Application of Smart Technology in the Integrated Environmental Management of Urban Wetland Park

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Abstract

Wetland Park is one of the important ecological infrastructures. Besides providing the ecosystem service function and value, it is also an important place for leisure and entertainment. Efficient environmental management is an important measure to promote the sustainable development of the wetland park. By combining the smart technology with routine management method, the efficiency of the environmental management for the urban wetland park can be improved. The application of smart technology set the users' requirements as the basic goal, which is divided into four layers: perception layer, transport layer, support layer and application layer. The perception layer consists of sensor, camera, RFID, mobile terminal device and so on; the transport layer is composed of optical fiber, WIFI and 3G network; the support layer is composed of data management system, information open platform and service support system; and the application layer is composed of four modules including panoramic-view park, environmental maintenance, smart tourism and public participation. A wetland park located in Zhangzhou city, Fujian, China, was taken as a practice case.

Keywords: Environmental Management, Smart Technology, Wetland Park, Planning

1. Introduction

The urbanization process in China is at the accelerative stage [1]. As cities expand, urban wetlands are continuously filled and invaded. In order to strengthen the construction of ecological infrastructures [2], protection and sustainable use of urban wetlands have become the consensus by the community. The simple wetland protection can't promote the sustainable development of the urban wetland. On the premise of ecological protection, carrying out appropriate development can realize the balanced development of the ecological protection and the leisure tourism. The wetland park possesses various functions such as ecological environmental protection, scientific popularization education, leisure and entertainment, maintenance of biological diversity, etc., which is the widely accepted mode of urban wetland conservation [3]. Nowadays, the development of the urban wetland park in China is quite fast. Cities including Beijing, Hangzhou, Shanghai have established wetland parks, which become the essential constituent part of ecological infrastructures of the city.

The previous establishment of the urban wetland park usually experiences the procedures of planning, design, construction and so on. Rational planning and design are the prerequisite for sustainable development. The basic principles of resource-saving and environment-friendly shall be followed to rationally organize sectorization, spatial layout, road traffic, and distribution of facilities, *etc.*, thus forming the overall layout of the park. The management of Wetland Park is the important guarantee for sustainable development, usually including the regulation of the ecological environment, the maintenance of

biodiversity, the monitoring of tourism development intensity, the maintenance of health and environment and the maintenance of all facilities etc. This stage is of long period with complex management, thus it needs high effective managing measures to maintain the normal operation of the system. Since lack of effective measures, various problems emerge in the wetland park management [4, 5].

The information technology is an important management tool, which can improve the environmental management efficiency, save the management cost and play an important role in the business management. The information technology has a great application potential wetland park management as well. Smart technology is the new stage of informatization development, which is widely applied in the construction of smart cities, smart communities and smart scenic [6]. This technology promotes the innovative application of EPC network, cloud computing, big data, 4G and other techniques through coordinating the material resources, information resources and smart resources of cities, so as to increase the use efficiency of city infrastructural facilities, improve urban operation and management level and public service level, and accelerate the shifting in economic growth model and readjustment of industrial structure [7]. At last, the happiness index of the city resident will be enhanced.

In China, applying smart technology in the environmental management of urban wetland parks is a new project. In the construction of Xixi Wetland Park [8], smart management has been gradually realized, and some achievements have been made. However, due to lack of systematic research, the current application of smart technology in the environmental management is still in an exploratory stage. This article tries to make an outline of application of smart technology to improve the environmental management efficiency of Wetland Park.

