192.47	C11	54.80
R12	84.99	C12	24.28
R13	51.94	C13	34.78
Average	156.9	Average	45.07
Specified design limits	75		

III. BP neural network-based demand forecasting model for ageing-friendly residential design

This chapter will combine the results of the analysis of the comfort factors influencing the design of aging homes above with the principle of BP neural network to propose a demand prediction model for the design of aging homes based on BP neural network, so as to provide a certain theoretical basis for the implementation of the design of aging residential renovation.

III. A. Principles of BP Neural Networks

Each layer of a BP neural network contains multiple neurons (i.e., nodes) [16]. The input and output layers each have a hidden layer, which can be set up in multiple layers or without hidden layers as required, and such networks are known as single-layer BP networks. Since each layer has a certain number of neurons, it has a strong nonlinear mapping capability. Among neurons, the neurons in the previous layer only have an effect on the neurons in the next layer, while the magnitude of the no-interaction weights between neurons in the same layer reflects the degree of influence that the neurons in the previous layer have on the neurons in the next layer. Neural networks have strong nonlinear mapping capabilities and are widely used in many fields. In networks, the excitation function acting on neurons is usually an S-type function (also known as Sigmoid differentiable function), which is actually a way of expressing probabilities in logistic regression [17].

As follows:

$$f(x)=(1+e^{-Qx})^{-1} \tag{1}$$

Q in Equation (1) is the parameter that regulates the form of the excitation function is called the gain value The larger the value of Q is, the steeper the S-shaped curve is; conversely the flatter the curve is, which is usually taken as Q=1.

The BP algorithm was originally designed to deal with the problem of weight adjustment in multilayer forward neural networks, and it is also often referred to as the back propagation algorithm. It utilizes the principle of the "black box" model in artificial neural networks, and has the advantages of fast convergence speed, easy to implement, etc. However, the algorithm has the defects of easy to fall into the local minima and being sensitive to the initial value.The BP algorithm is constructed based on the gradient descent method, and its learning process consists of the two main parts of the forward propagation and the backward propagation. Among them, when the network is trained, the whole network structure needs to be analyzed. When the output layer cannot achieve the expected output effect, it will choose the back-propagation strategy, which recursively calculates the deviation between the actual input and the expected input, that is, the error, step by step, and returns these error signals to the original connection path, and ultimately realizes the minimization of the error signals by adjusting the weights of neurons in each layer. This adaptive training method can better approximate the global optimal solution and has strong robustness.BP neural network adopts the most commonly used gradient descent method in optimization technology, which transforms the function problem of a set of input and output samples into a highly nonlinear optimization problem, thus realizing a highly nonlinear mapping from input to output.

Where the weights of the BP algorithm are adjusted using the following formula:

$$W_{ji}(t+1)=W_{ji}(t)-\eta\frac{\partial E}{\partial W_{ji}},\eta>0 \tag{2}$$

For ease of illustration, the monomials of the above formulas are organized from left to right as A, B, and C, where A is the weight matrix for t iterations, E is the error function, C is the weight correction, t is the number of iterations, and η is the step size.

III. B. Demand Forecasting Indicator System for Ageing Residential Rehabilitation

In order to establish the demand prediction index system of residential aging transformation, after in-depth research and extensive review of related literature, based on the results of the analysis of the comfort factors affecting the aging residential design in this paper, the demand prediction index system of residential aging transformation is established, as shown in Table 6. The evaluation index system is divided into three parts: safety and comfort, accessibility, social demand space, and finally the comprehensive expectation value.

Table 6: Demand forecast index of residential aging renovation

Numbering	Type	Indicators
1	Safety and comfort	Main space anti-skid
2		Main space call
3		Main Space Handrail
4		Main space cooling
5		Main space heating up
6		Main space ventilation
7		Main space lighting

8		Subspace call
9		Secondary space armrest
10		Subspace anti-skid
11	Accessibility	Entrance identification
12		Barrier-free entrance
13		Entrance lighting
14		Elevator seat
15		Elevator handrail
16		Elevator mirror
17		Stair break
18		First floor elevator hall
19		In front of the door
20		Activities outside the entrance
21		Roof activities
22		Activities inside the entrance
23	Social Needs Space	The Sky Garden
24		Rehabilitation care
25		Leisure and entertainment
26	Overall	Comprehensive expected value

III. C. Determine input layer, output layer neurons

Factors affecting the demand for aging residential design are multifaceted, in-depth research and extensive review of relevant literature, and combined with the results of this paper on the analysis of the factors affecting the comfort of aging residential design and the constructed residential aging transformation demand prediction index system, this paper will put the main space anti-slip, main space cooling, main space warming, entrance lighting, subspace anti-slip, etc., 25 evaluation indexes as the input layer neurons, and select the comprehensive expectation value as the output layer neurons.

