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Research on Sustainability Enhancement of Residential Communities Based on Landscape Design--A Case Study of Urban Low-Carbon Housing

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Abstract Landscape design plays a key role in enhancing the ecological and social benefits of residential communities. Through the application of green technologies, optimization of spatial layout and introduction of innovative landscape features, the ecological environment of residential communities and the quality of life of residents can be significantly improved. This paper evaluates the role of landscape design in enhancing the sustainability of residential neighborhoods with a focus on low-carbon housing. The study used a fuzzy comprehensive evaluation method to analyze the landscape space of the residential community, and data were collected by distributing questionnaires to 210 residents and recovering 200 valid questionnaires. The results showed that the optimized landscape design increased the greening rate by 80% and the overall satisfaction of the residents increased by 15%. In addition, this study used a small habitat genetic algorithm to optimize the landscape configuration, which improved the efficiency of landscape spatial planning and shortened the optimization time by 20% on average. Through the optimization of landscape design, the residential community was able to achieve significant improvements in ecological function and resident satisfaction. This study provides theoretical support and practical guidance for landscape optimization in low-carbon residential communities.

Index Terms Landscape design, sustainability, residential neighborhood, fuzzy evaluation, low-carbon housing, genetic algorithm

I. Introduction

The importance of green sustainable residential architecture is becoming more and more prominent as people's awareness of environmental protection deepens. Green sustainable residential building design is a design approach with sustainability as its core concept, aiming to reduce the adverse impact on the environment and provide a healthier and more comfortable living environment [1]. On the one hand, green sustainable residential building design pays great attention to energy efficiency, which can be minimized through the use of energy-saving equipment and technologies, as well as the optimization of the building's energy use [2]-[4]. On the other hand, through the design of reasonable landscape and energy-saving systems, it is possible to optimize the quality of the environment around the building by reducing the consumption of resources and lowering the generation of waste [5]-[7].

Among them, ecological landscape design is an important part of realizing the sustainable development of green housing. As some landscapes have the unique ability to perform consistently over a longer node range, they can provide a better experience for the humans living in them [8], [9]. A delicate balance can be achieved by planning a landscape design program that sustains the ecological effects, sustainability, and user experience of a residential community so that each party receives an optimal experience [10], [11]. For example, flowers, trees and shrubs can be planted to create a rich and diverse ecosystem, which not only provides residents with beautiful landscapes, but also absorbs carbon dioxide, purifies the air and improves environmental quality [12]-[14]. In addition, landscape design also focuses on the use of sustainable materials and technologies to further reduce carbon dioxide emissions during the construction of urban housing, which is important for the realization of sustainable urban development and the protection of the Earth's environment [15]-[17].

With global climate change and increasing urbanization, the sustainable development of urban housing has become a key issue in the current social development. In particular, green building and low-carbon design of residential communities not only help to reduce the waste of resources, but also improve the quality of life of residents. However, at present, many residential communities still have problems such as insufficient ecological function and irrational space planning in landscape design, resulting in the inability to effectively realize the dual goals of environmental protection and social benefits. Therefore, how to enhance the sustainability of residential communities by optimizing landscape design is an urgent topic to be solved.

The core objective of this study is to enhance the sustainability of residential communities through landscape design optimization, especially in the field of low-carbon housing. The study first collects residents' evaluations of the landscape space of existing residential communities through research, and analyzes various elements of the landscape, such as the greening rate, spatial privacy, and accessibility to public facilities, using a fuzzy comprehensive evaluation method. Subsequently, combined with the residents' needs and ecological requirements, the landscape space is optimized and designed using the small habitat genetic algorithm to improve the ecological function of the residential community landscape and the residents' satisfaction. Methodologically, the residents' satisfaction with landscape design was firstly understood by means of a questionnaire survey, which covered factors such as spatial safety, greening rate, color diversity, and so on. After that, a fuzzy comprehensive evaluation method was used to assess different landscape elements to obtain the degree of influence of each factor on the overall satisfaction. Finally, the landscape layout was optimized using genetic algorithm to achieve the optimal spatial configuration.

This study focuses on verifying the feasibility and effectiveness of the optimization method in practical applications. While ensuring that the landscape design has aesthetic value, it should also fully consider the ecological and social benefits, so that it not only meets the requirements of low-carbon buildings, but also improves the quality of residents' living.