2. Methods and Outline

The characteristics of the urban wetland park include naturality, ecological character and leisurely theme. The application of smart technology should be combined with the characteristics and environmental management requirements of Wetland Park, to meet the user's demand including public and managers. Through the investigation of the demand of the user, it can provide the basis for the application of smart technology (Table 1). Through the application of smart technology in the urban wetland park, we can get an overall perception into a world covered with the Internet and blending with smart application to contain human-oriented sustainable innovation (Figure 1). Establish comprehensive technique application outline and module distribution, constantly expand personalized needs and provide customized services to promote the sustainable development of wetland parks. The smart system consists of four layers: perception layer, transport layer, support layer and application layer (Figure 2).
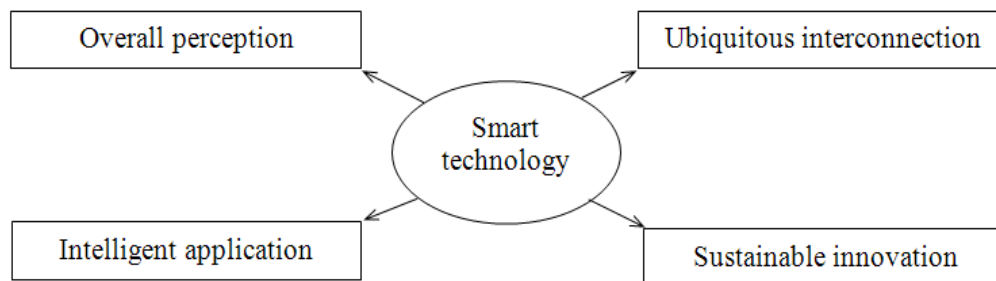

Figure 1. Application of Smart Technology in the Environmental Management

Table 1. The Users' Needs of the Urban Wetland Park

| The Public	Managers
Collect the information of parks and experience virtual tourism	The brand promotion of wetland park
Determine destinations, get traffic, weather and other information	Information including the number of visitors and types of traveler
Order tickets online and pay online	Personal safety of the travelers
Make tourism route, and guide on one's own	Automatic monitoring and regulation of the wetland environment
Learn wetland science, sightseeing, landscape and other information	Biological management of wetland park
Salvation of emergencies	The degree of satisfaction and improving suggestions of wetland park
Share tour landscape, mood and discovery *etc.*, and evaluate the park	Financial and personnel management of wetland park
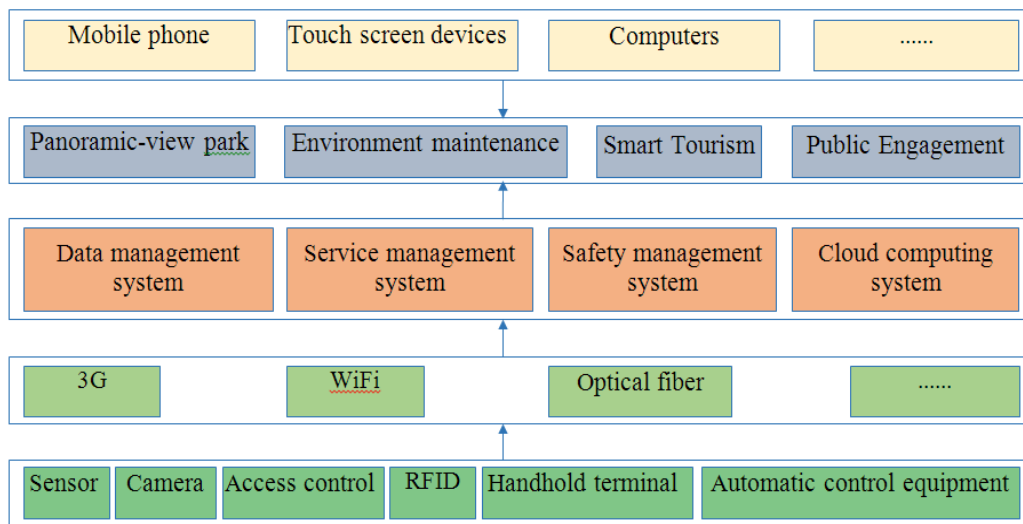
Figure 2. The Structure Chart of the Application of Smart Technology in the Environmental Management of Urban Wetland Park

3. Case Study

3.1. Location and Function Division

The wetland park is located in the Hua'an Economic Development Zone in Zhangzhou City, Fujian Province, China. The gross area of project areas is 173.5 hectares (Figure 3). The park has been built into a wetland park which integrates wetland ecological conservation, wetland protection and utilization, biological diversity protection, wetland science popularization education and wetland ecological travel. We effectively recover the wetland resource, increase the ecology function, improve the birds inhabiting environment and make the number of the wildlife resource, especially the waterfowl population, increase annually by construction. To form a perfect wetland protection network system and monitoring system through the application of smart technologies and to further enhance the stability, anti-interference performance and self-repairing capability of the wetland ecological system so as to promote the sustainable development of the wetland. The wetland park is divided into 5 functional areas: wetland ecological conservation area, wetland science popularization education area, wetland utilizing and

viewing area, wetland ecological art area and management service area (Figure 4, Table 2, Figure 5).

