Intelligent Management of Trees for Environmental Harmony

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Abstract: In alignment with the United Nations Sustainable Development Goals (SDGs) and the 2050 net-zero carbon emissions target, the Taichung City Government has taken upon itself the mission of realizing a vision of sustainable coexistence between humanity and the natural environment. The Taichung City Government actively promotes various initiatives related to urban air purification, diverse landscape planning, and eco-friendly living spaces, including projects such as the Beautiful Life Project, reforestation of natural forests, and the beautification of green corridors. These projects aim to transform Taichung City into a leading sustainable urban center committed to achieving net-zero carbon emissions. To effectively manage the increasing number of plantations, the local government has harnessed spatial information technology and cloud-based management. Innovative solutions include tree planting and maintenance records, AI-powered plant maintenance management, and a mobile app for tree inspection and reporting. These measures align with Taichung City's goal of becoming a competent, low-carbon, green urban hub.

Keywords: Sustainable, Beautiful Life Project, Green Corridor Beautification, Planting Management, Smart Management

I. Introduction

Taichung City is actively promoting urban green beautification efforts, encompassing areas such as parks, green spaces, pathways, central medians, and roadside regions, with the planting of approximately 230,000 trees. This initiative seeks to strengthen the city's green landscape, increasing urban greenery coverage. To shape Taichung City into a low-carbon, green metropolis and effectively manage its tree resources in a resource-efficient manner, a "smart management" approach is imperative. The local government harnesses spatial information technology and innovative tree maintenance methodologies to provide maintenance units with intelligent tree management tools, including tree planting site selection, pruning planning, maintenance inspections, and incident reporting. These measures aim to streamline labor requirements, enhance the quality of maintenance operations, and contribute to energy efficiency and carbon reduction objectives.

These sustainable urban development and smart tree management practices exemplify Taichung City's commitment to fostering an environmentally conscious, green-conscious, and low-carbon urban environment. These initiatives align with global sustainability goals and contribute to the city's vision of becoming a model of urban greenery for international urban development studies and initiatives.

II. Related Works

2.1 AI Smart Planting Site Selection

In Taichung City, more than 230,000 trees are spread across over a thousand parks and green spaces and along more than four thousand roads. The local government has introduced an "AI Smart Planting Site Selection" system to enhance tree management efficiency and urban greenery coverage. This system leverages geographic information systems (GIS), combines remote sensing imagery with on-site maintenance inspection records, and considers Taichung's climate, environmental conditions, and ecological characteristics. It utilizes big data to determine the most suitable tree species for planting.

Furthermore, through data analysis, the system prioritizes pruning for trees severely affected by diseases or pests, have larger crown areas, or are taller. This prioritization significantly reduces the time needed for manual inspections. Beyond contributing to landscape enhancement and urban development goals, this initiative helps maintain ecological balance in the green urban environment and creates a more pleasant living environment for residents.Implementing AI-based solutions in urban tree management underscores Taichung City's commitment to sustainable and environmentally friendly practices, ensuring a harmonious coexistence between urban development and nature.

Figure 1. Taichung Smart Tree Management Application Content Conceptual Diagram
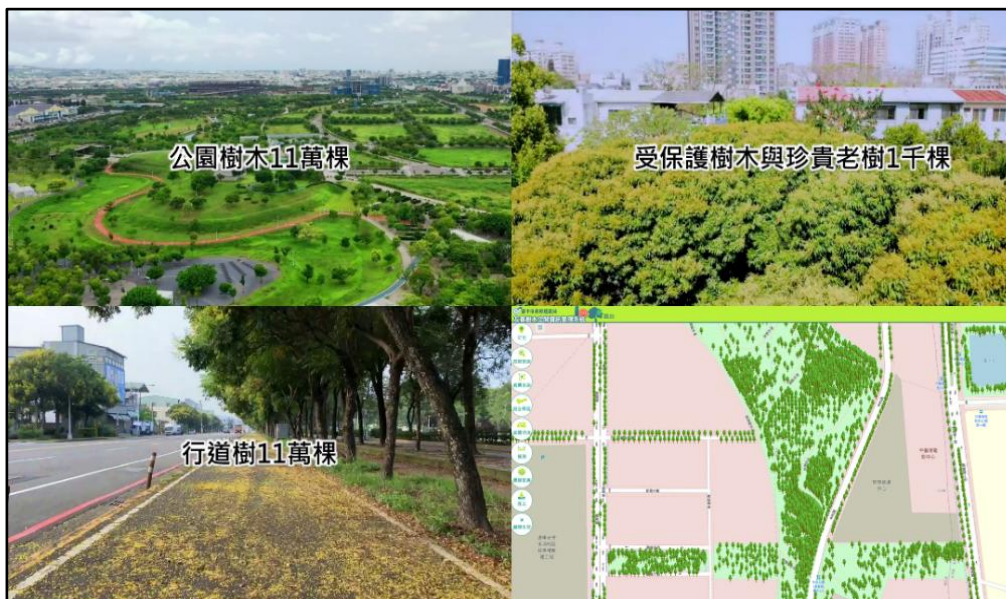

