ISSN: 2664-9640

Research on the Ecological Protection of Smart Cities Against the Background of the Fourth Industrial Revolution

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Abstract

With the approaching fourth industrial revolution, the innovative urban-development concept of smart city has been a concern to all sectors of society. This is because the operation mode for this city integrates current society's cutting-edge science and technology, which has brought unprecedented situations and developments in urban construction and residents' lives; it also drives the entire society's evolution toward intelligence and informatization. In this mode of urban development based on advanced science and technology, the new concept of ecological protection also arises at an historic moment. This study mainly examines and explores the ecological protection of smart cities with the aim of verifying the relationship between smart cities and ecological protection; the study summarizes how a smart city can be combined with ecological protection based on case analysis and references. The study finds that the current research on the ecological protection of a smart city is relatively limited; thus, this study also aims to explore this issue and to draw people's attention to it.

Keywords

Smart city, Ecological protection, The fourth industrial revolution.

1. Introduction

1.1. Research Background

Under the tide of the world's fourth industrial revolution dominated by emerging technologies such as artificial intelligence, clean energy, and biotechnology, the mode of intelligent life has had a subtle impact on human production and life, and the idea of building a new city has emerged. The concept of a smart city was formally proposed by IBM in 2010 to contribute to the world's and China's urban development. Not long after the concept of a smart city was proposed, Premier Li Keqiang proposed the first strategy of implementing a manufacturing power—"made in China 2025"—in the government work report of the two sessions of the National People's Congress in March 2015. In May of the same year, the State Council officially issued "made in China 2025," which clearly proposed the "green manufacturing project" in the content of its "five projects." This project mainly aims to organize and improve the traditional manufacturing industry's energy efficiency and promote the manufacturing industry's cleaner production and other special technological transformation. In addition, with the increasing attention paid to national security issues, ecological security has also become among the issues that cannot be ignored because it is related to the rise and fall of the country and the nation's survival. Ecological security is directly related to the well-being of our people, the sustainable development of our economy, and society's long-term stability. Evidently, China has paid increasing attention to the issue of ecological protection, which is also a manifestation of human

ISSN: 2664-9640

society's higher requirements for the living environment and conforms to the development of the times.

1.2. Research Origin

As is well known, research and development (R & D) investment in technology must be city-based. Under the traditional urban-development mode, the degree of informatization is not high, and industrial production remains the main mode, which will inevitably produce pollution emissions in production and in life. Against the above-mentioned macro-social background, and given the continuous modernization of China's governance system and capacity, this study proposes the following two questions in relation to the concept of a smart city.

"What is the relationship between a smart city and ecological protection?" (ii) "Why does a smart city need ecological protection?"

Therefore, this study addresses the above two questions through a literature search, an analysis of relevant cases, and a summary of personal views.

1.3. Research Purpose and Significance

The main purpose and significance of this study are as follows:

First, it is hoped that the research on the ecological and environmental protection of smart cities can arouse social attention and establish an awareness that, regardless of how rapidly science and technology develops, is inseparable from a sound ecological environment as a support. Second, we should learn from the effective experience of ecological protection through the practices of several smart cities that have been built globally. Third, the study summarizes the significance of the research on the ecological and environmental protection issues of today's smart city.

1.4. Research Methods

Literature research method -- The main method entails a review of the literature on the ecological environmental protection of smart cities and related fields as the basis for the research, which guarantees that the research problem will be addressed. Case analysis method -- This study analyzes the existing cases of smart city ecological protection to summarize their experiences and effective ways of protecting smart cities, including a case study of the country garden in China.

1.5. Article Structure and Innovation

The main structure of this paper is shown in the following figure. The main idea is to examine the ecological protection of smart cities against the background of the fourth industrial revolution; the focus is mainly on the cities' origin, development status, and current ecological protection, based on current specific measures implemented for a typical smart city. Based on a summary and an analysis, the question is raised as to what experience can be provided for the construction of country garden's smart city as a reference. Last, based on the above conclusion, the study proposes the prospects for the future ecological protection of smart cities.

