

Street Landscape Optimization in the Context of Smart City

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Abstract. With the continuous construction of smart cities, all aspects of urban management are also moving towards intelligence, and the smart city concept as a tool for urban planning can also help urban development. This paper analyses the current stage of China's urban street landscape construction to understand the importance of urban street landscapes for cities and what deficiencies still exist today. A certain vision of how the future smart city street landscape will develop is given.

Keywords: smart city; street landscapes; urban ecology; territoriality.

1. The Importance of Street Landscape to the City

1.1 Acting as an Urban Micro-landscape

The acceleration of urbanization has led to an increase in the fragmentation of green space. In addition to the importance of the construction of urban parks and the enhancement of their service capacity, it is also important for the further construction of street landscapes. The green space of the city streets is organically connected by its linear mesh, which is conducive to maintaining urban biodiversity, providing certain landscape services to areas far from the city parks and allowing the various streets of the city to contain a certain amount of green space.

1.2 Conditioning the Urban Air Environment

The ecological corridors and the network of green spaces formed by urban street green spaces can promote the metabolism of materials within the urban ecosystem, regulate the environment, mitigate the urban heat island effect and reduce urban pollution. As a subsystem within the urban ecosystem, urban street space is the equivalent of an urban air purifier. The breathing of city dwellers, the oxygen consumed by fossil fuels, the photosynthesis of plants has a great role to play, and in addition, the treatment of harmful gases in the air requires plant purification to achieve a natural balance in the atmosphere.

1.3 Reducing the Noise of Surrounding Environment

The continuous development of cities, commercial areas and the increase of vehicles make noise a threat to human survival and health, interfering with people's work, study, sleep and rest. When the city streets are flanked by offices or residential areas, the street green belt can absorb some of the energy when the sound waves pass through, providing a certain noise reduction function, which is beneficial to the working life of the surrounding people.

1.4 Highlighting the City's Regional Character

Street landscaping can reflect the characteristics of the city by planting plants and flowers with local characteristics, and can also avoid the phenomenon of a thousand cities caused by urbanization. With the continuous construction of smart cities, new technologies and materials are emerging, which also lay a solid foundation for the characterization of urban landscapes.

1.5 Representing Humanistic Significance

In the process of designing urban streets, the reasonable setting of greenery and convenient facilities, such as public seats and small sculptures, can make people's lives more comfortable and

relaxed. In the course of the continuous development of smart cities, new urban street problems will emerge, and if they can also be integrated through the street landscape will be more convenient for the public to travel and live.

2. Current Problems in Urban Street Landscapes

At present in China's urban construction, the choice of street trees, configuration is a problem to be paid attention to, the city in the planning of street landscape often only consider the green area rate, but the urban landscape, greening quality and effect is not given sufficient attention. As a result, the existing street trees often have these problems.

2.1 Singleness of Landscapes

2.1.1 Singleness of Landscape Types

Many cities choose the same species of trees, for example, many cities choose hanging trees as the main street tree species, this situation will hide the characteristics of the city, the city's history and culture and unique style cannot be reflected through the street trees in the landscape, this is currently a common problem in many cities in China.

2.1.2 Singleness of Landscape Layers

The current street greening is often not too many layers, basically just simple trees or shrubs, the ground set grass, this greening mode protection function is weak, the greening landscape effect is weak, for the land, the use of space is not sufficient.

2.2 Insufficient Consideration of Urban Roads

For tree-shaped greenery, it is not appropriate to place it too densely between the carriageways, as it will easily affect the line of sight between the carriageways, while in the part of the pavement close to the building, vines and woodland greenery can be considered to make maximum use of space resources.

2.3 Lack of Current Technology and Advanced Management Model

At present the management of urban streets is still in a relatively crude mode. The techniques of beautification, maintenance and operation of urban street greenery are not yet perfect, so the maintenance of greenery is not very satisfactory. In addition, the maintenance and supervision of greenery does not take full advantage of the advanced technology available.

2.4 Inadequate Consideration of the Biological Characteristics of Street Greening

The selection of tree species for street landscaping is rather blind and lacks long-term consideration, and the biological characteristics of some species are often not taken into account.

Based on the above problems, the planning and layout of street trees should not only consider the aesthetic effects of the species, but also focus on the ecological functions of street trees. In order to maximize the environmental benefits of street trees, we need to analyze the environmental benefits that street trees can bring and configure them in a reasonable manner.

