Cost Optimization Analysis of Low-carbon Landscape Construction Measures in Residential Properties

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Abstract. This paper takes the landscape construction of residential properties as a specific starting point, comprehensively and systematically sorts out various measures for low-carbon landscape construction. On this basis, it deeply explores multiple forms and levels of the effective integration of the low-carbon concept into landscape construction. According to the construction situation of low-carbon landscapes in residential properties, combined with on-site investigations and data collection, it analyzes the impact of low-carbon landscape construction measures on costs, considers how to effectively control costs, and initially explores cost optimization measures throughout the entire process of low-carbon landscape construction. This helps to enhance the economic and environmental benefits of landscape projects and provides a new perspective for the sustainable development of low-carbon landscape construction.

Keywords: Residential Properties; Low-carbon Landscape; Cost; Optimization

1 Introduction

In August 2024, the Central Committee of the Communist Party of China and the State Council issued the "Opinions on Accelerating the Comprehensive Green Transformation of Economic and Social Development", pointing out that guided by the work of carbon peak and carbon neutrality, it is necessary to jointly promote carbon reduction, pollution reduction, green expansion and economic growth, form a spatial pattern of saving resources and protecting the environment, comprehensively promote the construction of a beautiful China, and accelerate the modernization of harmonious coexistence between man and nature[1]. Landscape engineering, through "increasing sinks and reducing sources" to enhance its functions of carbon sequestration and oxygen release, has become an inevitable choice for achieving green and low-carbon development. Low-carbon landscape refers to achieving low energy consumption, low pollution and low emissions throughout the entire process of landscape engineering construction, reducing the consumption of natural resources and energy, minimizing carbon dioxide emissions, and giving full play to the environmental, social and economic benefits of landscape green spaces. That is, it is a kind of sustainable "green" landscape architecture[2]. Taking the landscape construction of residential properties as an example, this paper sorts out various measures in low-carbon landscape con-

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struction, analyzes the impact of low-carbon landscape construction measures on costs, and expounds the preliminary exploration of cost optimization throughout the entire process of low-carbon landscape construction.

2 Low-carbon Landscape Construction Measures in Residential Properties

2.1 Increasing the Green Quantity

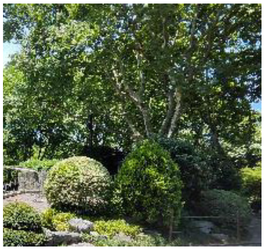
The green space area in residential properties is limited. To make full use of the carbon sequestration and oxygen release functions of green plants, it is necessary to increase the quantity of plant planting. Measures to increase the green quantity include enriching the plant layers, increasing the number of vegetation, and fully implementing three-dimensional greening, etc. Various types of measures to increase the green quantity are shown in Table 1.

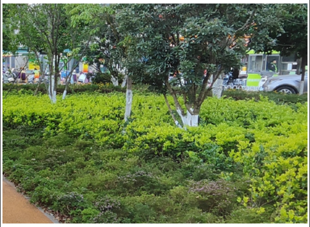
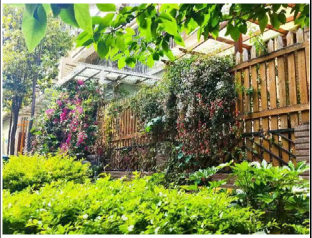
Enriching the plant layers refers to the planting structure of plants. A multi-layered greening planting mode combining the configuration of arbors, shrubs, herbs and ground covers should be adopted. An arbor is used as the high-level plant, shrubs fill the middle-level space under the arbor, and herbs and ground covers are planted on the ground layer. By constructing a plant community, the green quantity can be increased.

To increase the number of vegetation, on the one hand, the planting density can be appropriately increased. More plants can be planted within the same area to increase the green quantity per unit area and the utilization efficiency of light energy. On the other hand, plants with high green quantity can be selected more often, such as plants with rapid growth and large leaves, to increase the total leaf area of plants and create a dense forest effect so as to increase the green quantity.

