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The Experience and Enlightenment of Asian Smart City Development—A Comparative Study of China and Japan

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Abstract: With the urbanization level advancing in cities, increasingly significant urban ecological environment problems must be solved. The construction of a smart city with the overall development of information technology also regards environmental friendliness as the primary goal. The "smart" idea of urban environment innovation and governance has become a new model. In this paper, we first expound on the development process of low-carbon cities, eco-cities, and smart cities in Japan and China. Then, we analyze the coordinated development of intelligent environmental protection measures in government policies, transportation, energy utilization, resource recovery, and community management. Finally, we compare Japan and China's smart city development characteristics. We discuss the improvement measures for energy utilization, urban transportation, and urban operation, including developing renewable energy systems, efficient energy use, and citizen participation policy. These experiences can provide feasible measures for constructing Asian smart cities and have great significance for the city's sustainable applications and practice.

Keywords: smart city; low-carbon; environmental protection; urban environmental governance; innovative development

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1. Introduction

Urbanization development, increasing population, industrial agglomeration, and climatic deterioration have challenged urban capacity [1]. Urban governance has become an essential issue in the urban policies of various countries as a result of multiple urban problems [2,3]. The concept of a smart city is derived from successful social and economic operation, providing a new model of urban governance exploration by combining system innovation and mechanism reform [4,5]. The low-carbon city is to create a stable ecological environment and promote economic growth through innovative technologies to save energy, reduce carbon emissions, protect biodiversity, and improve the quality of living environment citizens [6,7].

The smart city emphasizes the overall intelligent development of the Internet, networking, cloud computing, communication technology, and other applications, achieving informatization, digitization, and modernization of urban governance. The construction of smart cities has brought new opportunities and paths for traditional towns' sustainable and low-carbon development [8]. Meanwhile, the innovation of low-carbon cities also needs the support of modern intelligent technologies [9]. Therefore, to realize the goal of a low-carbon city and people's intelligent life construction, an efficient management model should be applied to an urban environment [10].

Many scholars studied low-carbon and smart cities from industrial structure, economic development, transportation, operation management, and government policies [11]. In terms of energy utilization, some countries seek stable development of low-carbon cities through efficient energy saving of smart grids [12,13]. Regarding transportation, some cities in the UK and Singapore improve road traffic safety through smart transport systems and reduce the annual loss caused by urban traffic congestion [14,15]. As to economic development, energy conservation and emission reduction should consider the regional financial health to achieve the cities' sustainable and low-carbon [16]. The spatial form of cities has become a hot topic in low-carbon city research. Digital models and field measuring are essential for many scholars researching low-carbon cities [17]. Through the excavation of the practical experience of low-carbon cities in various countries [18] and the extensive cooperation between citizens and developers [19], the low-carbon cities construction can be further promoted. Many countries, including China, are vigorously developing the new generation of information technology, covering natural resources, transportation, architecture, citizen life, economy, and other aspects [20], hoping to lead all cities into the construction of smart cities through developed information technology. In 2014, the National New Urbanization Plan established the development principles of future urbanization, namely "intensive, intelligent, green and low-carbon" [21]. However, China's smart city construction lacks practical experience and theoretical guidance. There are many problems in developing low-carbon pilot cities, and composite and complete general indicators for intelligent city development have not yet been formed [22]. It is meaningful to analyze the characteristics of existing smart city construction.

In addition, the development of low-carbon cities has a positive effect on mitigating global warming and curbing climate change [23,24]. Figure 1 shows the CO_2 emissions trend and total CO_2 emissions of each country in the past years. The solid line is the total carbon emissions, and the dotted line is the carbon intensity. Since the 21st century, Chinese total carbon emissions have grown rapidly. In 2005, China became the world's largest carbon emitter. Although its carbon emission intensity has gradually declined, it is still much higher than in other developed countries. According to the International Energy Agency's public data, among the top five countries in the world's GDP in 2017, the carbon dioxide emissions in China was 0.891 kg/USD, higher than that of other developed countries. In contrast to Japan, it was only 0.184 kg/USD, which means Chinese energy efficiency, fossil energy use and energy structure need to be improved. The total annual carbon emissions of Japan, the UK and Germany were long-term stables. Japan plans to cut carbon emissions by 26% to 1.042 billion tonnes by 2030 compared with 2013 [25].

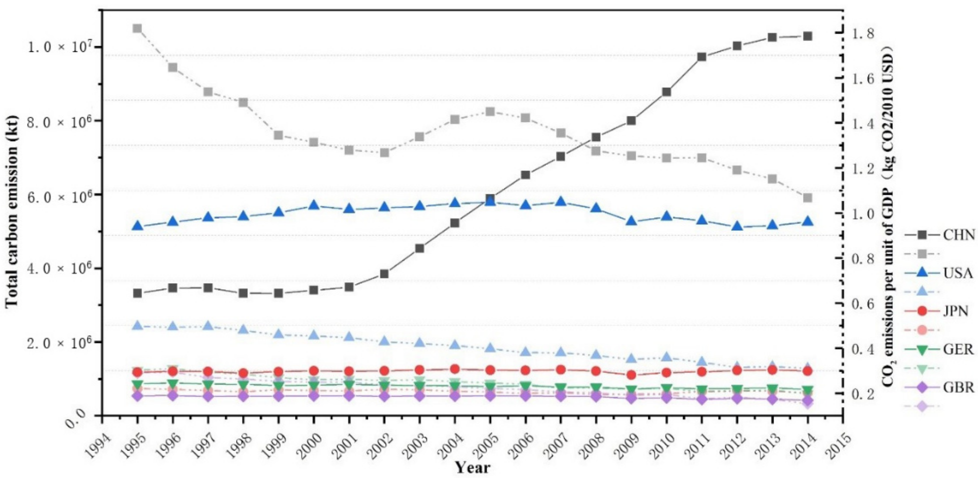

Figure 1. Total CO_2 emissions and CO_2 emissions per unit of GDP. (Data from the International Energy Agency and the World Bank).

China has made a target to reach the peak carbon dioxide in 2030 and is striving to become carbon neutral by 2060 [26]. This comparative study combines the development of smart and low-carbon cities in Japan and China. It selects Kitakyushu City in Japan, a "low-carbon environment capital", and a smart urban area in Shanghai as a typical case study. The development process of urban environmental governance in Kitakyushu was discussed, and urban ecological governance and innovation strategies were analyzed, to provide effective urban environmental management and innovative development experience for Asian future smart city construction.

2. Research Method and Object

At present, the smart city evaluation standard is still in its infancy [27] and there is no standardized smart city index applicable to smart city evaluation in multiple regions [28]. Different regions have different dimensions for smart cities [27,29]. Some scholars have classified smart cities into the smart economy, people, governance, mobility, environment and life [30]. Or have divided it into energy and environment, economy, safety and security, health and living, mobility, education and government [31].

In the world, the standards of smart cities are ISO 37120 (Sustainable Cities and Communities—Indicators for City Services and Quality of Life) [32] and ISO 37122. (Sustainable cities and communities—Indicators for smart cities) [33]. ISO 37122 is a further subdivision of ISO 37120. They divide smart cities into 19 aspects of indicators, including economy, education, energy, environment, transportation, etc.