3. Principles of Urban Street Landscape Planning

3.1 Adaptation of Plants to the Local and Road Environment

The selection of plants is, first of all, territorial, in line with the growth habits of plants. Locality means that according to the local climate, soil conditions, the surrounding environment is suitable for the growth and normal development of the plant. To a certain extent, it should be conducive to the plant to resist pests and diseases and maintain a stable and clean green environment. In addition, the reasonable selection of plants is also crucial to the regulation of urban climate. The regional

selection of plants is mainly reflected in increasing the planting of native species, reducing the breeding of cross-zone plants, and ensuring the survival rate of plants and a four-season landscape. Secondly, it is compatible with the urban road environment. For example, the underground pipeline network is, and overhead lines are critical functional parts of the city. Underground buried distance and overhead line height are critical considerations for landscape plant selection. Therefore, street landscape planning should be from the perspective of the road environment with the road from the height, crown width, plant spacing, wind resistance, ornamental performance and other aspects of the street landscape plant species' reasonable selection.

3.2 Street Landscape Design Plasticity

The difference in plants gives the landscape different charm, so contemporary landscape design should develop in the direction of diversification. The number of green plants in urban streets is large, and the street landscape can be scientifically and reasonably combined according to plant form, height and survival habits to shape the hierarchy of the street landscape and form a rich community structure. At the same time, according to the seasonal changes and color changes of plants in different seasons, the same street can produce different community appearances in different seasons. Meeting the diversity of plants can avoid the occurrence of the same phenomenon in each city street landscape and has a memorable role in increasing the resistance of plant communities to external environmental changes, reducing pests and diseases and reducing maintenance costs. Different plant texture also brings people different beauty impact. The texture of plants comes from the skin texture, color and morphology of plants, and the coordinated matching of plant texture can increase the ornamental value of plant communities. At the same time, in urban street landscape planning, we should reasonably use the knowledge of ecological theory to make the compound combination of plants to well allocate and utilize the resources of the planting site and meet the environmental function plasticity of the street landscape.

3.3 Display of the City's Image and Character

In the selection of plants to focus on showing the characteristics of the city, the selection of plants with different symbolic meanings symbolizes and marks the spirituality of a city. To highlight the city's image, one uses native and exotic domesticated tree species to create street landscape roads with regional cultural characteristics. Second, combine the traditional seasonal configuration of plants to shape the landscape of the four seasons with different perceptions. Third, during city's historical evolution, different plants are endowed with different traditional values and different emotional meanings. Therefore, in urban street landscape planning, fully explore the cultural connotation of various plants, inherit the local traditional culture, and shape the street landscape with cultural heritage. City streets link the traffic between cities, culture and other different factors, and rich and characteristic landscape streets are not only the visual focal point of urban public landscape, showing the artistic appearance of a city, but also enhance the sense of identity and belonging of local citizens.

3.4 Comprehensive Effect and Sustainable Development

Urban street landscape planning needs to consider the comprehensive effect of landscape design in terms of thermal comfort, landscape visualization, and maintenance cost. The factors that determine human thermal comfort are ambient radiation temperature, air temperature, air humidity, wind speed, physiological metabolic rate, and clothing thermal resistance, which are six major factors. Street landscape plants can influence the four environmental factors in the six factors through their own action. And the influence of plants on thermal comfort makes a significant difference in thermal comfort in the morning, midday and evening in different seasons. To create a suitable thermal comfort environment through street landscape design, we must compound plants' elements and consider the needs of people to improve the quality of the environment. The development of street landscape planning and design theory requires close integration of landscape

and visual perception with street landscape planning and design. Find a more scientific and rational planning and design strategy under the premise of public-oriented needs as well as sustainability. At the same time, considering local economic factors, natural planting methods are chosen to form stable and coordinated plant communities and reduce maintenance costs and human resource consumption.

Sustainable development is the harmonious and healthy development of society, economy, environment and resources, which means realizing the present generation's development needs without destroying the next generation's common interests. Ecology is the basic condition for sustainable development. Therefore, it is important to achieve rational greening, environmental protection, and coordinated development of resources. Ecology is the basic requirement of sustainable development. Therefore, reasonable greening, ecological maintenance, adapting to local conditions, strengthening the recycling of rainwater and sewage purification, focusing on the balance of landscape greening and urban streets, and building a good ecosystem.

4. Design Method of Street Landscape in the Context of Smart City

4.1 Intelligent Design

To realize the intelligent design of urban public space and improve the comfort of residents' lives, emerging technologies such as 5G, big data and cloud computing can be adopted in the construction of smart city street landscape. For example, with virtual reality, the system designer could integrate geographic information and network information technology organically to add a large number of intelligent data on the basis of the original street attractions, so as to form a virtual reality scene of famous sight all over the world for local residents to visit, which provides a variety of visual feelings and enrich the smart city street landscape.

