Research on the Integration of Smart City and Ecological Sustainability Driven by Digital Intelligence Empowerment

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ABSTRACT

In the background of the new era, digital intelligence empowerment has become a key force to promote the deep integration of smart cities and ecological sustainability. This study integrates the three themes of digital intelligence empowerment, urban sustainable construction, and ecological development, and puts forward the core concept of using digital intelligence empowerment to promote urban sustainable development. It aims to achieve the efficient use of urban resources, the effective protection of the environment and the balanced development of society through the deep integration of digital technology and intelligent systems. The research focuses on the use of digital intelligence empowerment to promote urban sustainable development, and the coordinated development of ecological sustainability and smart cities. This paper deeply analyzes the protection of the ecological environment and intelligent governance, emphasizing the protection of the environment and the efficient use and recycling of resources through digital technology, so as to promote the sustainable development of cities. This paper provides a theoretical basis and practical guidance for ecologically sustainable design in smart cities, and shows deep thinking and rigorous exploration of smart cities and ecologically sustainable issues driven by digital intelligence empowerment.

Keywords: Digital intelligence empowerment; Smart cities; Urban sustainable development; Ecological sustainability; Green development

1. Digital intelligence technology and smart cities

(1)Definition and characteristics of digital intelligence technology

At present, the information society is undergoing a compressed and parallel stage of the intertwined development of digitalization and intelligence, which is collectively referred to as digital intelligence . Digital intelligence technology is a combination of digital and intelligent technology, which not only refers to the application of digital technology, such as big data, Internet of Things, cloud computing, etc., but also includes intelligent technology, such as artificial intelligence (AI), machine learning, automation, etc. Together, these technologies promote the intelligence, automation and optimization of urban management. By collecting, storing and analyzing large amounts of data, digital technology helps city managers optimize the decision-making process and improve the efficiency of resource use, which is mainly characterized by data-driven, intelligent management, real-time feedback and sustainable optimization, which makes the construction of smart cities more efficient, flexible and sustainable.

(2)Definition and characteristics of smart cities

According to the review of smart city-related research, there are some differences in the views of researchers at home and abroad on the origin of the concept of smart city · Chinese researchers generally believe that the concept of smart city originated from

the concept of smart earth proposed by IBM in 2009; Foreign researchers prefer the pioneering work of Graham, Marvin, and Mitchell in the 1990s to provide the most basic theoretical basis for smart cities · Smart city is a new urban form that reconstructs the urban operation mode through data integration and intelligent application with the support of a new generation of information technology. Its essence lies in building a deep integration of urban physical space and digital space, and using technical infrastructure such as Internet of Things perception terminals, 5G communication networks, and cloud computing platforms to realize the global digitization and real-time dynamic monitoring of urban elements. This kind of technology empowerment enables urban management to shift from empirical decision-making to data-driven, forming an intelligent governance system covering the whole cycle of urban planning, construction, and operation.

Sustainable development is an important indicator that distinguishes smart cities from traditional cities. The smart grid increases the proportion of renewable energy to more than 40% through distributed energy management and demand-side response, and the combination of building information modeling and energy consumption monitoring system improves the energy-saving efficiency of large public buildings by 30%. More importantly, the smart city has built a digital channel for the whole people to participate in governance, citizens can check air quality and report urban management problems in real time through the APP, and the decision support system can absorb 200,000 pieces of citizen feedback data per day for policy optimization, truly realizing a new ecology of urban governance that is co-built, co-governed and shared.

2. Ecological sustainability in smart cities

(1)Definition and importance of ecological sustainability

Ecological sustainability refers to ensuring the long-term stable development of ecosystems without compromising the health and function of the natural environment while meeting current human needs, so as to maintain the harmonious coexistence of humans and nature. The premise of sustainable development is to change the previous development mode at the expense of the environment, and attention should be paied to the sustainable use of resources in the process of development . In the construction of smart cities, ecological sustainability is not only limited to resource conservation and environmental protection, but also involves the comprehensive and coordinated development of society, economy and environment. In the increasing global climate change, resource depletion and environmental pollution, ecological sustainability has become a core element that cannot be ignored in the process of urban planning and development. Ecological sustainability is essential for the construction of smart cities, as it is related to the long-term survival and development of cities. Ecological sustainability in smart city construction is not only related to the city's environmental quality and resource use efficiency, but also directly affects the quality of life, health and well-being of citizens.