II. Fuzzy Theory Based Design for Sustainability Enhancement of Architectural Landscape

There is a close relationship between optimization of landscape spatial pattern and sustainability enhancement in residential communities. Rational planning of spatial pattern can help to enhance ecological benefits, and promote social benefits of residential communities in terms of promoting community interactions, etc. The adoption of green technology can also reduce the reliance on traditional design methods, reduce operating costs, and help to enhance the sustainability of residential communities, which is in line with the pursuit of green and low-carbon living in modern society. It is in line with modern society's pursuit of green living and low-carbon living.

II. A.Architectural three-dimensional greening fuzzy morphology

The current architecture has an open character, the architectural landscape space is not separately presented in a certain architectural space interface, but is integrated in the architecture, in different architectural interfaces, the architecture, the nature and the indoor components are related to each other, penetrate and wrap up, and constitute the overall architectural landscape space. The blurring of landscape and architectural space interface and architectural level makes the boundary between architecture and nature blurred and hidden.

II. B.Technical means and ecology of three-dimensional green blurring

Due to the rapid development of science and technology, more new measures have appeared in architectural landscape design, such as fixing the plants through the support frame and artificial planting base plate, shaping a complete architectural landscape space, which contains a complete irrigation system. The new measures provide technical support for the blurring state of architectural landscape space, and the main blurring states are as follows.

II. B. 1) Straight-walled containerized greening systems

Straight-wall container type plants are planted in different containers, which are parallel to the ground, and the containers are deployed into the support structure of stainless steel, reinforced concrete, etc. to form a three-dimensional architectural landscape. Based on the difference in the stress angle between the containers and the supporting structure, the vertical architectural landscape of straight-wall container type includes the fixed type, the placement type, the hanging type, and the one-piece centralized type. The one-piece centralized type deploys different containers in the panels, connects the support panel with the containers to form a complete planting device, integrates multiple one-piece containers to obtain a complete architectural green landscape wall, and assembles different one-piece containers to obtain the corresponding patterns.

II. B. 2) Vertical modular greening system

The Vertical Mode Architectural Landscape Space consists of a greening module, a structural system, and a watering system. The greening module is capable of growing green plants, which are deployed into the building through the structural system to form the architectural landscape surface. Supporting frames are attached to the planting panels and the building walls, usually through corrosion-resistant, high-strength stainless steel frames to ensure the stability of the landscape planting panels.

Greening modules are constructed in the form of container skeleton modules, cassette modules, planting box modules and media modules. The container skeleton module is a vertical module that improves the visibility of architectural planting. The soil in the container is improved manually to provide plants with the nutrients they need to grow, and a stainless steel fixed skeleton is used to form the building's green façade, which is usually applied in small-scale greening projects. There is no planting tray in the media module, which consists of a plant growth mix, coconut fiber outer skin, and a foam membrane, etc. Normally, only a nutrient solution and non-toxic fungicide are incorporated into the irrigation water, which ensures the normal growth of the plants.

II. C. Spatial evaluation of residential landscape based on fuzzy comprehensive evaluation

II. C. 1) Survey area and data collection process

This paper uses the fuzzy comprehensive evaluation method [18] to implement the assessment of architectural landscape space in residential neighborhoods, and takes the architectural landscape space of a residential neighborhood as an example to implement the analysis. This paper carried out three researches: the first one was to organize the assessment factors, and surveyed the people who work and live near the district through random sampling method. A total of 210 questionnaires were sent to assess importance and satisfaction, and 200 were returned.

II. C. 2) Determination of the system of evaluation indicators

Based on the survey analysis, the assessment factors such as sense of space security, space privacy, greening rate, color diversity, convenience of public facilities, sense of openness of view, leisure atmosphere and personalization of space layout were derived.

II. C. 3) Fuzzy comprehensive evaluation of architectural landscape space

Based on the comprehensive evaluation method of fuzzy mathematics, the fuzzy comprehensive evaluation method is derived. Based on the characteristics of "creativity" of architectural landscape space with obvious subjective color, the fuzzy comprehensive evaluation method is used to analyze the degree of satisfaction. On the basis of evaluation indicators and evaluation factors, the establishment of the evaluation factor set: the creative class and then scored the above factors in turn, the comments are divided into five levels, the comment set $V =$ [very satisfied v_1, satisfied v_2, general v_3, unsatisfied v_4, very dissatisfied v_5].