In addition, smart design can also help to achieve environmental protection and energy saving in the construction of street landscape. The landscape lighting system of city streets often produces energy consumption and light pollution, so how to use the lighting system scientifically and reasonably has become one of the key issues of street landscape design. multi-function smart lighting pole is a kind of light pole which is equipped with a variety of equipment and could realize a variety of functions on the basis of meeting the lighting needs of the street. It has environmental monitoring, intelligent lighting, intelligent broadcasting, one-click help and other functions, both effective and visually appealing, and could realize the intelligent design and green transformation of street lighting. With the help of 5G technology, the management platform can monitor road traffic conditions in real time through sensors and automatically adjust the brightness and lighting rate of street lamps according to the volume of traffic flow, effectively reducing energy loss.

4.2 Ecological Interaction Design

Smart city is not a static system, people have to constantly solve problems in the process of practice. The dynamic capability should be considered in the planning and design of smart city street landscape, so as to realize real-time monitoring and timely adjustment and promote the sustainable development of smart city. Firstly, the water source information of various places is provided to the management end. Then, smart water meters are established through big data analysis and cloud computing technology to monitor multi-index data. Through the intelligent platform, technicians can grasp the relevant dynamics in real time, so as to solve problems such as water theft, failure and leakage. In addition, in order to solve the problem of stormwater runoff pollution, we can also connect the pollution reduction devices in the municipal sewage into the data network for intelligent monitoring and treatment, so as to reduce the pollution level to the allowable level.

4.3 Landscape Design

Smart city street construction must solve the problem of function and beauty at the same time, designers should combine the topography, geology and hydrology conditions to reasonable plan the street landscape configuration. The street landscape is generally optimized with natural approach, which not only meets the visual needs, but also realizes the self-circulation of the urban ecosystem. Rainwater garden is an effective nature purification and bio-retention technology commonly used in natural approach. It uses man-made shallow concave green spaces to absorb and purify rainwater while enriching the street landscape. In the initial stage of the design of rainwater park, it is necessary to study the regional meteorological, hydrology, soil quality and other conditions, and choose soil that is easy to let low-maintenance plants grow and develop and has better permeability. Usually, the size of the rain garden along the street is not large, but it needs to keep more than 3 meters away from the building to prevent the building foundation from getting damp and mildew. In addition, the rain garden should not be too close to the trees. This is mainly to ensure that there is enough light in the rain garden to ensure the growth of aquatic and semi-aquatic plants and maintain the health of the water body.

4.4 Public Space Design

Public space is an important part of street landscape, and also an important embodiment of humanistic care in smart city. To create public space in the design of smart city street landscape, the green space should be balanced, the boundary of buildings along the street should be considered, and the humanized and artistic design should be paid attention to.

TOD(public transport-oriented development) mode is an urban street theory oriented to public transportation and information sharing. It focuses on the design of pedestrian road system, emphasizes the high-density composite functional development around bus stations, and aims to create a walking and bicycle transportation system centered on public transportation. According to this theory, pedestrian area is the central carrier of landscape facilities and an important part of street landscape design. Therefore, the renovation design of Barrio de Gràcia, Barcelona expands the pedestrian space, thus increasing the humanistic care of the district and improving the quality of the whole district. In addition, when there are obstacles, spaces under bridges, parking lots and other ancillary spaces in the block system, designers can also fully reuse and integrate these spaces through landscape design, so as to form a humanized activity space and make it a part of the smart block space. For example, in Copenhagen Super Street Scene, designers made full use of the street space. They formed a free leisure space with rotated squares and lines, which greatly enhances the vitality of the block and satisfies the residents' life and entertainment requirements.

In addition, in order to emphasize the humanistic characteristics of the smart city, designers could consider the historical and cultural characteristics of the city, put public art into the street landscape and create a characteristic public space. For example, On the Wangfujing Pedestrian Street, one of the cultural landmarks of Beijing, designers placed a lot of bronze sculptures with old Beijing characteristics, which enhances the intimacy of the street and thus enhances the vitality of the entire ancient city.

4.5 Integration design

The term "ecosystem" is widely used in strategic decision-making and its application has been further expanded. Different from network structures such as alliances, the core of ecosystem connectivity is values and propositions, rather than connections between nodes. Therefore, the innovation ecosystem is a benefit co-creation system jointly participated by ecological owners and multi-party ecological partners. The ability level of interdependence among the partners exceeds that of the alliance and other organizations.