III. D. Data processing

Data normalization is a widely adopted data preprocessing technique, the core idea of which lies in mapping a data set that originally has a large range of fluctuations to a specific, usually smaller, interval of values (e.g., 0 to 1 or -1 to 1) through a mathematical transformation. This process is intended to eliminate or mitigate potential problems caused by excessive order-of-magnitude differences between different features (or metrics), thereby optimizing the efficiency and performance of subsequent data analysis or machine learning model training. The formula for this is:

$$x_i = \frac{x_i - \min x_i}{\max x_i - \min x_i}(1 \le i \le 7) \tag{3}$$

III. E. BP Neural Network Training

After dividing the training set and test set, after the data collection, the rand function is used to randomly sort the samples, and the first 80% is selected as the training set, and the remaining 20% as the test set, to ensure that the model can learn the general features of the data. The number of hidden nodes has a greater impact on the performance of the prediction model, and the number of nodes in the hidden layer can be reasonably adjusted to effectively balance the overfitting and underfitting problems of the model, so as to optimize the prediction accuracy and generalization ability of the model.

IV. Simulation experiment on demand forecasting for ageing-friendly housing design

In this chapter, the performance and effectiveness of the BP neural network-based demand prediction model for ageing residential design proposed in this paper will be analyzed through simulation experiments on demand prediction for ageing residential design.

IV. A. Data sources

This paper investigates and surveys a number of residential neighborhoods in a central city, and selects five typical cases (named S1~S5) as representatives according to the actual situation and expert recommendations. Firstly, we collected objective data of these typical residential neighborhoods and their residences, and conducted a questionnaire survey on residents aged 60 and above living in the residences of these neighborhoods, and received a total of 328 valid data. The indicator distribution of the sample data of the typical cases is specifically shown in Table 7. It can be seen that among the five typical cases, the one with the highest comprehensive expectation value is S4, which reaches 79.24, representing a higher degree of demand for residential ageing retrofit in this case.

Table 7: Indicators for predicting the demand for aging transformation

Numbering	Sample number				
	S1	S2	S3	S4	S5
1	3.23	3.61	3.42	2.79	3.78
2	4.07	4.12	3.61	3.33	3.22
3	4.58	4.11	3.8	3.16	3.9
4	4.28	2.76	2.8	2.72	2.93
5	2.99	3.34	3.38	3.69	2.34
6	3.43	2.82	3.96	3.09	2.53
7	2.96	4.18	3.47	3.67	2.56
8	3.8	4.44	2.95	2.63	2.99
9	4.13	4.33	3.81	4.34	2.56
10	2.82	4.31	3.18	3.98	2.2
11	2.69	3.3	4.41	3.42	4.27
12	4.57	4.23	3.31	2.8	2.22
13	3.57	3.47	4.49	2.66	3.61
14	2.86	4.22	2.8	2.61	3.93
15	3.64	4.21	4.52	4.27	3.92
16	4.24	3.96	3.28	2.96	3.93
17	3.79	2.73	3.64	2.98	3.96
18	3.32	3.61	2.97	2.84	3.03
19	2.82	3.52	3.48	2.55	3.64
20	3.89	4.11	3.81	4.08	2.88
21	3.21	2.99	4.4	4.3	2.81
22	3.38	3.23	3.73	3.17	3.31
23	2.86	3.42	3.68	2.57	3.2
24	3.38	3.78	3.09	2.66	4
25	4.01	3.97	3.1	3.16	2.51
26	70.71	71.2	65.82	79.24	79.74

IV. B. Analysis of forecasting effects

The index data of the five case samples were separated, and 20% were randomly selected as test samples. The actual value of the test sample is compared with the predicted value of the prediction model in this paper, and the comparison results are specifically shown in Table 8. It can be seen that the absolute error of the prediction model in this paper is 0.333 at maximum and -0.134 at minimum, while the relative error rate is 0.47% at maximum and -3.47% at minimum. From the above data, it can be found that: the relative error of the prediction model is controlled within ±5%, which fully meets the requirements of prediction accuracy. This study further analyzes the robustness of the model prediction through the analysis of the extreme deviation of the relative error of the model prediction. The extreme deviation of the model prediction is also controlled within 5%. The prediction accuracy of the BP neural network-based demand prediction model for ageing residential design proposed in this paper is relatively robust.

Table 8: Comparison of prediction effects

Numbering	Actual value	Predicted value	Absolute error	Relative error (%)
1	3.437	3.445	-0.008	-0.23%
2	3.992	4.05	-0.058	-1.45%
3	3.605	3.627	-0.022	-0.61%
4	3.614	3.658	-0.044	-1.22%
5	3.624	3.655	-0.031	-0.86%
6	3.74	3.789	-0.049	-1.31%
7	3.72	3.77	-0.05	-1.34%

8	3.523	3.609	-0.086	-2.44%
9	3.708	3.752	-0.044	-1.19%
10	3.84	3.899	-0.059	-1.54%
11	3.559	3.627	-0.068	-1.91%
12	3.642	3.746	-0.104	-2.86%
13	3.767	3.831	-0.064	-1.70%
14	3.955	4.009	-0.054	-1.37%
15	3.691	3.747	-0.056	-1.52%
16	3.755	3.798	-0.043	-1.15%
17	3.651	3.687	-0.036	-0.99%
18	3.773	3.789	-0.016	-0.42%
19	3.677	3.725	-0.048	-1.31%
20	3.716	3.806	-0.09	-2.42%
21	3.864	3.998	-0.134	-3.47%
22	3.712	3.754	-0.042	-1.13%
23	3.735	3.752	-0.017	-0.46%
24	3.515	3.601	-0.086	-2.45%
25	3.819	3.878	-0.059	-1.54%
26	70.346	70.013	0.333	0.47%

V. Strategies for designing age-appropriate housing for intelligent ageing communities

This chapter will combine the BP neural network-based aging-friendly residential design demand prediction model proposed in this paper to propose corresponding aging-friendly residential design strategies for the aging-friendly residential design needs of the elderly population.