The research objects are the smart pilot city in China and Japan. Japan is one of the early countries in smart cities construction, and its development is relatively mature. The smart city development analysis can provide experience from inception to maturity for future smart city development, such as China, still in the rapid growth stage. This paper analyzes smart city cases in Japan and China through case analysis and comparative investigation by ISO 371200. The framework is shown in Figure 2 as follows. The article is divided into three parts: introduction, analysis and discussion.

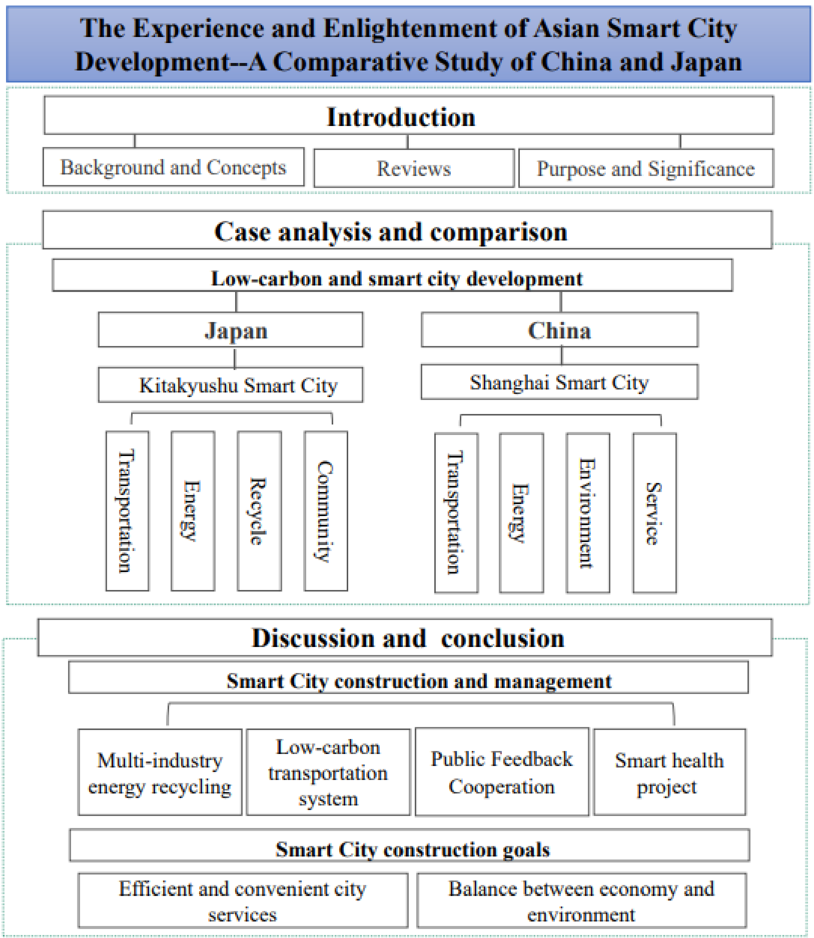

Figure 2. Article frame diagram (Source: Draw by author).

3. Low-Carbon and Smart City Development

Different living and cultural backgrounds lead to varying characteristics of smart cities worldwide. Amsterdam has launched the Amsterdam Smart Citizens Lab project in urban governance, which gathers different professionals and forms a multi-dimensional "citizen science", bringing innovation and technology to urban management [34]. To reduce urban carbon emissions and noise pollution, Germany put forward the Smart City Logistic project, which promotes electric vehicles and provides ICT for their driving range and logistics routes to achieve the purpose of energy conservation and efficiency [35]. Led by the municipal government, the city of Singapore has built an urban event association and scenario prediction system, which uses big data to analyze and summarize the historical situation and event correlation to predict potential urban problems and find solutions [36].

Throughout the development of urban governance in foreign countries today, urban transportation, energy, communication and water supply were considered separately in the past. Still, now a new system of mutual connection and mutual promotion has been formed [37]. Through the sharing and transmission of information, urban governance becomes efficient and convenient. Therefore, promoting the development of smart cities has become a feasible way to solve the anthropogenic urban environmental problems.

3.1. Japan

Japan is one of the earliest and the most prosperous globally to carry out smart city construction [38]. The impetus of Japan's smart city construction stems from the various ecological, social and economic problems [39]. For example, lack of resources, frequent natural disasters, small land and large numbers of people, old age and low birthrate, global warming. Japan adheres to the planning and construction concept of "people-oriented" and "ecology first". To promote the sustainable development of ecology and economy, Japan adheres to the planning and construction concept of "people-oriented" and "ecological priority". Following the smart city construction concept of "legislative guarantee first", mainly relying on market operation, active participation of enterprises and citizens, and policy guidance [40]. The smart Japanese city's steady development also depended on a series of government policies to build a digital society, such as the "e-Japan" strategy (e: electronic) in 2001, the "U-Japan" strategy (U: ubiquitous) in 2006 and the "I-Japan" strategy (i: information) in 2009 [41]. These policies promote the continuous development, reform and regeneration of Japan's entire industrial structure. A society penetrated with digital technology and information has been created. At the same time, strong infrastructure conditions have been laid for the construction of smart cities [42].

The development process of smart cities in Japan covers many sectors, including economy, environment, agriculture, culture [43]. The "Environmental Model City" launched by the Japanese Cabinet Office is achieving a sustainable low-carbon city by significantly reducing greenhouse gases and is the basis for the concept of "future city" policy. Kitakyushu is one of the first six cities selected as an "environmental model city" to deal with the energy environment and aging problems. In 2010, Keihanna Research City, Toyota City, Aichi Prefecture, Yokohama City, Kitakyushu City, and Kanagawa Prefecture were established as smart cities by the Ministry of Economy, Trade and Industry. It covered building intelligent power, gas, transportation facilities, waste, water and heat energy.

Baizhiye Smart City is one of the 11 "future cities" designated by the Japanese Cabinet in 2011 and won the highest "Platinum Certification" of "Community Development" certification in "LEED Certification" in 2016, which is a world-class environmental certification. Environmental symbiosis, "health and longevity", and "new industry creation" are the three major themes of its construction. In the wisdom city of Baizhiye, the "GATE SQUARE" is a block in front of Station 148, which integrates various functions such as energy, disaster prevention, transportation, health, disease care and prevention, business environment international exchange space. Its carbon emissions are 40–50% lower than the Tokyo average value in 2005. It has an integrated and efficient energy management system and an energy supply system to deal with emergencies, creating an environment-friendly, healthy and secure community for Baizhiye Smart City.

3.2. China

In the mid-1980s, China introduced the concept of "eco-city" and began to put it into practice with the increasingly severe carbon emission problem [44,45]. In the beginning, Yichun city of Jiangxi province proposed building an "ecological city" in 1986. Then the government carried out a series of policies to promote ecological city construction. In 2009, China put forward the new concept of a "low-carbon eco-city" for the first time at the International Forum of Urban Development and Planning, marking China entered a new stage [46]. By October 2014, the 30 provincial administrative departments and 380 cities set the construction target of building low-carbon eco-cities [47], covering nearly 60% of the cities in China.