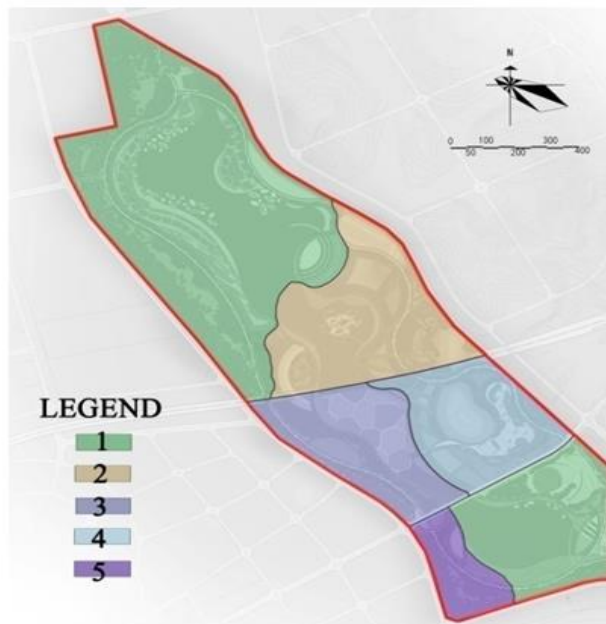**Figure 3. Location of the Wetland Park**

Figure 4. Division of the Wetland Park

Table 2. Functional Distribution of Wetland Park and its Contents

NO.	Division	Content
1	Wetland Conservation Area	It is the core area of the wetland park and made up of vast broad waters, shallow shoals and habitat islands, etc. This zone is mainly aimed at ecological protection and cultivation of the wet land, and facilitates improvement of biological diversity and functional recovery of the wetland.

2	Wetland science popularization education Area	It is a place for tourists to receive popular science education. At the same time it undertakes the work of wetland research and scientific experiment, establishes wetland ecology laboratory, waterfowl breeding farm, and observation and research base of the ecological change laws, etc.
3	Wetland Utilizing and Viewing Area	The emphasis is to show the water quality purification function, biological diversity and wetland natural landscapes of the wetland ecosystem.
4	Wetland Ecological Art Zone	It is mainly used for developing ecological and cultural tourism of wetland.
5	Management and Service Area	It is the center of information management and tourist management of the park.

Figure 5. Scenograph of the Wetland Park

3.2. Smart Technologies Application Planning

The smart technologies application planning is based on the application framework and the planning is conducted through combining the function division characteristic of the wetland park (Figure 6). With technology of intelligence, embed sensors and devices in a variety of environmental targets (objects) to be monitored and integrate human society with the environmental system through supercomputers and cloud computing to manage the environment of the wetland park and to make decisions in a more refined and dynamic way.

3.3. Application Module of Smart Technology in the Environmental Management

3.3.1 Panoramic-view Park: Through the combination of GIS and virtual reality, build 3D model of the wetland park. The model integrates the information of flora and fauna, facilities, roads, science, *etc.*, to facilitate the public inquiry. A true nature of the wetland park is displayed to the public by 720-degree imaging technology, and promotes them to understand the wetland park. The technology is a virtual reality technology. Through professional preliminary photographing on the spot by professional photographer and photographic equipment, and later flattening of the images and 3D display technology, 3D real visual effect with high interactivity of users will be realized, which integrates the virtual and the real. Through 3D real visual technology, virtual reality technology and panoramic shooting technology from a high altitude and by loading HD three-dimensional stereo image, map navigation, explanatory note, Chinese and English brief introduction,

human voice tour guide and other multi-media elements, the wetland park could be presented face to face. The public can gain an immersive experience through the simulation of 3D touring line which is conducted by the terminal use platform.