The study's innovations are as follows:

First, against the background of the fourth industrial revolution, it is proposed that the ecological protection of smart cities is consistent with the development of the current era. Second, a smart city itself contains human scientific and technological achievements in the social environment of the fourth industrial revolution, and it is a novel urban-development model closely related to science and technology. Finally, ecological protection cannot be ignored in the global context. Without a sound ecological environment, cities cannot develop healthily and orderly, while human civilization cannot advance healthily and continuously. Therefore, an appropriate ecological environment is the premise for the stable development of a smart city.

ISSN: 2664-9640

This study combines the above three aspects and proposes exploratory research on the ecological protection of smart cities against the background of the fourth industrial revolution. A combination of current, cutting-edge science and technology and ecological environmental protection can also reflect a compatibility with the theme of "scientific and technological environment" to a certain extent.However, the link between the above two aspects cannot continue to promote the ecological protection of smart cities, while the government can provide effective support only by issuing relevant policies and regulations. The specific relationship is shown in the following figure.

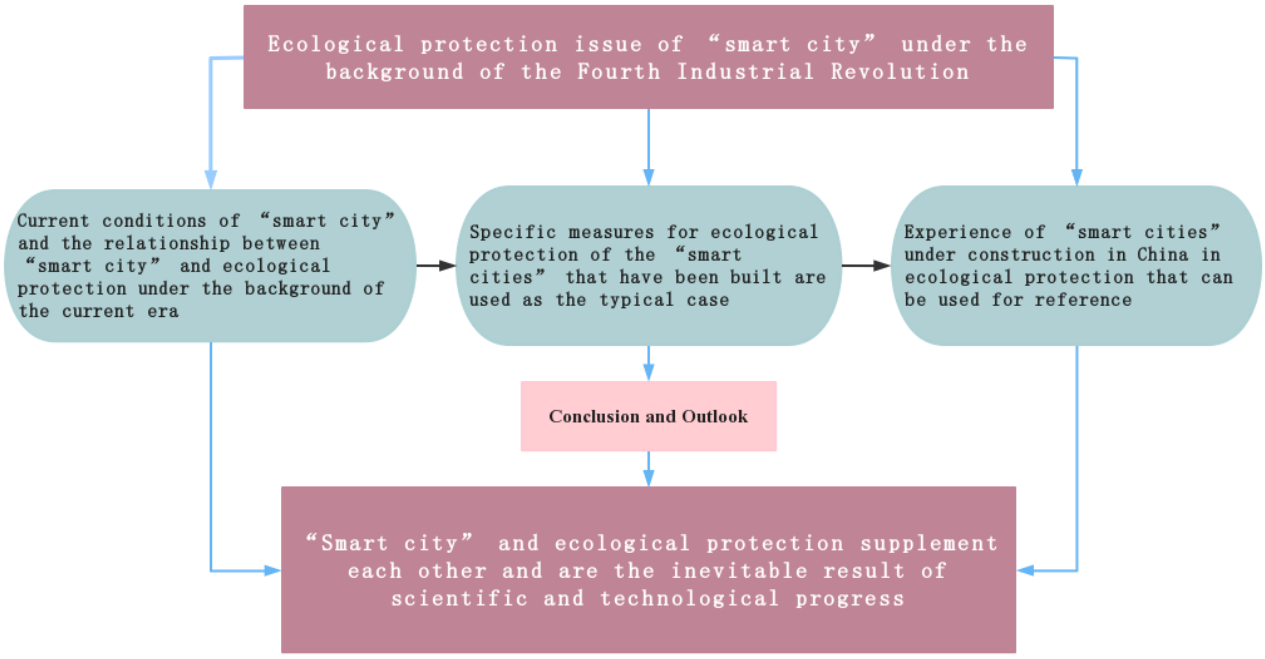

Figure 1:Main contents of the study

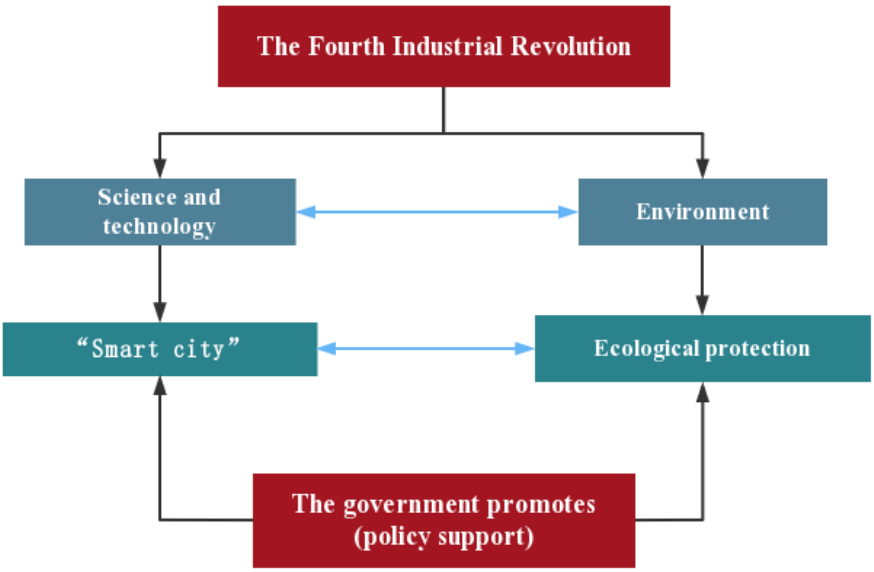

Figure 2:Conception of the study

ISSN: 2664-9640

Against the background of the coming fourth industrial revolution, smart cities imply mankind's latest scientific and technological achievements, while the ecological-protection problem implies environmental problems; the relationship between technology and the environment is also one between smart cities and ecological protection, to some extent. However, if the entire society seeks to promote the effective implementation of the ecological protection of smart cities, it is imperative for the government to issue policies to provide the necessary support. Given a lack of research on this issue, this study considers it as the research object for preliminary exploration.

2. Definition of the Concept of a Smart City

The concept of a smart city originated from the vision proposed by IBM in 2010. Although consensus on the precise definition of a smart city has not yet been reached, we can see from the figure below that a smart city represents another leap in human production capacity. The concept embodies future urban development and information construction, which has regained global popularity following the industrialization and digitalization of cities. Its rise has promoted the future development strategy for and form of cities.