A fuzzy relationship is constructed between the set of factors and the set of rubrics, and the degree of affiliation of each type of evaluation factor is calculated. The fuzzy relationship matrix [19] R_1, R_2, R_3 is derived from the uniformly obtained fuzzy evaluation vectors of the factors, and its corresponding architectural landscape space types are the building entrances and exits of the residential community, public areas, and green living areas. The weights are assigned according to the influence of each type of factor on the ultimate evaluation results. The method used in this paper is the comparative ranking method, which ranks and assigns a score to the innovative class filtered first in the evaluation factors (10 points for the most important, 9 points for the second most important, and so on in decreasing order). The weight of this factor is obtained by the weight of each factor score in the total factor score with the following formula:

$$w_j = \sum_{i=1}^{n} k_{ij} \Bigg/ \sum_{j=1}^{m} k_{ij} \tag{1}$$

where: i denotes the i th evaluator. j denotes the j th evaluation factor. k_{ij} denotes the score obtained by ranking the i th evaluator against the j th evaluation factor. n denotes the number of evaluators (same as the effective sample size). m denotes the number of evaluation factors. w_j denotes the weight of the j th evaluation factor.

For example, in the spatial category "building entrances", the weights of all evaluation factors based on U form a fuzzy vector A. This algorithm is also used for assigning factor weights to the spatial categories of public areas and green residential areas. The fuzzy comprehensive evaluation vector $B = A * R$ is clarified by matrix multiplication, and R is the fuzzy relationship matrix mentioned in the previous section, so as to obtain the results of the satisfaction assessment of different spatial types.

III. Sustainability enhancement of residential communities based on genetic algorithms for small habitats

III. A. Optimization of model construction

This paper takes the entrances and exits and parking spaces and other public facilities of residential district architectural landscape as the examination point, and optimizes the space and size of residential district architectural landscape based on the residents' satisfaction with the landscape space of residential district as the standard. Using the hierarchical analysis method to get the types of residential district architectural landscape to construct the judgment matrix of the index layer, and calculate the weight value. Comprehensively analyzing the weight value of public facilities in the architectural landscape space, such as green belt, seats, parking spaces, the final weight can be obtained.

III. B. Objective function construction

Through the analysis of green belts, seats, parking spaces and other factors related to the optimization of architectural landscape space, to construct the objective function of the construction cost and resident satisfaction in the residential district.

(1) Construction cost objective function, the construction cost objective function includes the price of various construction facilities, which can be expressed as:

$$\min cost = \sum_{1\le j\le n} a_j \times \Delta X_j \tag{2}$$

where $cost$ denotes the input cost of architectural landscape facilities in residential neighborhoods, a_j denotes the price of architectural landscape facilities in residential neighborhoods, and ΔX_j denotes the number of architectural landscape facilities in residential neighborhoods.

(2) Resident satisfaction function, when the proportion of architectural landscape is set at a certain level, the more architectural landscape facilities in a residential neighborhood, the higher the resident satisfaction will be. When in a fixed-size space, the larger the size of the architectural landscape facilities, the number of them will be reduced accordingly, at which time the residents' daily activity needs can not be met, which leads to a decrease in satisfaction. When the size of the architectural landscape facilities is small, the number will increase accordingly, and the arrangement will be more dense, affecting the aesthetics of the entire residential community building and environmental planning, etc., and the residents' satisfaction will also decline. Taken together, the resident satisfaction function can be expressed as follows: $\max S = \sum_{1\le j\le n} W_j \times \left(X_j + \Delta X_j\right)$, $\Delta X_j \in E$. Where: S denotes satisfaction, W_j denotes the weight value of the amenities, X_j denotes the number of landscape amenities already deployed in the building, and ΔX_j denotes the number of landscape amenities added.

III. C. Small Habitat Genetic Algorithm for Sustainability Enhancement in Residential Communities

Using small habitat genetic algorithm [20] to optimize the size of architectural landscape, due to the genetic algorithm's weak local search ability, this paper improves the genetic algorithm on the basis of the shared function small habitat technique to make the optimization results more reliable.