3.3.2 Environment Maintenance: The wetland environment is the foundation of wetland park, and its monitoring and regulation are the difficulties of management [9]. Realize automatic sense and regulation of wetland environment by setting automatic monitoring stations of water quality, automatic monitoring station of air quality, zoology weather stations, experimental station of water circulation, experimental station of pond purification system, etc. For example, the water quality automatic monitoring station is mainly composed of automatic water gathering system, water pretreatment system and automatic detection of water quality online system, data acquisition and processing system, network transmission system, etc. Monitoring indicators including pH, dissolved oxygen, water temperature, turbidity, conductivity, ammonia nitrogen, potassium permanganate index, total organic carbon, total nitrogen and total phosphorus, etc. When the indicator of dissolved oxygen is lower than the set value, the system will automatically start the oxygen increasing pump to supply oxygen.

The wetland park possesses the function of biodiversity protection and recovery and it is usually divided into the core area, the buffer area and the development area during the construction. The main purpose of the core area is to protect animals, plants and the environment nearby. However, visitors often enter this area, which disrupt the regular management. Therefore, setting monitors around the sensitive wetland environment can achieve the visual management.

The management of trees and facilities in wetland park needs to depend on the way of worker's patrol. The terminal equipment with the functions of GPS and camera of the technicians will upload the problems to the management system at any time, which will help the managerial personnel to make the corresponding solutions. These problems include tree maintaining, animal epidemics, pests and diseases, infrastructure damage, waste cleaning, *etc.*

Figure 6. Smart Technologies Application Planning of the Wetland Park

3.3.3. Smart Tourism: The urban wetland park undertakes an important role of leisure and entertainment, while because of the sensibility of ecological environment; the developing intensity of tourism should be strictly controlled. The smart tourism is convenient for the public by actively perceiving information such as tourism resource, tourism economy, tourism activity, tourist and releasing to the public in time [10]. Electronic ticket business: wetland park makes use of comprehensive ticket management system integrating the selling, management, financing and checking, which will help to improve management efficiency. Meanwhile, it should meet the demands of clients booking tickets online and make the service more humanized. The control of the tourists capacity: in order to protect the ecological environment of the park, the tourists capacity of the wetland park should be controlled strictly. Aiming at the free wetland park, it can adopt the mode of granting free tickets to tourists, which can count up the number of tourists through the access control system automatically. RFID technology application [11]: Providing wrist straps with RFID electronic labels for tourists. With the whole park covering effectively with RFID readers under reasonable layout, tourists with RFID can be traced and located in the park. Meanwhile, tourists management and environmental protection can be effectively achieved according to tourists distribution. Safety monitoring: Through wireless monitoring, security guards of the park can dynamically monitor the park's entry zone, main crossings, important places of the activity zone and places with complex security to ensure that once any emergency occurs in the park, the security guards will rush to the scene as soon as possible to deal with it.

3.3.4. Public Participation: The sustainable development of Wetland Park can't go without the participation of the public. Through public engagement, the park's shortcomings can be corrected and its services can be improved, ensuring the health of the wetland park and safeguarding the interests of the public. APP is an important approach which the wetland park public participate in, and the public can share the experience through video, photos and information. The general public can organize rich and colorful activities through the "Smart Wetland Park" system such as wetland park visiting, photography and parent-child parties, *etc*.

4. Conclusions

The management of Wetland Park is all-round and multi-level, and the management efficiency directly influences the sustainable development of the wetland park. The service needs of the parks are increasing daily and the traditional management mode cannot meet the demands for the management. The smart wetland parks have become an effective solution of improving management efficiency of parks. The smart technology can make full use of information and communication technology methods to sense, analyze and integrate all the key information of operating core systems of the urban wetland park. With the help of smart platform, users can improve their quality of life and service by the information technology and mobile application service.

Acknowledgements

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