Fully implementing three-dimensional greening means that in the vertical space of residential buildings, structures and landscape facilities, with plants as the main body, greening planting modes such as vertical wall greening, roof garden greening, and trellis and fence greening are constructed. By increasing the greening layers and area, a three-dimensional effect is created to increase the green quantity.

Table 1. Measures to Increase the Green Quantity (Photo Source: Taken by the Author)

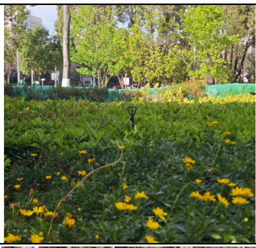
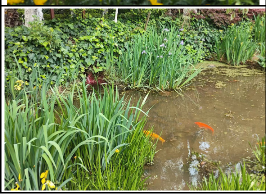
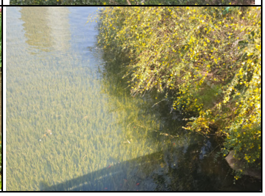
Construction measures	Characteristics	Figure	Figure
Enriching the plant layers	Adopt the multi-layered greening and planting with the combined configuration of arbors, shrubs, herbs		

	and ground covers		
Increase the number of vegetation	Appropriately increase the planting density and select plants with high green biomass		
Fully implementing three-dimensional greening	Plant greenery in every available space, and carry out vertical greening and roof greening.		

2.2 Water and Energy Conservation

In order to enhance the environmental benefits of landscape construction in residential properties, it is necessary to fully conserve water and energy. Measures for water and energy conservation include saving water resources, the sustainable utilization of water resources, and the application of renewable resources, etc. Various types of water and energy conservation measures are shown in Table 2.

Table 2. Measures for Water and Energy Conservation (Photo Source: Taken by the Author)

Construction measures	Characteristics	Figure	Figure
Save water resources	Utilize reclaimed water and adopt water-saving sprinkler irrigation		
The sustainable utilization of water resources	Construct a water body ecosystem		

Apply renewable energy sources	Utilize solar energy		

For saving water resources, wastewater should be collected, treated and reused. Treated wastewater such as rainwater can be used in the sprinkler irrigation of green spaces, reducing the use of tap water. At the same time, for water-saving sprinkler irrigation, choosing water-saving equipment and appliances can help reduce the consumption of water resources.

For the sustainable utilization of water resources, a water body ecosystem can be constructed through the symbiotic system of underwater plants, underwater animals and microorganisms to achieve the self-purification and circulation of the water body[3], improve the water quality, and ensure the sustainable utilization of water resources.

The application of renewable energy means using renewable energy sources such as solar energy to provide the energy required by the lighting system, improving the traditional way of using electrical boxes for power supply, and reducing resource consumption.

2.3 Emission Reduction and Environmental Protection

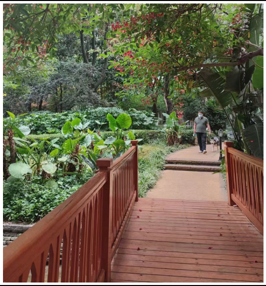
To enhance the ecological benefits of landscape construction in residential properties, it is necessary to fully reduce carbon emissions. Measures for emission reduction and environmental protection include making use of the topography, selecting environmentally friendly landscape materials, and setting up special projects for residents' interaction, etc. Various types of emission reduction and environmental protection measures are shown in Table 3.

Making use of the topography means making overall arrangements according to the original topography in the residential landscape, reasonably arranging landscape elements, and avoiding large - scale topographical transformation as much as possible to reduce earthwork projects[4]. This can reduce carbon emissions during the construction process to achieve emission reduction and environmental protection.

Selecting environmentally friendly landscape materials involves using materials with renewable characteristics, such as bamboo, wood, and recycled wood. This can reduce the consumption of natural resources, lower the pollution of the environment by toxic substances, and reduce carbon emissions during the production, transportation, and disposal of materials to achieve emission reduction and environmental protection.