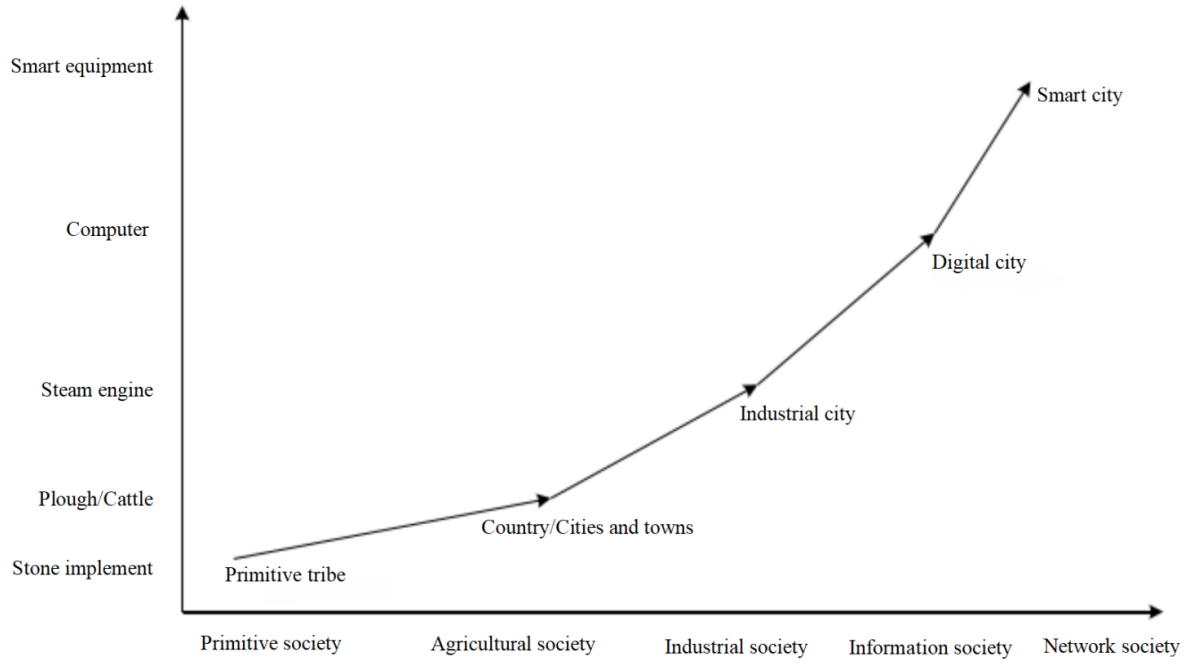

Figure 3: City characteristics at different stages

We believe that the connotation of a smart city is a new type of city that integrates modern intelligent technology for the healthy and orderly development of cities. Its emergence conforms to the development of the times. In the long run, improving the establishment of smart cities can provide a guarantee for mankind's better production and life.

3. Construction Status of the Smart City

In 2012, Dr. Boyd Cohen first evaluated the world's top ten smart cities based on the evaluation indicators of regional green cities, urban innovation, urban digital governance, and residents' quality of life -- Vienna, Toronto, Paris, New York, London, Tokyo, Berlin, Copenhagen, Hong Kong and Barcelona. At present, the concept of building a smart city has been accepted by an

ISSN: 2664-9640

increasing number of countries. In the fifth part, this study focuses on four typical smart cities for reference and analysis.

4. Reasons for the Ecological Protection of Smart Cities

First, the relationship between a smart city and ecological protection essentially explains that between man and nature. A smart city is the external manifestation of the advancement of human civilization, and an ecosystem is an inseparable part of nature. A smart city requires ecological protection just as humans need nature for their survival. From this viewpoint, it is an eternal law. Similarly, only by effectively protecting nature can nature continue to provide protection for human development. The two interact and are interdependent.

The difference is that a smart city is a leap forward for human civilization following industrial civilization, and it focuses on the new urban-operation model generated by human's new science and technology in this period. However, ecological protection has been a continuous topic since the emergence of human civilization.

In China's ancient society famous for farming, the investigation and protection of the population's living environment were included in the scope of the government as early as the Western Zhou Dynasty. For example, it is stipulated in the order of cutting and worshipping that "no houses should be destroyed, no wells should be filled, no trees should be cut down, and no six livestock should be moved. There is no amnesty for those who are not as good as today." The most familiar sentence in the Spring and Autumn Annals of the Lu family reads as follows, "if you fish with all your strength, you will not get it; and there will be no fish next year." In addition, the great thinker, Mencius, once said, "Without breaking the farming season, the valley cannot be eaten; without entering the pond, the fish and turtles cannot be eaten; when the axe and Jin enter the mountains and forests, the wood cannot be used." All these reflect that ancient ancestors realized that ecological protection was inseparable from the development of cities and even human society.

The embryonic form of a "wisdom" city building was also reflected in ancient Greek city states -- During the Minoan civilization of ancient Greece, the water-conservancy technology reached outstanding development levels (for example, aqueduct drinking-water system, diversion-ditch system, wastewater and rainwater sewer system, etc.). Evidently, mankind's desire to live in an ecologically sound and sustainable environment is eternal; thus, the pace of exploring how cities can maintain a sound ecological environment has never stopped. As history developed, the ecological protection of smart cities was always imminent and resulted from a compliance with the inevitability of the development of the times. Only a sound ecological environment can ensure that human civilization continues to advance and develop more intelligently; therefore, this is considered the primary reason for studying the ecological protection of smart cities.