Chen Nan evaluated the three batches of low-carbon leading cities and found that they had achieved the effect with a significant improvement. However, there were still some shortcomings in development [48]. Whether the low-carbon city evaluation system is effective whether its relationship with economic growth is reasonable were doubted [49,50]. Research shows that low-carbon cities often reduce productivity while improving the environment [51]. Therefore, the smart city with big data prediction and efficient operation ability is more important [52].

With the development of smart cities, China has established more than 700 innovative city projects in more than 500 cities [53]. Figure 3 is the distribution map of typical smart cities in China, which shows Chinese smart city development is mainly concentrated in the southeast coastal areas, which have an excellent economic foundation and rapid growth. They focused on extensive data construction in government affairs, management and services, while the other smart cities worldwide were mostly linked by green and low-carbon development. The current development of smart cities in China is still in its infancy [54]. Shenzhen focuses on constructing an urban intelligent cloud data system for the urban public service, public security, urban management and smart industry in information sharing and service coordination [55]. Citizen participation is also critical [56]. Guiyang city regards big data as an opportunity for urban transformation and provides citizens with a mobile platform for complaints and opinions. Industrial Big Data has increased interaction between the government and the public. This innovation has achieved a new channel for the people and government to govern the city jointly [57]. Shanghai explores the relationship between intelligent industries and geographical and economic factors and rationally builds a smart city [58]. China highlights urban IoT data management and information sharing, effectively coordinates urban environmental governance, and takes measures based on local conditions [59]. China should also consider achieving energy saving and CO_2 emission reduction goals in terms of transportation and power distribution system of residents' lives [60,61]. And build an intelligent city with Chinese characteristics based on existing cases [62].

Figure 3. Distribution map of typical smart cities in China. (Reprinted from [63]).

4. Case Study of Kitakyushu City

In this study, we choose Kitakyushu city as the case study because the transformation has been well done from "Seven colors smoke city" to a smart low-carbon model city. Kitakyushu City is located at the northernmost of Kyushu Island in Japan. It is the second-largest city in Kyushu, with 1 million population and 180 square kilometers. The Chikugo area was rich in coal resources and developed rapidly in 1870. The industrialization of Kitakyushu started in 1901 when the Yawata Steel Works began to operate. Industries such as steel, chemicals, ceramics, and power have developed rapidly due to abundant coal reserves and strategic ports for Asia. It has brought a sharp increase in the economic strength of Kitakyushu. It has become one of Japan's four major industrial zones that made significant contributions to Japan's modern industrial development.

With the rapid development of iron, steel, chemical industry and other industries in Kitakyushu, the ecological environment and human health are threatened by industrial pollution. Taking Dokai Bay as an example, the concentration of smoke, dust, nitrous oxide (NO_x), particulate matter and sulfur oxides (SO_x) far exceeded the standards of the World Health Organization (WHO). The dust amount in the air of the Shiroyama area is highest in Japan. Kitakyushu City became a region with the most severe air pollution in Japan at that time and was called "Seven-color Smoke City". Dokai Bay was once rich in biological resources and developed fisheries, but with a large amount of sewage discharged from factories and households, the fishing volume dropped to zero in 1942. Then the fishing rights were abolished in 1956 [64]. In 1965, the average dust collection reached 80 tons/month, and the highest time got 108 tons/month. It broke the highest record in Japan [65]. Many residents suffered from respiratory diseases and many schools were forced to relocate. In 1966, a scientific study confirmed that Dokai Bay contains high toxic substances (such as cyanogens and arsenic), with zero dissolved oxygen capacity and a maximum chemical oxygen demand of 36 parts per million. In 1969, about 4 million m^3 of industrial wastewater and 60,000 m^3 of domestic sewage were released daily into the Bay. The factory wastewater accounted for 97.4% of the chemical oxygen demand load. Dokai Bay was also known as the "Sea of Death".

Since the early 1950s, various women's associations have been set up a "We Want Our Skies Back" campaign. They mobilized public and private companies to fight industrial pollution. It prompted Kitakyushu to seek solutions from all sectors of society. After a series of effective regulations of using clean energy and reducing pollutant emissions, the ecological environment of Kitakyushu city was fundamentally improved and gradually restored in the early 1980s. Clean energy was used gradually replaced coal and oil as the primary energy supply. The air pollutant quality was effectively controlled, the water quality and supply were enhanced to meet all national standards.

Through the environmental remediation in Kitakyushu, Japan, we found that Kitakyushu relied on non-governmental forces in the early stage of ecological governance, which was weak and narrow in scope. Then we sought solutions from all sectors of society. It shows that there is a management loophole between economic and environmental protection. People became the first to protest because the government did not timely formulate policies to protect people's living environment and follow perfect policy provisions. In this regard, the construction of environmental and economic policy system, the modernization of ecological governance system and governance capacity, and the formulation of policies in line with national conditions, such as green taxation, environmental charges, ecological compensation, emission trading, can help accelerate the construction of smart cities.

5. The Innovative Development of the Smart City in Kitakyushu

5.1. Government Policy

Japan launched related policies to solve pollution and environmental problems to achieve symbiosis with nature and build a livable environment. Then it established a complete ecological protection legal guarantee and basis to govern the environment and accelerate the restoration of the polluted natural environment. Its iconic and influential policy formulation and revision process are shown in Figure 4. From 1967 to 1970, Japan enacted and implemented the fundamental law for pollution control and act. Then it established the Environment Agency in 1971. The Basic Environment Law was promulgated in 1993. Since 2000, "greenhouse gas emission reduction" has become another focus of environmental protection besides "circular social construction" [66]. And formed the "Basic Law for Promotion of Recycling Society". The Kyoto Protocol, signed in 1997 to encourage countries to meet their greenhouse-gas emissions targets, came into force in 2005. In addition to policies at the national level, Kitakyushu also had local plans. In 1992, Kitakyushu City Green Basic Plan was formulated, focusing on maintaining green plants and parks. In 2000, Kitakyushu put forward a new "Environmental Capital of the World program". From 2010 to 2015, the construction of a smart community in Kitakyushu was listed as one of the government's new growth strategic cities. The development of the smart grid and new-generation transportation system became the primary development mode in this region. In the 27th Session of Kitakyushu Municipal, Environmental Review Council formulated the Low-Carbon City Planning Promotion Plan in the central part of Ogura, promoting five basic principles and fifty-seven measures. Kitakyushu Environmental Model City Action Plan became one of the leading projects, which laid a solid foundation for the construction of Kitakyushu smart City.

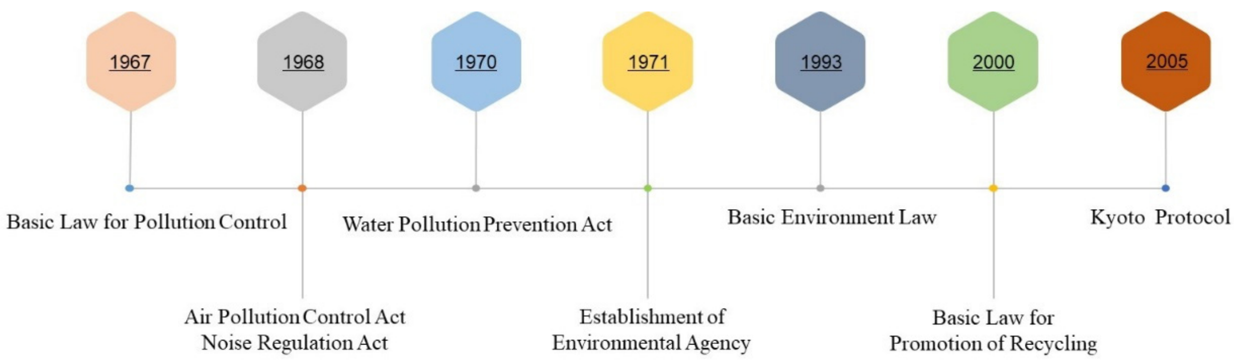

Figure 4. Policies making and revision process (Source: Collation by Author).