The core elements of ecological sustainability mainly include environmental protection, resource conservation, social equity, etc., specifically, reducing pollution and conserving natural resources and biodiversity for the health of ecosystems, efficient use of natural resources such as water, electricity, energy, and land for reducing waste, and fair distribution of all kinds of resources and services for promotion of the harmonious development of society. With the acceleration of urbanization, environmental degradation and resource scarcity have become more serious, and ecological sustainability has become an important goal of smart city construction.

(2)Ecological environment challenges faced by smart cities

Environmental pollution is inevitable in the process of urbanization, and with the continuous increase of population and the improvement of urbanization level, cities are facing increasingly serious environmental pollution problems. Large amounts of industrial emissions, traffic pollution, and building construction are all putting great pressure on the air quality, water quality, and noise levels of cities. Despite the introduction

of advanced technologies in the construction of smart cities, the traditional pollution problem is still difficult to address, and it is often difficult for fast-growing cities to effectively supervise pollution sources.

In terms of energy consumption and carbon emissions, urban energy demand is huge, especially in high-rise buildings, transportation and other fields, which accounts for a high proportion of energy consumption, resulting in a large number of carbon emissions. Energy consumption in smart cities is mainly reflected in electricity, heating, cooling and transportation systems, and without an effective energy management system, it is easy to exacerbate the burden on the ecological environment.

The excessive consumption of natural resources is one of the important ecological environment challenges faced by smart cities. Urbanization not only increases the demand for natural resources such as water, land, and mineral resources, but also increases the amount of garbage, wastewater, and exhaust gases. The traditional resource consumption mode often causes waste of resources and environmental burden, and how to realize the rational allocation and efficient utilization of resources in the construction of smart cities has become an urgent problem to be solved.

Urbanization has led to the destruction of the natural ecological environment. Ecosystems such as forests, wetlands, and lakes have been encroached upon or polluted, affecting biodiversity and ecological balance. Although environmental planning in smart city construction focuses on ecological protection, it still needs to balance the relationship between economic development and ecological protection in the construction process.

(3)Ecological sustainability goals in smart cities

To improve the efficiency of resource use, smart cities need to optimize the use of resources such as water, electricity, and energy. Through intelligent resource management systems, such as smart grids, smart water, etc., accurate monitoring and scheduling of resources can be achieved to avoid waste of resources. Smart grids regulate energy supply and demand through real-time data feedback, reducing energy waste and promoting the use of renewable energy.

To promote low carbon emissions, energy conservation and emission reduction, efforts should be made to reduce greenhouse gas emissions and promote the development of low-carbon economy in the process of smart city construction. Intelligent transportation systems enable green mobility by optimizing traffic flow, reducing traffic congestion, and reducing vehicle emissions. Green building and intelligent building design can effectively reduce building energy consumption and carbon emissions, and improve the energy efficiency of buildings.

Ecological protection and green space construction, smart city planning should pay attention to the protection of ecosystems and the construction of green space. By planning green spaces such as green spaces, parks, and wetlands, cities can provide residents with clean air and natural landscapes while enhancing biodiversity. Environmental designers need to consider ecological restoration and green buildings in the design process to achieve a harmonious coexistence between human activities and the natural environment.

To achieve circular economy and waste management, smart cities should promote the resource utilization of waste and the concept of circular economy, improve the recycling rate of waste through intelligent waste sorting and recycling systems, and reduce landfill and incineration. The waste management system is not only the collection and treatment of waste, but also includes the recycling, reuse and reproduction of waste, forming a closed-loop economy.

To raise citizens' awareness and participation in environmental protection, the ecological sustainability goal of smart cities depends not only on the application of technical means, but also on the extensive participation of citizens. Through digital platforms and intelligent tools, citizens are encouraged to participate in environmental protection activities and enhance their awareness of environmental protection and social responsibility. For example, environmental APPs can help citizens monitor data such as air quality and energy consumption in real

time, prompting them to take environmental actions.

Ecological sustainability in smart cities is a multi-dimensional and complex system engineering, involving resource conservation, environmental protection, social equity and other aspects. Smart cities need to optimize resource management, reduce carbon emissions, promote green buildings and transportation, and promote ecological protection and environmental restoration through innovative digital and intelligent technologies. Urban planning and design must have ecological sustainability as a core objective, ensuring a balance between economic development and environmental protection. In order to achieve these goals, in addition to technology, citizen participation, policy support and collaboration from all sectors of society are also indispensable.