Setting up special projects for residents' interaction is to advocate a low - carbon and environmentally friendly lifestyle and jointly build a green home. It includes promoting the classified disposal of garbage, recycling recyclable waste such as waste paper, reducing the pollution of the environment by hazardous waste such as household chemicals. At the same time, it guides residents in the residential area to practice a low - carbon lifestyle, encourages walking or cycling, and reduces carbon emissions in daily life to achieve emission reduction and environmental protection.

Table 3. Measures for Emission Reduction and Environmental Protection (Photo Source: Taken by the Author)

Construction measures	Characteristics	Figure	Figure
Utilize the terrain and landform	Make full use of the original terrain and landform		
Select environmentally friendly garden materials	Use renewable materials to reduce the consumption of natural resources		
Set up a special project for residents' interaction	Sort and dispose of garbage, and practice a low-carbon lifestyle		

3 Impact of Low-carbon Landscape Construction Measures on Costs

3.1 Increase in Costs Caused by the Increase in Plant Species, Quantity, Forms, etc.

To enrich the plant layers, different types of plants are required to construct the plant community, which directly leads to an increase in the types of planted plants and causes the plant procurement cost to rise. In addition, different types of plants have different ecological habits and maintenance requirements, increasing the difficulty of maintenance and resulting in an increase in maintenance costs.

To increase the number of vegetation, the planting density needs to be increased, which will lead to an increase in the number of planted plants. Planting more plants within the same area causes the plant procurement cost to rise. At the same time, the increase in quantity also leads to an increase in the workload and cost of maintenance.

For fully implementing three-dimensional greening, the plant wall technology needs to be applied to plant vegetation on the vertical walls, bringing about a corresponding increase in the planting forms of the planted plants. Special planting techniques and equipment will be used, resulting in an increase in construction costs.

3.2 Increase in Costs Caused by the Addition of Facilities Such as Water Collection, Treatment, Conveyance, Water Quality Monitoring, and Solar Lighting Fixtures

To achieve the goal of saving water resources, it is necessary to collect, treat, and convey rainwater. Additional facilities for water storage, water treatment and purification facilities, and the construction of pipeline pumping stations are required. For water-saving sprinkler irrigation, the construction of an irrigation system and the installation of water-saving equipment will all lead to an increase in construction costs. At the same time, with the expansion of the collection scope, the continuous upgrading of equipment treatment technology, and the increase in the conveying distance, the maintenance costs of facilities and equipment will also rise.

To achieve the sustainable utilization of water resources, it is necessary to increase the input of underwater plants, animals, and microorganisms during construction, and add maintenance measures such as water quality monitoring, water body cleaning, and management of underwater plants and animals during maintenance, resulting in an increase in both construction and maintenance costs.

To achieve the application of renewable resources, advanced technologies and equipment support are needed, such as solar photovoltaic panels, which leads to an increase in procurement and construction installation costs. After use, equipment failures, repairs, and replacements will occur, resulting in an increase in maintenance costs.

3.3 Measures Such as Construction According to the Original Terrain, Use of Environmentally Friendly Landscape Materials, and Construction of Leisure Facilities and Activity Spaces will Lead to an Increase in Costs

Making use of the topography requires carrying out design and construction on the original terrain. In the case of a relatively complex terrain, it will increase the design time and construction difficulty. The drainage and sprinkler irrigation systems also require more refined solutions, resulting in an increase in construction costs.

When choosing environmentally friendly landscape materials, their purchase prices are often higher than those of traditional landscape materials. Some materials also need to be purchased in specific regions, which will increase transportation costs and lead to an increase in procurement costs. In addition, environmentally friendly landscape materials require special technologies and equipment for construction and maintenance, resulting in an increase in construction costs.

Setting up special projects for residents' interaction requires the construction of classified trash bins, signboards, leisure facilities and activity spaces, which will increase the construction cost. The management and maintenance of publicity and interaction facilities will also increase the operation cost. At the same time, in order to encourage residents to participate in the interaction, activities need to be held regularly, leading to an increase in costs.

4 Cost Optimization Analysis

4.1 Optimizing Plant Configuration

Plant configuration requires a scientific and reasonable selection and combination, taking into account various needs such as the improvement of green quantity, plant survival, environmental adaptation, and maintenance management.