5.2. Transportation

It is vital to support and encourage the use of public transport and enhance environmental awareness to make the cities' green economy more competitive in the future. In the past ten years, the transportation methods chosen by people have changed significantly. Figure 5 shows the statistics of transportation methods from 1981 to 2005. The dependence of Kitakyushu on private cars increased from 45.7% to 63.7%. The use rate of public transport decreased from 20.1% to 7.6%, which was one of the essential factors for the increase of greenhouse gases gas emissions in Kitakyushu. Table 1 is traffic improvement measures. As shown in Table 1, Kitakyushu has improved public transport services quality. From the renewal of station facilities, convenient services promote clean energy. The length of the bicycle road is 1867 km [67]. People were encouraged to use public transport. They also pay attention to the participation of residents in the transport system.

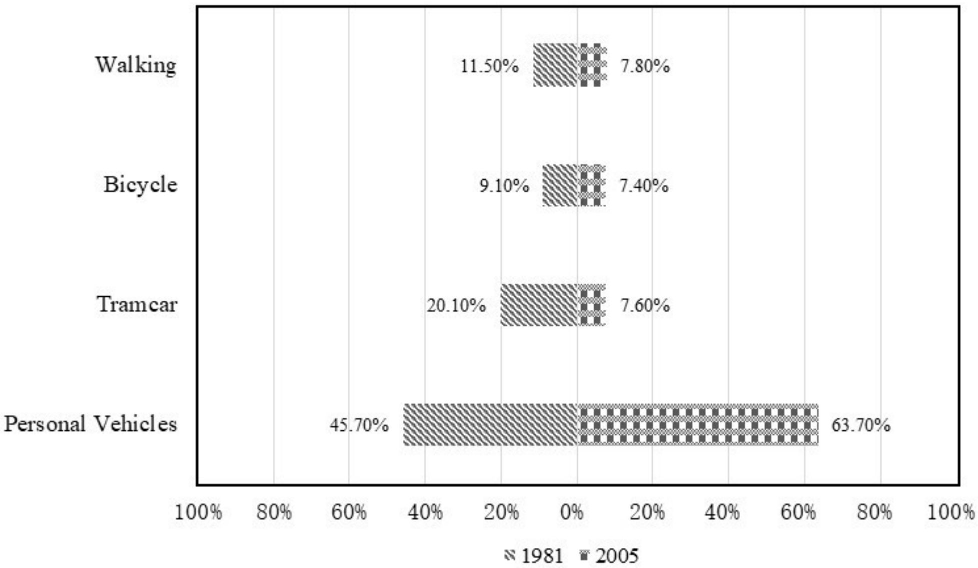

Figure 5. Changes in the share of transportation modes. (Data from OECD).

Table 1. Traffic improvement measures.

Main Measures	Implementation Content
1. Updating site facilities	Kept the original traffic lines and updated the hardware facilities in the station to meet the convenience of the elderly and children.
2. Concessionary fare	The "100 Yen monorail" system promoted monorail use by setting fares between adjacent stations.
3. Bus priority	Unique bus lines would be opened to improve transport efficiency.
4. Bus upgrade	Lower the height of the door pedal for the elderly and the disabled. Electric cars were gradually replacing gas-powered ones.
5. Free parking	The government paid for parking in parking lots near significant transportation sites and encouraged people to use public transportation.
6. Bike sharing	A large amount of investment in bicycle sharing and planning of bicycle lanes.
7. Promoting clean energy	Many new electric charging stations would be built in the urban area to encourage citizens to use clean energy vehicles.

(Source: Collation by Author).

5.3. Energy Utilization

Large-scale industrial energy consumption dominated the city's energy demand, accounting for 66% of the total energy consumption. Therefore, Kitakyushu City regarded solving the energy supply problem as the key to liberating Kitakyushu's green economy, increasing energy independence, and realizing the potential of a "low-carbon society." Figure 6 shows the proportion of different energy supply methods in Kitakyushu City. Among the energy supply in Kitakyushu, nuclear power accounted for 45%, thermal power accounted for 42%, and natural gas accounted for 13%. It can be seen that wind energy, solar energy, water energy and renewable energy had colossal development potential.

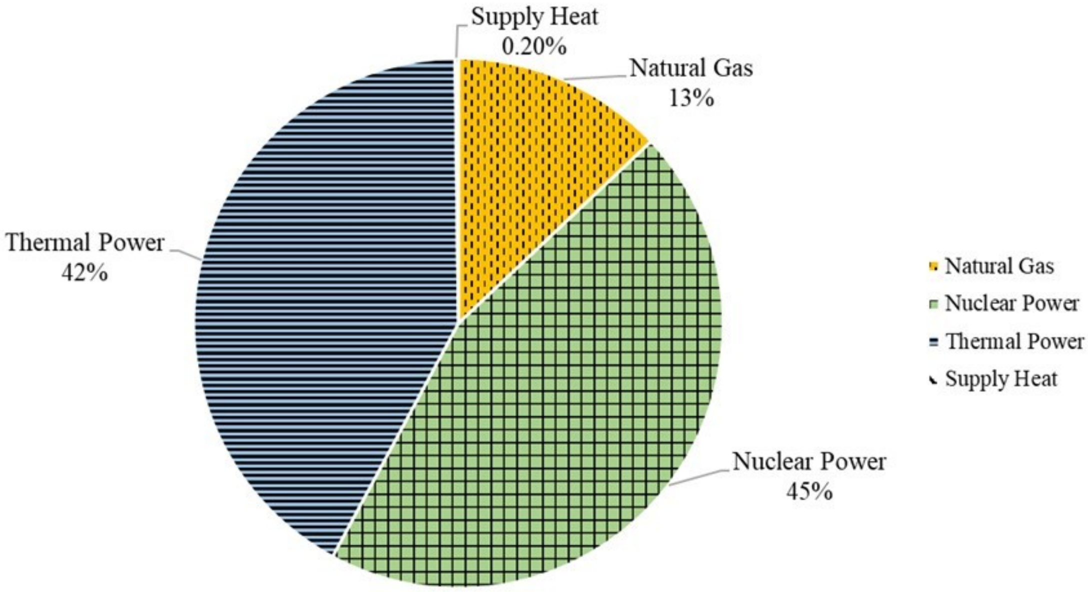

Figure 6. The proportion of different energy supply modes in Kitakyushu city (Data from OECD).