Although the genetic algorithm can find the optimal individual through a series of operations, but because of its calculation parameters are fixed, can not make dynamic adjustment with the changes of the actual environment, the result is that the optimal solution accuracy can not meet the requirements. After analysis, it can be seen that the main factor affecting its performance lies in the fact that the individual in the process of adapting to the environment, in order to make itself more adaptable, its genetic behavior has undergone unexpected changes. As a result, adaptive genetic algorithm is proposed. In adaptive genetic algorithm, if the adaptability of the population is in a more concentrated state, the values of crossover probability P_c and mutation probability P_m will increase. Conversely, if the population's fitness is in a more decentralized state, the values of P_c and P_m will decrease. The two parameter probabilities automatically adjust their own values according to the following two equations:

$$P_c = \begin{cases} k_1 (f_{\max} - f') / (f_{\max} - f_{ave}), & f' \ge f_{ave} \\ k_2, & f' < f_{ave} \end{cases} \tag{3}$$

$$P_m = \begin{cases} k_3 (f_{\max} - f) / (f_{\max} - f_{ave}), & f \ge f_{ave} \\ k_4, & f < f_{ave} \end{cases} \tag{4}$$

where f_{max} denotes the highest fitness, f_{ave} denotes the mean value of fitness, f' denotes the fitness of the individual with the higher fitness among multiple crossover individuals, f denotes the fitness of the individual that generates variation, and $0 < k_1, k_2, k_3, k_4 \leq 1$.

The sharing function is utilized to correct the values of individual fitness in a population as a means of ensuring population diversity. This sharing function is formed by the combination of coding type difference and fitness difference, assuming that there are two individuals x_i, x_j, and the coding value distance between them is $d_1(x_i, x_j)$, and the fitness distance is $d_2(x_i, x_j)$, then the sharing function $S(x_i, x_j)$ can be expressed as:

$$S(x_i,x_j)=\begin{cases}1-d_1(x_i,x_j)/\alpha_1, & (d_1<\alpha_1,d_2\geq\alpha_2)\\ 1-d_2(x_i,x_j)/\alpha_2, & (d_1\geq\alpha_1,d_2<\alpha_2)\\ 1-d_1(x_i,x_j)d_2(x_i,x_j)/\alpha_1\alpha_2, & (d_1\geq\alpha_1,d_2\geq\alpha_2)\\ 0, & (Other)\end{cases} \tag{5}$$

where α_1 and α_2 are the radius of the niche. The sharing function is incorporated into the individual's fitness function to obtain the modified individual's fitness function:

$$\overline{f}(x_i)=f(x_i)\Big/\sum_{j=1}^{N}S\left(x_i,x_j\right) \tag{6}$$

where $\overline{f}(x_i)$ denotes the modified individual fitness function, $f(x_i)$ denotes the original individual fitness function, and N denotes the total number of individuals.

IV. Simulation and analysis of microhabitat genetic algorithms

IV. A. Comparison of diversity indices of different algorithms

In order to verify the overall effectiveness of the landscape spatial planning optimization method under dynamic visual quantitative analysis, it needs to be tested. The analysis is carried out in Simulink platform, and Shannon's diversity index (SHID) is used as the evaluation index, SHID is used to describe the diversity of the landscape, the value range is [0,1], and its value reflects the strength of the heterogeneity of the landscape, and an increase in SHID indicates that the patches have a balanced distribution tendency in the landscape, and it also represents that the optimization method of the spatial planning of the landscape used is more effective. Based on this, the proposed method and particle swarm optimization algorithm, ant colony optimization algorithm were tested, and the diversity trend of different methods in the case of increasing the number of iterations is shown in Figure 1.

As can be seen from Fig. 1, the diversity index of the proposed method is always maintained above 0.75 in the process of multiple iterations. Ant colony optimization algorithm has certain fluctuations, and the landscape diversity index obtained by particle swarm optimization algorithm is not more than 0.5. Comparing the three methods, it can be seen that the landscape diversity index of the proposed method in this paper is higher, which is due to the fact that the proposed method firstly analyzes the dynamic change characteristics of the landscape before the implementation of the spatial planning optimization of the landscape, which improves the precision and diversity of the landscape spatial planning optimization of the residential community, and further improves the sustainability of the residential community.