Figure 2. Managing over 230,000 trees in Taichung City using spatial information technology

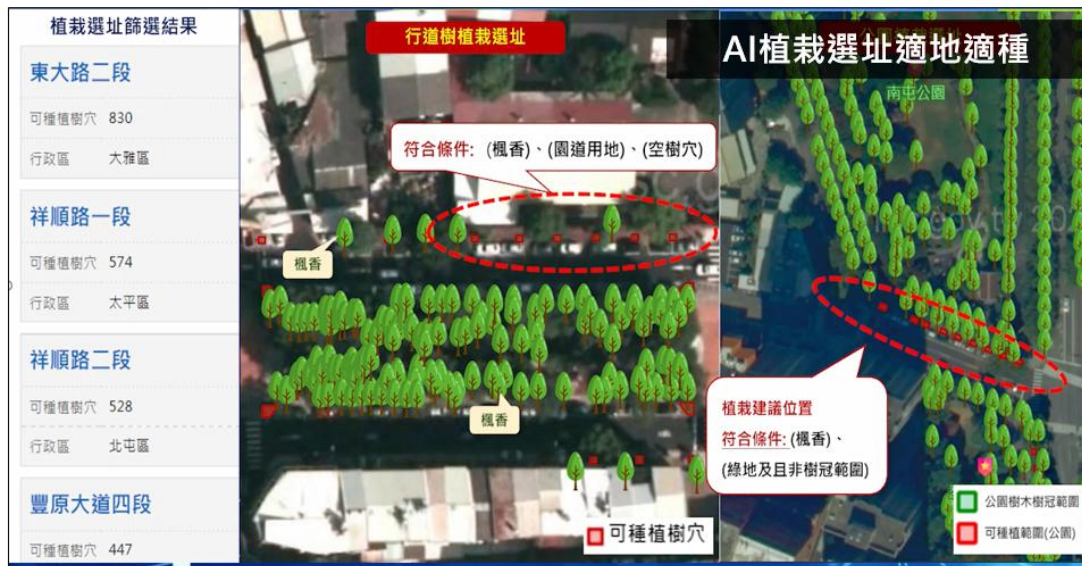Figure 3. Establishing a Comprehensive Tree Profile Information Chart

Figure 4. Utilizing Artificial Intelligence for Optimal Tree Species Selection and Planting

III. Introduction to the Method

We face a series of challenges in tree maintenance and have proposed corresponding solutions. Tree maintenance requires continuously updating tree records to meet real-world demands, including tree planting site selection, pruning planning, maintenance inspections, and incident reporting, among other tasks. These challenges stem from the ever-changing condition of trees, which can result from various factors such as tree planting in new parks, tree planting along newly constructed roads, tree damage caused by storms, or tree mortality due to diseases and pests.

In the past, we had to conduct ground surveys to update tree records, a process that was both time-consuming and required significant human resources. However, to achieve our goal of net-zero carbon emissions and streamline our operations, we introduced information management methods to improve park landscape maintenance. We use work orders to record the results of tree planting and care, and we have integrated an AR-based smart tree planting maintenance management application. This allows inspection personnel to update the tree records database in real time. As a result, construction and maintenance activities can seamlessly cooperate, enhancing the completeness of tree records.