Concerning solar energy, Kitakyushu first offered 30,000 yen up to 70,000 yen per kilowatt to encourage residents to install solar systems in their homes. A new generation of energy parks, consisting mainly of wind and solar energy, was also promoted. In addition, Kitakyushu's chemical industry and its research capabilities in solar-related technology areas such as semiconductors can be used to develop second and third-generation advanced solar technologies. These initiatives were enough to demonstrate its efforts to achieve low-carbon cities. Through the change of energy structure and technology, Kitakyushu's energy consumption was 24,084 TJ in 2016 [68]. As for water resources, the water quality of Kitakyushu has been dramatically improved by advanced industrial wastewater treatment. The New Energy Industry Technology Development Organization (NEDO) of Kitakyushu City and some private enterprises set up "water Plaza". It cooperated with the Global Water Cycle and Reuse Solution Technology Research Association (GWSTA), aiming to develop the water cycle and desalination technology.

5.4. Recycling of Resources

The eco-industrial park in Kitakyushu city was mainly divided into verification research area, total environmental industrial area, and Habiki-nada recycling industrial area. Through the "industry-education-research" mode, the university research institutions, enterprises, and government support were combined to reprocess and recycle different waste products. Specific characteristics of the eco-industrial park are shown in Table 2. There were nearly 30 kinds of projects, including the experimental and verification research platform of professional research institutions in Kitakyushu University, the comprehensive environmental, industrial area project of office equipment, automobile, household appliances, medical treatment. And industrial regeneration projects. The park implemented 3R (Reduce, Reuse, Recycle) measures to realize the recycling of wastes and strived to reduce carbon emissions. Figure 7 is a schematic diagram of waste trading and utilization in Kitakyushu Eco-industrial Park. The figure's different color areas represent different ways of circulation in enterprises, factories, offices and daily supplies. The park carried out waste resource recycling and trading in the whole park through cross-recycling of different types of projects and cooperation among enterprises. Kitakyushu also promulgated the relevant laws on waste disposal and cleaning. For example, enterprises and operators cannot waste paper in cities for destruction, including letters, newspapers, paper bags, etc. It must be recycled through the relevant wastepaper recycling department. The waste recycling industry in Japan's eco-industrial parks was also protected and supported by the Japanese Law on Household Appliance Reuse, the Law on Automobile Reuse and the Law on Container Packaging Reuse [69]. According to statistics, 85900 T of solid waste recovered by the factory, the solid waste recovery rate reached more than 22% [70].

Table 2. Specific and characteristics of eco-industrial park.

Industrial Park	Verification Research Area	Comprehensive Environmental Industrial Area	Habiki-Nada Recycling Industrial Area
Participants	Enterprises, Administrative departments, Universities	Home appliances, fluorescent tubes, medical equipment, and other enterprises	Seven car demolition plants, The small waste treatment plant
Project	Institute of Resource Recycling environment Control System, Fukuoka University Validation Research Center of Eco-industrial Park, Kyushu University of Technology Kitakyushu Eco-Industrial Park Center Waste Research Facilities Study on verification of thermal decomposition of biological substances Verification Research on Specific Strengthening Technology of Foundation Based on Geocell Construction Method Verification research on charcoal technology of organic waste Research on technical verification of metal pressing block;	Recycling Project; Office equipment recycling project Plastic bottle recycling project Medical equipment recycling project Home Appliance Fluorescent tube regeneration project Building mixed waste regeneration project Nonferrous metal comprehensive regeneration project; Car recycling project.	Edible oil Regeneration Project Organic solvent extraction and recycling project after use Recycling of waste paper Beverage can regeneration project Wind power project Pinball Game Regeneration Project Recycling project of waste wood and plastic Vending machine regeneration project Sludge, metal, and other recycling projects;
Features	Research on waste treatment technology and resource recycling technology.	Recycling waste materials to generate electricity.	Disassembled auto parts can be reused to the maximum.

(Source: Collation by Author).

5.5. Community Management

Yahata Higashida's innovative community in Kitakyushu city was one of the demonstrations of the Ministry of Economy, Trade and Industry in Japan to promote the "new generation of energy and social system". It was also an important area to advance the cause of the "advanced smart grid" in Japan. Figure 8 shows the community management system of Yahata Higashida's innovative community in Kitakyushu. The community included buildings and infrastructure in housing, schools, hospitals, factories, shops and offices, intelligent bike rental stations and new energy vehicle service stations for transportation and intellectual data centers. Through the energy use data analysis of the smart community center, we could grasp the relationship between different energy supply and demand levels in a day and use it to improve the energy utilization rate. The innovative community could use different types of buildings such as factories and offices through regulation and management of energy-saving equipment and energy systems such as standardized intelligent instruments. It also could realize the data communication and share between the creative community center and the intelligent buildings and facilities for various uses. As well as meet the individual energy facility and the whole block energy utilization optimization.

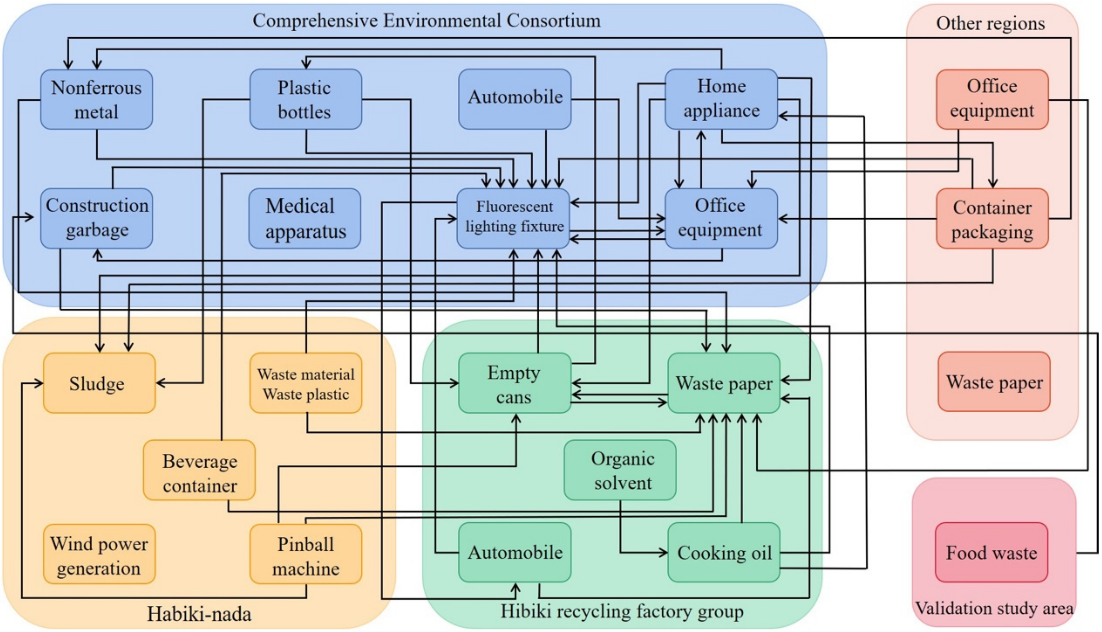

Figure 7. Schematic diagram of waste trading in Kitakyushu Eco-Industrial Park (Translated by author).