Second, from the perspective of the current historical period, smart cities can provide a new way for ecological protection, that is, recycling resources and focusing on intensive production.

In traditional urban construction, people tend to consider energy consumption as the cost of seeking development in order to rapidly attain more benefits. Once serious ecological problems have been caused, typical solutions mostly include reconstruction and filling; however, this is not an appropriate cure for all the ecological problems, and there is often a phenomenon of treating the symptoms rather than the root cause. With the advent of the intelligent era, industrial production has become increasingly intensive, and the concept of recycling has gained increasing support. This way of integrating human life with ecological and environmental protection has gradually gained public acceptance. That is, it is more effective to solve ecological problems than to fill them. This is also closely related to the characteristics of some smart cities.

ISSN: 2664-9640

At present, most of the smart cities that have been established are pilot demonstration cities, with limited geographical space; however, the use of some intelligent methods for ecological protection has achieved certain results. Once this method is adopted and can be popularized, the intensive recycling of ecological protection becomes imperative. This is among the reasons for the need for smart cities' ecological protection.

Finally, we consider why smart cities will require ecological protection in the future. A smart city is built by gathering cutting-edge technologies in society. Without a sound ecosystem as a guarantee, these high-end technologies have no proper "place to use" and their effectiveness cannot be maximized. The ecology of a smart city can be well protected, which not only improves human beings' living environment, but also provides sound infrastructure conditions for the sustainable cultivation of high-end talents in the future. From a longer-term perspective, it can provide powerful conditions for human society's continued progress. This is also among the important reasons for the need to protect a smart city's ecology.

5. Case Study on the Ecological Protection of a Smart City

5.1. Barcelona's Smart City and Ecological Protection

Barcelona, located in the northeast of the Iberian Peninsula and bordering on the Mediterranean Sea, is the second largest city in Spain and the most important trade, industrial, and financial base in Spain. Barcelona's construction of a smart city mainly revolves around the following three levels.

First, providing municipal infrastructure and planning according to the existing urban infrastructure; second, promoting the establishment of social networks between the government and residents based on knowledge industries; third, promoting positive interaction among knowledge groups to achieve the purpose of mutual benefit and win-win results. Through a literature review, it is found that Barcelona's initiative to build a smart city can be traced back to 2000. Then, Barcelona had begun to support the use of solar energy by the entire population. Simultaneously, bus stations erected solar-energy signboards to provide travel information for citizens. This practice not only reduced the city's carbon emissions, but also facilitated people's lives, changing their daily costs of production and inducing them to adopt ecological-protection behavior.

In Barcelona's innovative urban area, the ecological environmental protection of a smart city is most vividly reflected. The €180 million construction fund will be invested in the innovative urban area, and its construction focus is mainly on the reconstruction of 35 kilometers of streets. The main purpose is to open up public space, build efficient network systems, and introduce new service facilities, such as new energy, electronic communications, garbage collection, noise-pollution control, and other intelligent facilities. These measures, which not only apply new technologies to urban people's lives, but also promote intensive production and reduce ecological pollution, are typical representatives of ecological protection in smart cities.

5.2. Smart City and Ecological Protection in Amsterdam

Located in the west of the Netherlands, Amsterdam is among the largest cities in the Netherlands, with a population of approximately 1.1 million. It is among the world's famous metropolises. At the beginning of the 21st century, Amsterdam's environmental and energy problems have become increasingly severe. In the process of solving these problems, some methods of building a smart city have been continuously explored.