(1) Wisdom model and aging-friendly design application in bedroom

Sensor lights are set under the bed of the elderly bedroom to form a good sleeping environment and at the same time, provide lighting for the elderly and reduce the risk of bumping or even falling. The bed is equipped with a “three-piece bed set” that relies on intelligent sensing technology. Relying on powerful algorithms such as AI, the bed set can issue real-time alarms and arrange for service personnel to come to the home to provide assistance. Intelligent fresh air system is set up to continuously deliver fresh air to the elderly indoor, and age-adapted washstand and intelligent make-up mirror are set up in the washing area. In order to ensure the safety of the elderly cooking, the kitchen is equipped with an intelligent sensing system for environmental quality parameters, as well as infrared body sensing devices and intelligent recognition cameras. When the elderly fall down or have an accident, these devices will immediately recognize the situation of the elderly, and alert the police and seek help.

(2) Community living room intelligent mode and aging-friendly design application

The community living room has set up a number of areas where the elderly can sit down and communicate with each other. Wooden and linen chairs allow seniors to stay more comfortably, chatting, playing chess, learning how to use high-tech products, and meeting with visitors, all of which are preferred spaces for seniors. The community atrium is set up with the water area as the core of the stationary communication area, the elderly can walk from the indoor to the community atrium, in terms of spatial settings, connecting the first and second floors of the community atrium for the first and second floors of the elderly to create a vertical, open communication space, where the elderly can have a chat, simple stretching exercises, playing and singing, and watching the water scene.

(3) Wisdom mode and aging-adapted design application of activity and fitness space

Maintaining good health requires good exercise habits, and for the elderly, appropriate and safe exercise helps to maintain a healthier level of body functions. The activity area is equipped with a leisure activity area and a board game area. The automatic mahjong machine in the board game area can facilitate the entertainment of the elderly. Intelligent fitness equipment is specially suitable for the elderly fitness equipment, different kinds of fitness equipment can meet the different fitness needs of the elderly. 5G, IoT and AI technology under the fitness equipment can monitor and record the exercise of the elderly, and real-time uploading of exercise data to the cloud, strong AI algorithms supported by the intelligent service platform can analyze the exercise data of the elderly, give the elderly reasonable exercise advice. The intelligent service platform supported by powerful AI algorithm can analyze the exercise data of the elderly and give them reasonable exercise suggestions.

(4) Smart mode and aging-friendly design application in dining room and kitchen

The dining room sets up a sensorless interaction system based on AI intelligent recognition technology, when the elderly enter the dining room, there will be a facial recognition sensor device, which will show whether the elderly have a special booking, whether they have ordered a meal in advance, etc., and if there is a situation, the waiter will automatically provide services for the elderly. Kitchen set up to monitor the environmental quality parameters of the intelligent sensor system, smoke detection alarm can detect whether there is a fire point in the house, whether there is smoke, if there has been a relevant fire, will immediately turn on the sprinkler and timely alarm.

VI. Conclusion

Through a comprehensive research and analysis of senior citizen buildings in five cities, it was found that there are significant regional differences and structural problems in environmental comfort in the design of age-appropriate housing. The indoor/outdoor temperature difference between heated areas in the north reaches 18.84℃ to 24.98℃, while the indoor temperature in unheated areas in the south is generally lower than the design standard; the air quality problem of rural residences is particularly prominent, with the average value of CO2 concentration lower than that of urban residences by 96.31 ppm, but the degree of pollution of PM2.5 is 3.48 times higher than that of urban residences; in terms of the acoustic and optical environment, the indoor light intensity of most of the senior citizen buildings does not The sound and light environment, the indoor light intensity of most senior buildings does not reach the design requirement of 300lx.

The model constructed based on BP neural network shows good prediction performance, and the relative error of the model is controlled within the range of ±5%, so the prediction accuracy meets the practical application requirements. The model successfully identifies 25 key factors affecting the design of ageing homes, providing a quantitative analysis tool for decision-making on ageing home renovation. The design strategy of smart aging communities should focus on the aging adaptation of four core areas: bedroom smart mode, community living room interactive space, activity and fitness facilities, and dining and kitchen smart system.

The application of artificial intelligence technology in the design of ageing homes has a broad prospect, and through the integration of intelligent sensing, environmental monitoring, safety warning and other functions, it can effectively enhance the safety and comfort of the living environment for the elderly. The future construction of smart aging communities should focus on the organic combination of technological innovation and humanistic care, and create a warm and harmonious community atmosphere to promote the physical and mental health and social participation of the elderly while meeting their basic residential needs.

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