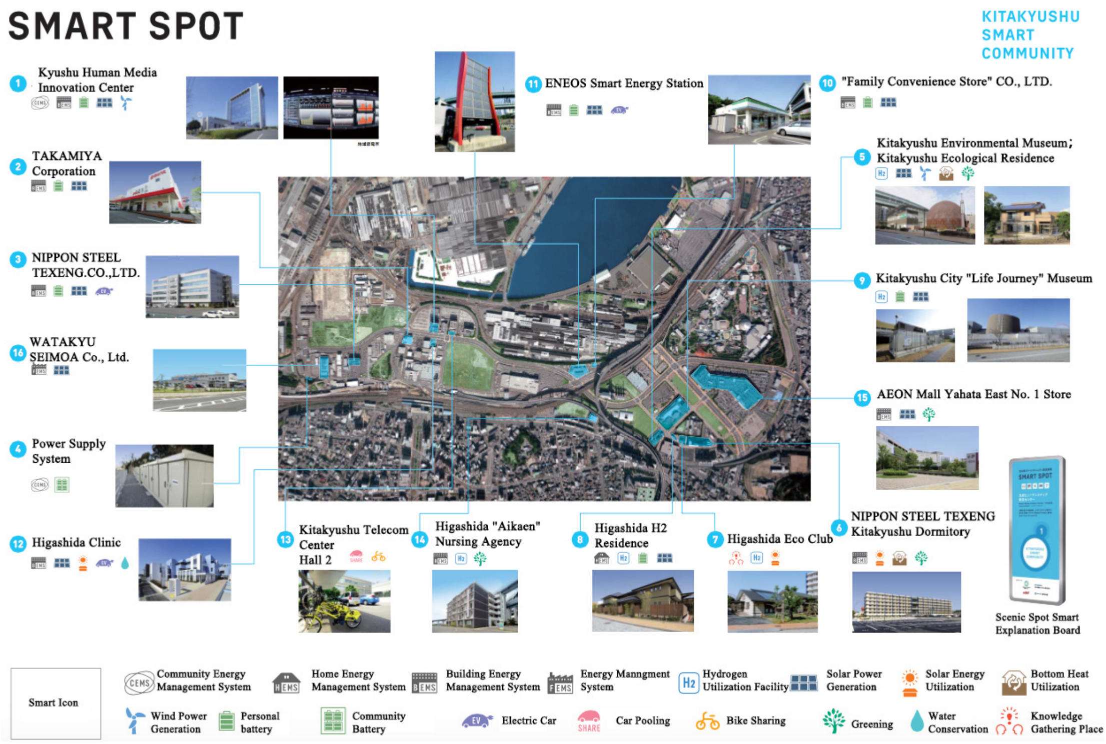

Figure 8. Yahata Higashida smart community management system. (Translated by author: http://doc.future-city.go.jp/pdf/torikumi_project/kitakyushu/p002_panf.pdf (accessed on 14 October 2021)).

The overall power grid of the smart community was divided into Household Energy Management System (HEMS) and Building Energy Management System (BEMS). Energy data collection and demand-side management regulation were carried out through installed smart meters. About 70 companies and 200 families in the smart community have installed smart meters using the system. Enterprises and residents could track their energy consumption through the real-time data of BEMS and hems and adjust the power demand in the appropriate range of the electricity fee to reduce the peak electricity consumption.

The innovative community has set up a "community power-saving center", established carbon compensation and ecological points system, encouraged the citizens' behavior of energy conservation and emission reduction. By using the smart meters, they control and reduce community energy usage, improve the supply and demand efficiency of new energy, and reduce the impact of further energy power instability on the work and life of residents.

Furthermore, the community also built a new generation of transportation systems, and clean energy such as electricity and hydrogen became the primary transportation consumption. Many charging devices have been put into the community to use the new generation of cars, electric bicycles, etc. And through the real-time data analysis of the "block power-saving institute," the total energy of each charging station was distributed according to demand. The electricity of the charging device mainly came from the conversion of clean energy with solar and wind power in the community. Moreover, the use of shared transport in the community was vigorously promoted, so that citizens could get convenient transportation by using mobile phones. At the same time, local enterprises, citizens, governments and scholars jointly formed the "Yahata Higashida community construction Liaison Meeting" [65]. With this liaison meeting as the core, citizens were encouraged to participate in it and promote the low-carbon and intellectual development of the intelligent Higashida Yahata community.

6. The Development of the Smart City in China

Like Japan, Chinese Smart cities construction also selects pilot cities to drive regional development. With the same situation as Kitakyushu, Shanghai Smart City is one of the best pilot cities in China. The two cities have the same status in the smart city development of their country. The Shanghai smart city was planned in 2006 and formed by developing a comprehensive transportation hub. It uses the massive flow of people, logistics and information of transportation hub to drive the development of surrounding cities [71]. In 2010, it began low-carbon construction and was rated as the first three-star national ecological operation city in China in 2018 [72]. Cities' economic development and environmental protection can be balanced through practical measures.

6.1. Shanghai Smart City Measures

6.1.1. Energy Supply

Five energy supply stations in the smart city meet the energy demand of building air conditioning and domestic water in the area. Figure 9 is a diagram of typical energy stations' heating, cooling, and power generation per unit area. As was shown, the cooling capacity is higher than the heating capacity and power generation capacity. The cooling capacity per unit area increases rapidly. The peak value in 18 years is 69.78 kWh/m^2 which shows that many high energy consumption enterprises have entered urban areas. In 2018, the overall energy supply reached its peak. With the implementation of green operation management measures, the overall energy supply declined, the heat supply decreased significantly, and the unit area decreased by 12.53 kWh/m^2. The power generation has remained stable in recent years. Generally speaking, the energy consumption in urban areas is gradually decreasing, and the effect of energy-saving and emission reduction is noticeable. According to the energy system statistics, the annual energy consumption in smart city was more than 200,000 MWh in 2018.