First, the Amsterdam government encourages households to install energy-feedback display devices. Users who install these devices can obtain the energy consumption situation in time. The device can set household energy-consumption goals and offer personalized suggestions based on the set goals and use conditions. In addition, the device can separately display the

ISSN: 2664-9640

energy consumption of each household appliance and achieve the goal of minimizing energy consumption through the function of "turning off all appliances with one button." The residents of Amsterdam have greatly reduced the energy consumption of household electricity by installing such "smart" equipment, which has not only improved the residents' awareness of environmental protection, but has also played an important role in reducing carbon emissions.

Second, the Amsterdam Smart CITY plan was launched in Amsterdam in 2009. The plan mainly comprises residents, enterprises, municipal government, and relevant social groups. Its main purpose is to propose more appropriate solutions to some existing problems in the city. Specific targets include energy conservation and carbon-emission reduction.

In addition, the Amsterdam government has allocated a budget of US $40million each year for the transformation of urban infrastructure and introduction of new energy-saving smart technologies. These are Amsterdam's main practices in the ecological protection of the smart city.

5.3. Smart City and the Ecological Protection of Songdo New City

Songdo new city is located in the west of Seoul, South Korea. It is a new urban area formed by "land reclamation." The island was officially started in 2003 and is expected to be officially completed in 2020. Songdo new city's urban design attaches great importance to the conservation and reuse of water resources. The island is equipped with equipment and devices for collecting rainwater. In addition, there is a system for purifying and treating wastewater recovered from sinks, washing machines, and dishwashers, which greatly improves the utilization rate for water purification resources so that rainwater and domestic sewage can be retreated and reprocessed for recycling; thus, freshwater resources are protected to a certain extent. In addition, Songdo new city intelligently manages residents' garbage. There is no special garbage collection vehicle in Songdo new city; however, an underground passage is erected in all buildings. Under the "pressure driven" effect, the central garbage-collection system can pump the garbage from all buildings and then send it to the automatic garbage-collection plant through the underground passage.

Furthermore, Songdo new city is supported by technical solutions and networks provided by Cisco and has introduced many IT technologies into the city's infrastructure construction. It has also built a technology park to allow some Internet enterprises to settle in. Meanwhile, it implements transnational cooperation with Cisco, Microsoft, and other enterprises to ensure the intelligent construction of the city. These are Songdo new city's efforts in the construction of a smart city and its ecological protection.

5.4. Singapore's Smart City and Ecological Protection

As is well known, as an island country, the peculiarity of Singapore's geographical location has made its water resources particularly valuable. To address the water crisis caused by the massive importation of water resources from Malaysia, the Singapore government decided to vigorously develop seawater desalination and sewage-reuse projects. The most representative is the "new water" project. The "fresh water" project adopts two main technologies -- microfiltration and reverse osmosis. First, the particles, bacteria, and other impurities in the sewage are filtered out through the microfiltration technology; the sewage is then extruded under high pressure and relatively small impurities such as dissolved chemicals are filtered out through the reverse osmosis membrane; finally, by using ultraviolet disinfection technology, the sewage obtained from the previous step is disinfected to obtain recyclable "newborn water."

This technology also shows that Singapore has achieved win-win results in the construction of the smart city and its ecological protection. Moreover, Singapore has constantly improved its transformation from smart city to "smart country" in the development process in recent years.

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From this perspective, Singapore can become among the model countries globally to practice the ecological protection of a smart city.

6. Approaches to the Ecological Protection of a Smart City

It is evident from the above smart-city cases that the ecological protection and construction of a smart city are simultaneously implemented; that is, the concept of ecological protection has been integrated into the construction of a smart city. Based on the above four cases, this study summarizes the following measures in the practice of the ecological environmental protection of a smart city.

First, the government must issue policies to provide support. Both the smart cities in Barcelona and Singapore mentioned that the government had provided support for their ecological construction. The support policies issued by these governments not only include the laws, regulations, and institutional provisions for the construction, but also relevant financial support. For example, in the case of Amsterdam, the government's budget has evidently been tilted toward the construction of the smart city.