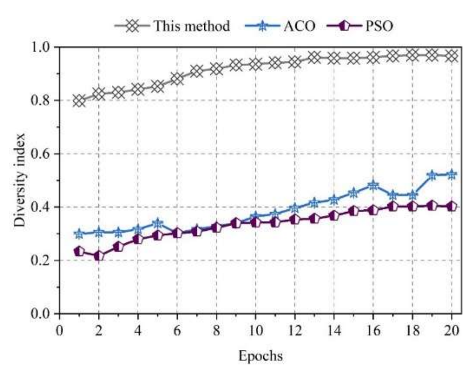

Figure 1: Diversity index of different methods

IV. B. Comparison of sustainability improvement optimization efficiency in residential communities

In order to further verify the optimization effect of the proposed method for landscape spatial planning, the optimization time of the proposed method, particle swarm optimization algorithm and ant colony optimization algorithm is compared with that of particle swarm optimization algorithm and ant colony optimization algorithm when the number of landscape facilities to be planned is increasing in the landscape, and the comparison results are shown in Table 1.

According to the statistical results in Table 1, it can be seen that with the increase of the number of landscape facilities to be planned, the particle swarm optimization algorithm has the longest optimization time, with an average time of 34.01s, which increases the landscape space planning time. Ant colony optimization algorithm has the lowest optimization time of 12.45s, the highest optimization time of 28.45s, and the average time of 20.53s, which is higher than the proposed method by 4.99s compared with the proposed method.The proposed method is the lowest time-consuming among the three methods, and the average time is 15.54s.It can be seen that the proposed method, after launching the optimization of landscape spatial planning, is able to effectively shorten the landscape planning time, reasonably allocate various facilities, and improve the optimization efficiency of sustainability enhancement in residential communities.

Table 1: Different methods of optimization time(s)

Total facilities	This method	PSO	ACO
4	10.56	25.89	12.45
8	11.25	26.99	13.61
12	11.93	28.09	14.77
16	12.62	29.19	15.93
20	13.30	30.29	17.08
24	13.99	31.39	18.24
28	14.67	32.49	19.40
32	15.36	33.59	20.56
36	15.96	34.60	21.42
40	16.57	35.61	22.27
44	17.17	36.62	23.13
48	17.77	37.62	23.99
52	18.37	38.63	24.85
56	18.98	39.64	25.70
60	19.58	40.65	26.56
64	20.56	42.89	28.45
Mean	15.54	34.01	20.53

V. Example of the effectiveness of sustainability enhancement in residential communities

V. A. Testing the Effectiveness of Residential Community Sustainability Programs

The sustainability enhancement program for the residential community was obtained and the results of the program are shown in Table 2. From the table, it can be seen that the residential community sustainability enhancement program considers the characteristics and needs of different polluted areas, and provides a referable remediation plan for the comprehensive effect of ecological restoration, environmental improvement and landscape beautification by rationally configuring different plant types and planting quantities.

The plant configuration and planting were carried out according to the sustainability enhancement plan for residential areas shown in Table 2, and for a period of 6 months, 14 monitoring points were deployed in the study area, and monitoring equipment was used to monitor the pollutant concentration and calculate the removal rate. The results of pollutant concentration reduction are shown in Table 3.

The pollution concentration of the monitoring points all decreased, and the removal rate of pollutant concentration reached more than 70% in most of them, and even reached more than 90% in some of them, and the data fully demonstrated that the sustainability enhancement program of the residential community has achieved significant results. The strategy of this paper takes the small habitat genetic algorithm as the core, and effectively reduces the infringement of pollutants on the ecosystem of the residential community by optimizing the layout of the residential community. At the same time, it focuses on enhancing the ecological function of the residential community, and enhances the absorption and purification capacity of the residential community for pollutants through the reasonable configuration of plant species and layout.