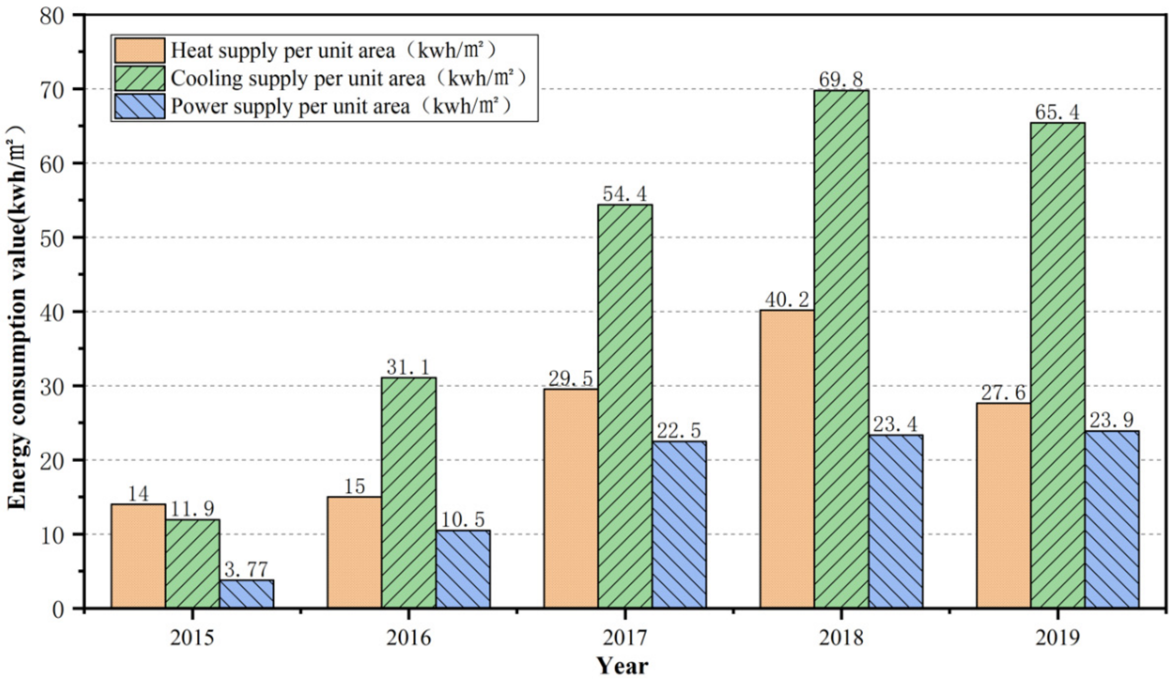

Figure 9. Typical energy stations energy supply date. (Source: Collation by Author).

6.1.2. Transportation

As shown in Table 3, the smart city traffic scale is designed from the large scale to the small scale. It uses overpasses and underground passages to improve the grid walking system, and the three-dimensional traffic coverage rate reaches 100%. Public transportation connects urban roads and important traffic nodes for efficient transfer. Shared transportation solution key areas: shared bicycles are densely arranged, and shared buses are set up in the morning and evening to solve the instantaneous flow of people. The overall transportation system provides sufficient conditions for low-carbon travel. The smart city has 3 subway lines, 17 bus lines, and a 30 km length of bicycle road.

Table 3. Specific and characteristics of the eco-industrial park.

Overpass system	Connect the north-south pedestrian system and supplement the grid road network to form a continuous pedestrian space
Underground system	Connect to essential traffic nodes and quickly evacuate the flow of people
Public transport	A large number of bus stops are set up within a 45-min travel circle, and non-motorized lanes achieve full road coverage
Shared traffic	Set up shared bicycle rental within 300–400 m, and set up shared buses in the morning and evening peak
Green road	Relying on the natural landscape to build a slow-moving system

(Source: Collation by Author).

6.1.3. Building Management

As shown in Figure 10, buildings achieve low-carbon and energy-saving management throughout the life cycle. The green building grade is specified according to the building location and attributes in the planning and design stage. During building construction, Clear divide responsibilities and organize regular acceptance inspection. The building information data is connected to the low-carbon energy-efficient operation management platform in the operation stage. Summarize the regional water, electricity and energy consumption data, and make the building energy consumption in the region verifiable and evaluated to achieve targeted energy conservation and emission reduction. By 2019, more than 300 buildings will be connected to the energy platform.

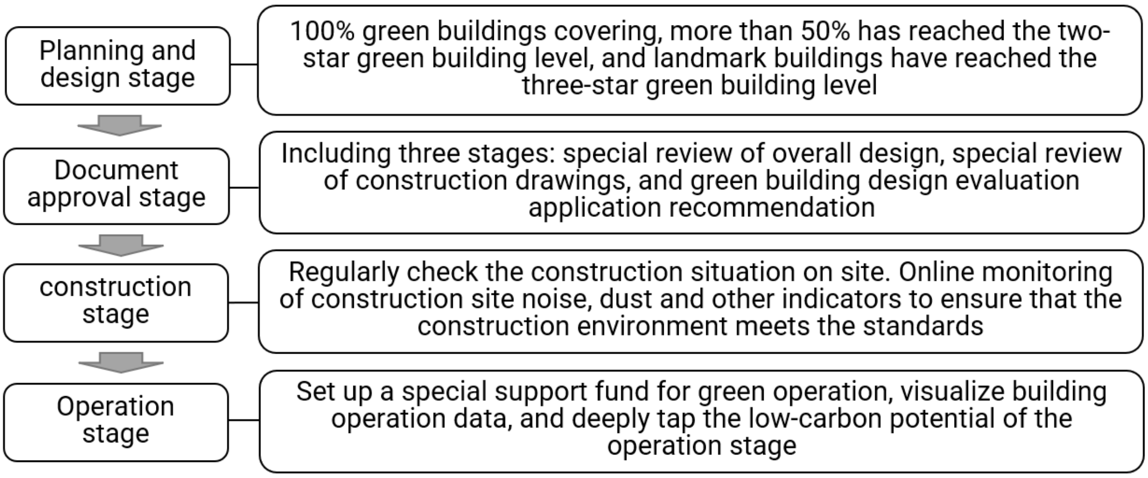

Figure 10. Building management flow chart (Source: Collation by Author).

6.1.4. Smart Node

As shown in Table 4, city management closely relies on smart city construction. For the regular operation of the Hongqiao transportation hub, the integrated command platform allows decision-makers to make accurate judgments for the first time through instantaneity data analysis. The city interior is divided into various grid areas fully covered by monitors. In residents' lives, set up a 24-h unmanned convenience store to ensure an adequate supply of life materials. To improve travel efficiency, provide remote check-in service. Generally speaking, the construction of smart nodes meets people's basic living needs and maximizes energy conservation and emission reduction in the operation stage.

Table 4. Smart node construction.

Transportation hub command platform	Responsible for emergency coordination, access to real-time video and data information such as traffic, environment, weather, etc., to ensure the operation of the city stable
Grid Control Center	Urban grid management, monitoring the internal streets, greening, maintenance, environmental sanitation, etc.
Communication service construction	100% fiber-to-the-home rate, full wireless network coverage, deployment of a three-in-one metropolitan area Internet of Things network of "IoT, data connection, and intelligent connection".
Unmanned convenience store	Using computer vision, machine learning and other technologies to identify customer shopping behaviors and improve operational efficiency accurately
Self-service check-in system	Use face recognition technology to self-check customs clearance system to improve the efficiency of traffic nodes

(Source: Collation by Author).

6.1.5. Ecological Environment

Ecological construction is a crucial way to save energy and reduce emissions. The environmental construction of a smart city mainly includes a river system and landscape greening. For the water system, each river is divided into responsible persons to realize "one river, one policy", and finally make the overall water quality meet the national standard. As for landscape greening, roof greening is widely used in urban buildings, with a coverage rate exceeding 50%. Dividing the green space management right to enterprises so that they can bear the responsibility of environmental construction and improve environmental quality.

6.2. Summary

Shanghai smart City effectively reduces primary energy consumption in urban operation through centralized regional energy supply, green building rating. And the Low-carbon transport and natural environment have increased the awareness of environmental protection for citizens. The construction of various intelligent platforms also avoids energy waste. However, the Shanghai Smart city construction is mostly top-down management, lacking timely feedback and cooperation from citizens. In general, Shanghai Hongqiao Smart City is still early development. We should learn from advanced cases to further improve smart city construction in the future.