In addition, in the four cases mentioned above, it was mentioned that the government encouraged enterprises to introduce new technologies into the construction of the smart cities. The government plays the same role in the ecological protection of the smart cities. The introduction of new technologies is conducive to the development of a smart city in a smarter and cleaner manner, which is also one way to promote its ecological protection.

On the one hand, the government's support for the construction of a smart city has promoted its progress in ecological protection; on the other hand, it also reflects the internal relationship between the scientific and technological environment and policies. Therefore, in this study, it is believed that a government-policy guarantee is among the effective ways to promote the ecological protection of a smart city.

Second, it is necessary to enhance citizens' awareness of environmental protection. All sectors of society must strengthen publicity and supervision regarding the ecological environmental protection of a smart city so that residents can develop sound smart-ecology habits and combine smart life with ecological protection in their daily lives. However, the improvement of ecological protection awareness cannot be achieved overnight; it is realized in the process of social development and the gradual deepening of the concept of ecological environmental protection. As can be seen from the above measures of waste recycling in Songdo new city, to complete an efficient and intelligent waste-recycling work, a sound foundation is required for residents' classified-waste release in the early stage. After the concept of garbage classification and recycling has been deeply rooted in citizens' hearts , efficient and intelligent garbage classification and treatment are guaranteed. In the current situation in China, the concept of waste classification and recycling must be further improved. Therefore, from the perspective of this phenomenon, widely publicizing ecological environmental protection and improving residents' awareness thereof are among the effective ways to improve a smart city's ecological protection.

Third, to effectively protect smart cities ecologically, we must cooperate with other countries' smart cities for collaborative development and introduce their outstanding achievements in the ecological protection of smart cities, such as intelligent power-saving devices, water-recycling devices, and other intelligent technologies in the above four cases. This will provide relevant experience for the development of a framework for the ecological protection of smart cities in China.

Finally, the state and local governments must improve legislation and strengthen the supervision of the construction of smart cities to promote the benign development of ecological protection. This study contends that in terms of legislative supervision, we should focus on the

ISSN: 2664-9640

authenticity of the R & D of innovative technologies in the ecological protection measures for smart cities and the adaptability of those brought about by a certain technology to local conditions.

Real technology R & D is critical in any field of society. Only real technological innovation can effectively guarantee the safety of people's lives and promote social progress. Moreover, technology R & D in the ecological protection of smart cities is directly related to the R & D in the important field of production as well as in a city's or even a country's life. Therefore, laws and regulations should be established and improved. Making the law play a real role of restriction and protection also provides a good guarantee for the smooth progress of the ecological protection of smart cities.

The ecological-protection system of establishing a smart city according to local conditions must also be constrained and legally supervised. Among the most important concepts in the ecological and environmental protection of a smart city is to follow the trend and establish a sound and orderly ecological environment. However, some enterprises or developers engage in improper "smart" development at the cost of destroying the ecological environment in pursuit of their own interests, which should not be permitted. Ecological resources cannot be wasted for the purpose of ecological development. From the above four cases, it is evident that the development of a smart city occurs parallel to ecological protection. Smart technology brings effective ecological protection. Meanwhile, a sound ecological environment provides protection for the smart development of new technologies. To stabilize this virtuous circle of relations, the protection of the law is indispensable. Therefore, this study believes that the national and local governments must improve the legislation and strengthen the supervision of the ecological protection of smart cities.

7. Lessons to be Learned -- Taking Country Garden as an Example

The Country garden group, or Country Garden Holdings Co., Ltd., headquartered in Shunde, Foshan, Guangdong, is the largest new urbanization residential developer in China. In recent years, it has been mainly committed to becoming the builder of the global, green, ecological smart city. Its main characteristic projects include Country Garden forest city, Shunde country garden, Guangzhou Phoenix City, Jurong Phoenix City, country garden Shili silver beach, country garden Lanzhou New City, country garden coral palace, and country Garden Guanting Lake 1.