Table 2: Planning plan for landscape layout of residential community

Contaminated area	Plant type	Number of planting
First class	Cedar	14
	Dragon	10
	Cypress	16
	Gold jade bamboo	206
	Great leaf	189
	Privet	65
Second class	Secondary spider	19
	SPAR	22
	Camor	15
	Great leaf	365
	Purple bamboo	255
	Gardenia	49
	Octagon	2
Third class	Three-angle gold plate	025
	Gold jade bamboo	140
	toluvine	25
	Little leaf	23
Fourth class	Climbing tiger	55
	Wisteria	14
	Privet	28
	Camor	6
Fifth class	Stewed	39
	Cuckoo	25
	Doying	29

Table 3: Concentration and removal of pollutants

Monitoring point	SO_2		$PM_{2.5}$		TSP		NO_2	
	Concentration mg/L	Removal rate/%	Concentration mg/L	Removal rate/%	Concentration mg/L	Removal rate/%	Concentration mg/L	Removal rate/%
1	10.59	79.56	14.56	74.66	5.63	75.77	12.45	75.34
2	8.97	79.54	15.56	75.83	16.51	79.96	9.64	78.83
3	5.64	78.56	18.95	81.23	7.04	81.09	14.03	80.33
4	12.89	76.54	21.65	77.66	11.31	77.75	14.54	76.15
5	32.45	71.56	22.86	83.14	31.54	77.18	34.43	83.78
6	14.56	78.59	14.56	80.13	10.96	80.04	12.30	85.82
7	5.29	97.46	18.97	93.30	15.66	95.45	12.23	98.07
8	3.56	75.64	15.64	86.13	12.09	76.05	0.93	82.05
9	4.59	76.58	18.23	68.08	8.21	70.46	13.04	72.24
10	2.89	96.53	18.94	97.00	9.38	94.09	12.84	95.80
11	24.55	85.46	22.35	90.23	20.59	89.01	16.10	88.54
12	21.59	88.23	22.64	77.33	17.03	81.55	16.54	80.13
13	14.68	95.12	18.09	94.52	13.21	98.85	11.73	94.60
14	20.56	90.56	20.91	98.68	21.33	91.34	19.37	97.86

V. B. Analysis of Resident Satisfaction with Sustainability Enhancement Effects

In the process of enhancing the sustainability of residential communities, the ecological source of residential communities is the key content, but there is a scale effect in the landscape, and the appropriate ecological source is analyzed and judged. Landscape patches to meet a certain scale will affect the ecosystem, and the ecological source is composed of isolated islands of landscape, scale is to ensure ecological stability and avoid ecological traps constitute the main factors, is the main basis for judging the ecological source. Through the method proposed in this paper to optimize the residential community landscape selected in this paper, and through the satisfaction of the people's acceptance of the performance. Table 4 shows people's attention to the evaluation factors in the public area and residential area of the residential community landscape, and Table 5 shows people's satisfaction after optimizing the landscape. It is assumed that the satisfaction level in this paper includes five different levels.

Through the optimization algorithm in this paper, the results of different evaluation factors are different, and for most of the evaluation factors of architectural landscape, people are satisfied or more, indicating that people recognize the spatial layout after landscape optimization, and the algorithm in this paper is able to optimize the landscape space of the residential district, and to achieve the purpose of enhancing the sustainability of the residential district.

In order to master the residential community environment of urban low-carbon housing, this paper carries out a comprehensive analysis and simulation, and realizes the optimization of ecological landscape pattern spatial structure based on small habitat genetic algorithm. The experimental results show that the optimization algorithm designed in this paper can meet the actual demand.

Table 4: Evaluation factor attention

Evaluation factor	Public area	Residential area	Other regions
Space security	0.062	0.068	0.055
Space privacy	0.072	0.075	0.052
Green rate	0.184	0.165	0.016
Color diversity	0.082	0.075	0.063
Convenience of public equipment	0.241	0.254	0.158
Open view	0.079	0.081	0.060
Leisure atmosphere	0.179	0.192	0.099
Spatial layout personalization	0.101	0.090	0.070

Table 5: After optimizing the landscape people's satisfaction

Evaluation factor	Public area	Residential area	Other regions
Space security	0.413	0.271	0.268
Space privacy	0.722	0.315	0.452
Green rate	0.82	0.652	0.526
Color diversity	0.511	0.311	0.363
Convenience of public equipment	0.825	0.47	0.486
Open view	0.244	0.265	0.261
Leisure atmosphere	0.729	0.339	0.45
Spatial layout personalization	0.512	0.352	0.528

VI. Low-carbon building strategies for urban housing

VI. A. Energy efficient building technologies

The implementation of relevant innovative mechanisms to effectively combine the daily maintenance and management of advanced technology with the employment of non-working residents. Wall exterior insulation materials should be used to select efficient XPS insulation boards, composite walls (adding one or more layers of adiabatic thermal insulation insulation materials) since the improvement of the thermal performance of the wall to reduce energy waste.