7. Discussion on Urban Environmental Governance and Innovation

The continuous advancement of urbanization is the current situation faced by all countries worldwide. Although urbanization brings many ecological, social and economic problems, it also brings opportunities to promote social and technological progress and renewal comprehensively. Asian's Smart cities are characterized by efficient management and policy implementation. Japan and Singapore have developed smart cities earlier in Asia, combining economic growth with smart urban operations earlier. Balance the relationship between environmental protection and economic growth. Then China, Thailand, India and other countries also gradually promote the construction of smart cities. We hope that the comparative discussion of the two cases between China and Japan will reference the subsequent development of smart cities in Asia. They were combined with their development characteristics to explore the national conditions and suitable for the urban development model.

Table 5 shows the indicators of Kitakyushu and Shanghai smart city comparison. We compared the key construction aspects of Kitakyushu and Shanghai through ISO 3217200 standards, including energy consumption, environment, solid waste, communication, and transportation. Kitakyushu smart city area is about 1/3 of Shanghai, and its population density is 1/5 of Shanghai. Kitakyushu's per capita energy consumption is about 20% higher than Shanghai's. However, the overall energy consumption is less than Shanghai smart city. In terms of environmental indicators, as the Shanghai smart city is still under construction, Kitakyushu is obviously better than the Shanghai smart city; PM2.5 and PM10 concentrations are 1/3 of those in Shanghai and carbon emissions are 1/10 of those in Shanghai. This indicator will be improved with the subsequent construction and improvement of Shanghai's smart city. In terms of solid waste, we did not find statistics on it in Shanghai. The two cases situation is similar in terms of telecommunication: the percentage of residential network reaches 100%, and the building information data is connected to the smart platform. In terms of transportation, although the Kitakyushu area is smaller, it has more tourists, and the road construction is better.

Table 5. Comparison of smart city indicators between Shanghai and Kitakyushu.

Dimension	Indicators	Kitakyushu	Shanghai
Area	Smart city construction area (km^2)	1.2	3.7
Population	Smart city resident population	7000	110458
Energy	Total end-use energy consumption per capita (GJ/year) (ISO 371200 7.1)	8.4	6.82
	Final energy consumption of public buildings per year (GJ/m^2)	-	0.18
Environment	Fine particulate matter (PM2.5) concentration (μg/m^3) (ISO 371200 8.1)	11	31.1
	Particulate matter (PM10) concentration (μg/m^3) (ISO 371200 8.2)	18	47.2
	Greenhouse gas emissions measured in tones per capita (t CO^2 /capita) (ISO 371200 8.3)	0.484	5.44
Solid waste	Total collected municipal solid waste per capita (t/capita) (ISO 371200 16.2)	0.12	-
	Percentage of the city's solid waste that is recycled (ISO 371200 16.3)	22.10%	-
	Percentage of the city's solid waste that is treated in energy-from-waste plants (ISO 371200 16.5)	16.40%	-
Telecommunication	Number of internet connections per 100,000 population (ISO 371200 17.5)	100%	100%
	Number of buildings connected in city smart platforms	70	318
Transportation	The average daily traffic volume (10,000 times)	20.6	94.83
	Kilometers of bicycle paths and lanes per 100,000 population (km) (ISO 371200 19.4)	187.1	26.18

(Drawn by author, Data sources: [67,72–75]).

Through the review and indicators comparison of the two cases:

- From the perspective of energy utilization and resource recovery, the recycling economy in Kitakyushu city has a high reference value for constructing a low-carbon eco-city in China. Industrial production could be combined with urban development, using steam from factories and waste heat from molten waste to generate electricity in urban streets and industrial parks. Furthermore, the hydrogen produced by secondary production of ironworks will be used as fuel for a new generation of cars to realize the integration of industry and urban development and maximize economic benefits. In the industrial concentration areas, Kitakyushu city actively develops the purpose of recycling economy eco-industry, forming a recyclable industrial chain to achieve "zero emissions". The successful construction of the Kitakyushu eco-industrial park was led and organized by the government, with the cooperation of enterprises and the sharing of resources to create an exchange platform. The combination of "industry, education and research" forms an excellent closed-loop flow to realize the efficient utilization of resources. However, Shanghai Smart City only stays on the efficient use of energy. China should learn from the model of Kitakyushu ecological park to utilize renewable energy, make the industrial waste return to the recycling system and play its role. It is vital to build a sustainable industrial chain and create environmental protection industrialization and an industrial environment.
- About transportation, the Yahata Higashida community transportation is as widespread as Shanghai Smart City's "shared cars" and "shared bicycles". But there are fewer integrated energy stations in China. In the built charging station, its power supply is not provided by clean energy such as solar energy or wind power. The establishment of the charging station also brings obstacles to environmental protection. In the Yahata Higashida community, the power-saving station was the core of its energy distribution, making it reasonably optimized and the energy loss minimized. Transportation construction in this community is worth learning, further improving energy efficiency. When planning a large-scale comprehensive energy station, resources and the environ-

ment should be considered whole, and the construction of an environmentally friendly society and ecological civilization should be promoted.

- In terms of community management, the management of Shanghai Smart City is top-down, mainly including various supervision platforms and responsibilities divided. However, while top-down managing, Bagan Dong Tian Wireless City also encouraged citizens to construct low-carbon cities. Only when citizens experience smart cities can they better understand the need to develop low-carbon cities and contribute their efforts to protect the ecological environment and reduce carbon emissions. Therefore, in future Chinese smart cities construction, we should pay more attention to public participation.
- Smart health projects are also the core of the future development of the smart city. It connects healthcare services and other facilities in cities through big data and mobile networks [76]. It can enhance the city's medical service capabilities and provide humanized and effective urban population services [77]. In addition, with the normalization of the COVID-19 pandemic, an efficient and convenient smart health system is important in operation and maintenance of the cities' management [78]. The case studies do not sort out the smart health projects, which should be considered and promoted in the future.

This paper is an attempt to compare smart cities in different regions. Although the ISO standard contains 19 indicators, data are calculated differently in the other areas. In addition, part of the data is confidential. At last, we exert our greatest efforts to summarize five key construction indicators of two cases for comparison. In the future, we can further investigate and analyze more aspects.

8. Conclusions

Currently, the booming smart city combines various urban systems and services with advanced information technology, promoting citizens' quality of life, optimizing urban management and services, and improving resource utilization efficiency. In particular, it provides a new development path for urban environmental governance. This study first compares the continuous development of the ecological, low-carbon, and innovative cities in Japan and China. Shanghai's measures in policymaking, transportation, energy development, resource recovery, and environmental protection are demonstrated and compared using ISO 371200. The results show that the Shanghai smart city needs to improve the urban environment and waste recycling. In addition, the Chinese smart city measures are always from the managers' perspective, enhancing collaborative feedback from urban citizens. And the cases should increase the smart health projects and establish a smart city post-evaluation system to achieve a "win–win" situation between economic and environmental.

Through the analysis of Kitakyushu and Shanghai smart city, the future Asian smart city construction should establish a smart platform for urban information, monitor operational data, set up centralized energy supple system to reduce energy loss, improve the citizens awareness of energy conservation, and enhance the degree of recycling of urban resources. The project policy should avoid establishing the cooperative feedback mechanism between managers and citizens from a single dimension perspective and balance the relationship between economic development and environmental protection, ultimately realizing the true capabilities of smart cities.

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