3. Integration of digital intelligence empowerment and ecological sustainability

(1) Application of digital intelligence technology in urban planning and design

In terms of digital city model and simulation, urban planners can build virtual city models in the design stage through digital modeling technology to simulate the operation of different design schemes. For example, the use of BIM (Building Information Modeling) and GIS (Geographic Information System) technology can systematically analyze the environment, infrastructure, transportation, and energy demand of the city, and predict the use and emissions of various resources, so as to formulate the most energy-efficient and environmentally friendly design scheme.

In terms of intelligent planning and resource allocation, through big data and artificial intelligence algorithms. It can analyze the current situation and development trend of the city in real time to optimize the spatial distribution and allocation of resources. In urban planning, digital intelligence technology can help more accurately identify the needs of land, transportation, public service facilities, etc., and integrate ecological factors (such as green spaces, parks, nature reserves, etc.) into the planning to ensure the sustainable use of urban space and the protection of ecosystems.

In terms of green building design and optimization, digital intelligence technology provides great support for the design of green buildings. In the building design process, the energy efficiency and resource use of the building can be adjusted in real time through the use of intelligent tools, ensuring that the negative impact on the environment is minimized during the construction and operation of the building. For example, with intelligent temperature control systems, solar panels and intelligent lighting control systems, buildings can not only reduce energy consumption, but also optimize the use of resources and meet green building standards.

(2)Smart transportation and green travel

The core goal of the intelligent transportation system is to improve transportation efficiency, reduce energy consumption and carbon emissions through digital intelligence technology, and promote ecological sustainability. Through real-time data analysis and automated scheduling, smart transportation optimizes the use of road resources, reduces traffic congestion, and reduces carbon emissions. The intelligent traffic light control system can dynamically adjust the traffic light cycle according to the real-time traffic flow, reducing the waiting time of vehicles at intersections, thereby reducing energy waste. In addition, the traffic prediction system based on big data analysis can predict traffic bottlenecks in advance for traffic flow allocation, effectively alleviating urban traffic pressure.

The efficiency of public transportation such as buses, subways, and shared bicycles can be optimized in smart cities through intelligent public transportation systems. Through real-time scheduling and intelligent route planning, urban public transport can more accurately match the travel needs of citizens, reduce the use of private cars, and reduce transportation carbon emissions. Smart transportation also encourages green modes of travel, such as electric vehicles, bike sharing, and walking. Through the construction of charging pile network and intelligent sharing platform, the popularization of electric vehicles and the use of shared bicycles will be promoted, and the environmental pollution and resource

consumption of traditional fuel vehicles will be reduced. Through the guidance of intelligent systems, citizens can choose green travel methods more conveniently.

(3) Intelligent environmental monitoring and green energy management

In terms of environmental monitoring and data analysis, smart cities can collect and analyze environmental data such as air quality, water quality, and noise pollution in real time through the Internet of Things, sensors, and big data technologies. These data can provide a scientific basis for environmental governance and help the government take timely measures. Based on air quality monitoring data, cities can automatically trigger emergency responses, implement measures such as traffic restrictions and factory emission reductions to prevent further deterioration of air pollution.

In terms of green energy management, green energy, such as solar, wind and geothermal, is a core resource that drives ecological sustainability. Through the integration of smart grids and renewable energy technologies, smart cities can achieve efficient management of green energy. Smart grids can adjust the distribution of energy according to real-time supply and demand, prioritizing the use of green energy to reduce dependence on traditional fossil fuels. Through big data analytics, energy consumption can be optimized for buildings, utilities, and businesses, driving energy savings and carbon reduction.

Water management is extremely important in ecological sustainability when it comes to smart water management, especially in water-stressed urban environments. Through the intelligent water management system, cities can monitor water use, pipe network leakage, pollution sources, etc., in real time to ensure the efficient use and protection of water resources. Through sensors and big data analysis, the system can accurately determine the leakage point of water pipes and repair them in time to reduce water waste.

Conclusion

The construction of smart cities is closely linked to ecological sustainability, and digital intelligence technology provides unprecedented possibilities for the integration of the two. Through digital and intelligent means, smart cities not only improve management efficiency, but also promote the optimal use of resources and the sustainable protection of the environment. In the fields of urban transportation, energy management, and architectural design, digital intelligence technology reduces energy consumption and carbon emissions through real-time data analysis and automatic control, while improving the efficiency of resource use, and promoting green and low-carbon development. With the continuous innovation and improvement of digital intelligence technology, smart cities will achieve more harmonious resource allocation and environmental protection, and create a better urban life.

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