Smart city is a typical innovation ecosystem that usually coordinates many actors to collaborate on a new urban development proposition. Smart street landscape is not a stack of isolated facilities, but an organic whole. Designers should integrate different smart facilities and use the Internet of

Things to build smart street landscape system. For example, in the intellectualized design of waterscape, designers should not only design colorful waterscape forms like cascade, falling water and ornamental fountain, but also use intelligent induction control technology to integrate the lighting system and music system, so that the intelligent waterscape becomes more vivid and interesting. At the same time, the waterscape design should be combined with the recycling treatment system to reuse water resources and become a part of the water body in the urban ecosystem. Thus, it can be seen that street landscape design needs to integrate urban facilities and systems at all levels to realize the integrated design of smart city.

5. Conclusion

Urban street landscape is a big project which is beneficial to modern and future, and has an important role in urban environmental protection, people's life security, and urban ecological maintenance. Today, as smart cities continue to be built, it is important to increase the construction of urban streets in terms of design concept, overall layout, technology level, and management system. As various technologies become more and more mature, technologies such as Internet of everything and artificial intelligence will gradually penetrate into the street landscape in the future and keep pushing it towards intelligence.

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References

- [1] Ma Yuxiang, Li Huina. The environmental significance of urban greening and the basic ideas to promote its environmental role[J]. *Wisdom China*,2022,(09):82-83.
- [2] Li Xiaohui. Streetscape design in the process of urban renewal [J]. *China Architecture Decoration*, 2022(05):81-83.
- [3] Jiao Jian, Mu Zhan Yu. Research on the application of regional culture in the landscape of old and new urban neighborhoods[J]. *Green building materials*,2020(09):193-194. doi:10.16767/j.cnki.10-1213/tu.2020.09.095.
- [4] Zhou Hongwan. Analysis of the application of urban street tree selection and planting maintenance points in Siming District, Xiamen City [J]. doi:10.14051/j.cnki.xdy.2022.20.038.
- [5] Jiang Shengqi. The role of street trees in urban green space ecosystem and layout suggestions[J]. *Beauty and Times (Urban Edition)*, 2020(05):66-67.
- [6] Yu Lei. Exploration of urban street landscape under the concept of smart city [J]. *Beauty and Times (Urban Edition)*, 2022(09):67-69.
- [7] Sun Xiaoting. Exploring the application of artificial intelligence in modern landscape garden design [J]. *Real Estate World*,2022(23):155-157.
- [8] Ma Yong, Deng XinChun. Plant configuration in municipal road greening [J]. *Construction Engineering Technology and Design*,2018(23):5242.
- [9] Chen Chao. Analysis of urban street landscape design [J]. *Heilongjiang science and technology information*,2017(17):196.
- [10] Xiong Xingfu, Wu Tianhan. Research on plasticity of plants in landscape planning[J]. *Northern Horticulture*,2011(19):87-89.
- [11] Qian Qiumin. Exploration of urban landscape design under the concept of sustainable development [J]. *Digital Design*,2022(10):114-116.

- [12] Xu Jian. Research on the design of self-cleaning smart city street light based on IOT technology.2020.Southeast University,MA thesis.
- [13] Luan, C.L.." Research on TOC development model for transit corridor-based development to promote ecological city realization". Diversity and Inclusion - Proceedings of the 2012 China Urban Planning Annual Conference (04. Urban Design).Ed. Diversity and Inclusion - Proceedings of the 2012 China Urban Planning Annual Conference (04. Urban Design), 2012, 667-679.
- [14] Tang Rui,and Xu Dawei." Exploration of urban street landscape design based on the background of smart city." Green Building Materials .05(2019):99+226.
- [15] Bai O,and Li Tuoyu." From competitive advantage to sustainable development: a study of the dynamic capabilities of smart city innovation ecosystems." Research and Development Management 33.06(2021):44-57.
- [16] Xu Jian. Research on the design of self-cleaning smart city street light based on IOT technology.2020.Southeast University,MA thesis
- [17] Luan, C.L.." Research on TOC Development Model for Transit Corridor-based Development to Promote the Realization of Ecological Cities". Diversity and Inclusion - Proceedings of the 2012 China Urban Planning Annual Conference (04. Urban Design).Ed. Diversity and Inclusion - Proceedings of the 2012 China Urban Planning Annual Conference (04. Urban Design), 2012, 667-679.
- [18] Tang Rui,and Xu Dawei." Exploration of urban street landscape design based on the background of smart city." Green Building Materials .05(2019):99+226.
- [19] Bai O,and Li Tuoyu." From competitive advantage to sustainable development: a study of the dynamic capabilities of smart city innovation ecosystems." Research and Development Management 33.06(2021):44-57.