Country garden is currently among the typical cases of ecological protection in the construction of smart cities in China. Its most prominent performance in ecological protection is the construction of greening. The scientific collocation of various kinds of plants not only visually creates the beauty of "building roof" greening and "wall vertical" greening, but also considers the functions of different plants. This practice can not only prevent and control pollution, slow down the heat-island effect, prevent wind, and fix sand, but can also help to absorb carbon dioxide and noise to create a sound living environment for residents. In addition, this approach can also provide favorable conditions for the protection of biodiversity.

The ecological construction of country garden is mainly based on the coverage of green plants; however, the utilization rate for water resources for planting such large-scale plants must be improved, and there is great potential for smart development in plant disease and pest defense. For example, as mentioned above, we can seek policy and financial support from the government. We can learn from the Amsterdam Smart City plan to develop a model for the ecological protection of a smart city that is jointly built by residents, enterprises, real-estate developers, and the municipal government. In addition, we can participate in joint development with other smart cities globally and introduce advanced, economical, intelligent irrigation and

ISSN: 2664-9640

pest-control technologies. This would improve and integrate country garden's ecological development concept with the construction of smart cities.

8. Research Conclusions and Deficiencies in the Ecological Protection of Smart Cities

The ecological protection of smart cities is a problem that must be further explored. Through a literature review and case analysis, this study concludes that the construction of a smart city is closely related to ecological protection. They are interdependent and cannot be separated from the ecological protection of a smart city. The relationship between the two can be closely linked by government-led policy support, which can promote the effective establishment of smart cities and their ecological protection.

Based on the above arguments and analysis, this study proposes two questions at the beginning. (i) What is the relationship between a smart city and ecological protection? (ii) Why does a smart city need ecological protection? These questions are addressed and explained. Additionally, through the analysis of the ecological-protection cases of four smart cities in foreign countries, some measures that are significant as references for the ecological protection of smart cities in China are summarized.

However, because the ecological protection of smart cities is a problem on a macro scale, this study only draws a conclusion based on the literature review and case analysis. Deficiencies remain in the theoretical framework to support the research of this problem; however, this study aims to raise awareness of the problem hopes to inspire interest in continued research on the subject for improvement.

References

[1] WU Yulong: Smart City: the Way of Building Modern City in the Context of Internet of Things. (Publishing House of Electronics Industry, Beijing 2011).

[2] LIANG Xiaona. Study of the Application of Ecological Strategy in Smart City Space Planning -- Taking HengQin New District as an Example [D]. South China University of Technology, 2015.

[3] ZOU Jiajia. A Study on Approaches of Smart City Construction -- A Case Study of Ningbo, Zhejiang [D]. Zhejiang Normal University, 2013.

[4] ZHANG Xiaojuan. The Elements, Structure and Model of Smart City System [D]. South China University of Technology, 2015.

[5] LU Shiling. The IT explore ways of Historical Environmental Protection under the idea of Smart City [D]. South China University of Technology, 2013.

[6] LV Shuli, XUE Hua, WANG Kun. The Review and Outlook on Smart City Construction [J]. Contemporary Economic Management, 2017,39(04):53-57.

[7] LIU Haixing. Barcelona: The blooming smart "European Flower" [J]. Green Environmental Protection Building Materials, 2014(05):94-97.

[8] AN Xiaomi. Studies in Smart City Development -- oriented Information Resource Management Collaborative Innovation Strategy: A Case Study of Smart City of Amsterdam in the Netherlands [J]. Information and Documentation Services, 2014(03):49-53.

[9] SONG Na, YANG Xiudan. The Construction of Smart City in Amsterdam and Enlightenment [J]. Modern Industrial Economy and Informationization, 2017,7(05):3-5+13.

[10] LIU Chenyu, LUO Meng. Experience and Enlightenment of Singapore's Environment Protection and Governance [J]. Journal of Zhengzhou University of Aeronautics, 2013,31(04):118-122.

[11] HE Haiyan. Study on conservation landscape model of Biguiyuan [D]. South China University of Technology, 2017.