1) Optimization of plant species: On the one hand, give priority to planting native tree species. Native plants have strong adaptability, which can ensure a high survival rate, reduce procurement costs, and are easy to maintain and manage, thus reducing maintenance costs. At the same time, it can shorten the transportation distance between seedlings and the planting site, reducing transportation costs and plant losses during long-distance transportation. On the other hand, control the number of rare and precious tree species. These tree species have high costs, and the costs of transplantation, transportation, and maintenance are relatively high. Pay attention to the number of rare and precious tree species to control costs.

2) Optimization of plant quantity: Reasonably plan the planting density according to the spatial requirements of plant growth. Plant in stages according to the project progress, ensure an appropriate plant spacing, and reduce excessive planting.

3) Optimization of plant planting forms: Make full use of the original plants, reduce plant transplantation, and integrate the original plants into the new environment to achieve cost savings.

4.2 Optimizing Resource Allocation

Resource allocation needs to comprehensively consider the water requirements of green plants, the advancement and applicability of technologies such as water treatment and solar power generation, so as to achieve the recycling of resources[5].

1) Optimization of reclaimed water use: The cost of reclaimed water is lower than that of tap water. Water-saving technical equipment should be adopted in the sprinkler irrigation of green spaces to reduce the cost of water resources. At the same time, good maintenance of the equipment should be carried out to reduce maintenance costs.

2) Optimization of water resource circulation: Reasonably plan the water body area to avoid an overly large water surface in the residential landscape, so as to control the construction cost. Select underwater plants and animals that are easy to survive and have low maintenance costs, and reduce the selection of some water body ecosystems that require special maintenance in the residential landscape to control costs.

3) Optimization of renewable resources: Select photovoltaic panels with high photoelectric conversion efficiency and high-performance batteries to reduce the cost of landscape lighting. Optimize the design of lighting fixtures, reduce unnecessary decorations, and lower the material cost.

4.3 Optimize Spatial Configuration

Spatial configuration needs to comprehensively consider the current situation of the terrain, the usage locations of materials, and the setting requirements of leisure facilities and activity spaces, so as to achieve the rational utilization of space.

1) Optimization of Terrain Design: Set up landscape layers according to the terrain to reduce the cost of earthwork projects. Utilize the slope of the terrain for natural drainage to reduce the construction cost of the drainage system. Avoid designing complex landscape structures on complex terrains to reduce construction difficulty and costs.

2) Optimization of Material Selection: Give priority to environmentally friendly materials with high cost-effectiveness in the local area to reduce procurement costs. According to the requirements of the residential landscape, reasonably determine the usage locations and quantities of environmentally friendly materials. Minimize material losses during construction, improve the utilization rate of materials, and reduce material costs[6].

3) Optimization of Activity Space: Reasonably plan the activity space for residents to avoid excessive construction. During operation, control the costs of planning residents' activities, enhance residents' awareness of low-carbon living, and strengthen their environmental protection awareness.

5 Conclusion

Combined with the research materials of the landscape construction of residential properties, this paper sorts out various measures in the construction of low-carbon landscapes, demonstrating multiple forms and levels of the effective integration of the low-carbon concept into landscape construction. At the same time, it analyzes the impact of low-carbon landscape construction measures on costs and expounds the preliminary exploration of cost optimization throughout the entire process of low-carbon landscape construction. Due to measures such as expanding green areas, saving energy, and reducing emissions, the construction of low-carbon landscapes will lead to a certain increase in costs in the short term. However, in the long run, these measures are of great significance for protecting the ecological environment and promoting sustainable development.

By grasping the specific situations throughout the entire process of landscape construction, ensuring the smooth connection of each construction link, reducing cost expenditures, and proposing beneficial measures suitable for cost control throughout the entire process of low-carbon landscape construction, which are more refined and practical, it can provide assistance for landscape construction to achieve higher output and lower input, serving as a reference for constructors. It is also hoped that the sustainable development of low-carbon landscapes will attract sufficient attention from a large number of construction participants, and that everyone will jointly explore the sustainable development path of harmonious coexistence between landscape development and the ecological environment.

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