The use of heat-insulating reflective coating or asphalt perlite or cement perlite insulation core board, lower density, lower thermal conductivity, water absorption and vapor permeability coefficient and so on are also lower. Not only is it easy to construct, inexpensive and non-polluting, it is a flexible material that can be used not only for flat roofs, but also for sloping roofs, curved roofs and so on.

Windows, doors and curtain walls are the most active parts of the building heat exchange and heat conduction. The north should minimize the area of external wall windows, the use of LOW-E insulating glass, not only can block the amount of outdoor solar radiation, saving air-conditioning power consumption, and low light transmittance, to provide a comfortable natural light environment indoors.

VI. B. Optimizing building performance

It is necessary to find ways and means to increase the service life of sheltered housing with a view to its efficient utilization in a limited cycle. The use of precast concrete assembly systems, the conversion of vertical high-rise structures into horizontal low-rise continuous structures, the separation of primary and secondary structures, and the adoption of unitized and cross-moment industrial production methods will significantly reduce construction costs.

Selecting locally produced construction and environmental protection materials, reducing the transportation cost of materials and promoting the comprehensive utilization of materials. Focus on the recycling of local materials to maximize the multiple use of resources. For example, residents of Shandong's Jiaodong Peninsula build seaweed houses; southwestern bamboo-producing regions use natural bamboo materials for moisture-proofing and sun-shading on floors, roofs, and walls; mountainous regions utilize masonry processed with good soil quality and viscosity, and northeastern forest-rich regions utilize timber, and so on.

In the design of low-carbon housing, the needs of low-income groups such as those using affordable housing, public rental housing and low-cost housing should be met in accordance with the demographic structure of the applicant's family, rationally determining the size of the household, focusing on the development of land-saving, energy-saving and environmentally friendly buildings, and at the same time giving full consideration to the actual living needs of the masses, rationally configuring the internal space of the housing, and creating a safe, suitable and healthy living environment.

VI. C. Resource recycling

Establish a complete rainwater retention, purification, collection and infiltration system in a natural way; use infiltration paving to minimize surface rainwater runoff and replenish ecological water; use green roofs and other measures to collect and store roof rainwater, and recycle it for irrigation and landscaping; and convey and purify rainwater through measures such as recessed green spaces, water retention wetlands and vegetated shallow ditches to maintain the natural water cycle. Process.

Construction of a vacuum garbage pipe collection system to control the garbage collection and transportation process in a closed, automated process. The entire collection process is fully computerized and automatically controlled, supporting garbage classification at source, realizing mechanization and automation of garbage collection, and the garbage flow is sealed, hidden, and completely isolated from the human flow, effectively avoiding visual and olfactory contamination during the garbage collection process.

VII. Conclusion

The results of the study show that optimizing landscape design has significant effects in enhancing the sustainability of residential communities. Through the fine planning of landscape space and the application of green technology, the ecological function of the residential community has been significantly improved. The survey data showed that the optimized greening rate increased by 80%, and the pollutant removal rate reached more than 70%, and even exceeded 90% in some areas. In addition, the satisfaction of the residents after the optimization of landscape design has been significantly improved, especially in terms of spatial security, privacy and convenience of public facilities, the satisfaction has been increased by 41%, 72% and 82% respectively.

The optimized landscape design not only effectively improves the ecological restoration ability of the residential community, but also enhances the quality of life of the residents through reasonable spatial layout and facility configuration. The small habitat genetic algorithm used demonstrated its superior effect and lower optimization time during the optimization process, saving about 5 seconds on average compared with the particle swarm optimization algorithm and ant colony optimization algorithm, proving the high efficiency of this method in landscape optimization.

Taken together, the optimization scheme of this study provides strong theoretical support and practical reference for the sustainability enhancement of residential communities, especially in the context of low-carbon housing, the optimization scheme of landscape design can effectively promote the coordinated development of ecological, environmental and social benefits.

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