By analyzing big data, we can more precisely select suitable tree species for planting and prioritize pruning for trees severely affected by diseases or pests, those with larger crown areas, or taller trees. This initiative significantly reduces the time required for manual inspections. These efforts contribute to landscape improvement and urban development goals and help maintain ecological balance in the urban environment, creating a more habitable environment.

Figure 5. AI Smart Planting Site Selection Can Prioritize Trees Requiring Pruning

Figure 6. AR Smart Planting Maintenance Management Provides Inspection Personnel with Real-Time Updates to the Tree Records Database

Figure 7. Integrating Tree Assignment Maintenance Operations to Document a Comprehensive Tree Care History Chart

IV. Results and Discussion

We are currently actively promoting smart tree management, and the following are explanations of our innovative indicators:

1. Smart Planting Maintenance Management, Promoting Urban Greening, and Creating a Low-Carbon Green City: Trees absorb carbon dioxide from the atmosphere during their growth, making reforestation one of the methods to reduce atmospheric carbon dioxide levels. There are over 230,000 trees in the city, including precious old trees under protection. Through smart management and maintenance, we actively promote planting new tree species and replacements, focusing on selecting suitable tree species to enhance carbon absorption capacity. We aim to add approximately 30,000 trees annually, with a cumulative target of 20,000 metric tons of carbon sequestration by 2050.

2. Smart Planting Site Selection, Creating Beautiful Urban Landscapes in Taichung: We adhere to the principle of "right tree in the right place" when planting roadside trees, aided by a smart planting system to assist in selecting appropriate tree species. We gradually phase out tree species unsuitable for Taichung, aiming to create a beautiful landscape of roadside trees. We publish information about these trees on our website, combining it with details about various tree-viewing locations throughout the city. This proactive approach provides citizens with leisure and recreational spaces and allows them to enjoy the beauty of flowers and trees. Additionally, we utilize air quality monitoring data to remind citizens of suitable outdoor activity areas, contributing to creating a tree-friendly garden city.

3. Roadside Trees as Green Energy Air Guardians: Roadside trees act as natural caretakers of the city's environment. Taichung has planted over 230,000 trees to date. To help citizens better understand the air purification effects of roadside trees on the urban environment, we integrate air quality monitoring data from the Environmental Protection Bureau into each roadside tree. Citizens can obtain information about air quality in various areas of the city by scanning QR codes, ensuring they always breathe fresh air.

Furthermore, we continue to ensure that implementing these smart tree management measures benefits our city and residents and provides a more environmentally friendly living environment for the future.

Figure 8. Using Roadside Trees as an Illustration of Urban Environmental Air Purification Effects

V. Conclusion

In conclusion, we are actively promoting smart tree management, focusing on creating a tree-friendly urban environment. The innovative indicators we have established are as follows:

(1) Through intelligent planting maintenance management, we are actively accelerating urban tree planting to increase carbon sequestration by trees and build a low-carbon green city. Trees absorb carbon dioxide from the atmosphere as they grow, making afforestation one of the effective methods to reduce atmospheric carbon dioxide levels. We are dedicated to selecting suitable tree species and continuously enhancing the carbon sequestration capabilities of trees through intelligent management and care. Our goal is to increase the number of trees by approximately 30,000 annually to accumulate 20,000 metric tons of carbon sequestration by 2050.

(2) We adhere to the principle of "right tree, right place" and utilize a smart planting location selection system to carefully plant street trees, creating a beautiful urban landscape in Taichung. We gradually phase out tree species unsuitable for the city and actively provide recreational and flower-watching spaces for the public by announcing information about tree-lined streets and scenic spots on our website. Additionally, we utilize air quality monitoring data to inform residents about suitable outdoor activity areas, thereby establishing a tree-friendly garden city and promoting urban landscape aesthetics.

(3) Finally, we consider street trees as natural guardians of the city's green energy and air quality. With over 230,000 street trees planted in Taichung, these trees play a crucial role in purifying the urban environment. To help residents better understand the air purification effects of street trees on the city environment, we have integrated air quality monitoring data from the Environmental Protection Bureau into each street tree. Residents can access air quality information from various city areas by scanning QR codes, ensuring they can always breathe clean and fresh air.

Implementing these intelligent tree management measures not only contributes to improving the urban environment but also paves the way for a more environmentally friendly future. We remain committed to ensuring the successful implementation of these measures for the benefit of our city and its residents.

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