Journal of Civil Engineering and Urban Planning (2023)
Clausius Scientific Press, Canada

DOI: 10.23977/jceup.2023.051005
ISSN 2616-3969 Vol. 5 Num. 10

Modular Floating City: The Road to Future Development of Smart Cities

Jianqiu Wang[1], Dr. Anukul Tamprasirt[1,*]

[1]*International College of Digital Innovation, Chiangmai University, Chiangmai, Thailand*
[*]*Corresponding anthor*

Keywords: Modular Floating City, Smart Cities, Smart Transportation

Abstract: With the continuous development of science and technology, smart cities are becoming an important direction for future urban development. By utilizing advanced information and communication technologies, smart cities realize the intelligence of urban infrastructure, public services and management, thus enhancing the sustainable development of cities and the quality of life of residents. However, the traditional smart city model has some limitations, such as high construction cost and fixed infrastructure layout. Therefore, floating city, as an innovative form of smart city, has unique advantages and potentials. Floating city refers to a city model based on advanced mobile and wireless communication technologies that provides city functions and services to residents and users in a movable way. Compared with traditional fixed smart cities, floating cities have several advantages. First, floating cities are highly flexible and scalable. As its infrastructure and services can be moved and adjusted at any time, adapting to the needs of different regions. Second, floating cities can better meet the personalized needs of the people. Through mobile technology and smart devices, residents can enjoy more personalized services and conveniences to enhance their quality of life. In addition, floating cities can better respond to emergencies and disasters and provide flexible emergency relief and services. This paper explores the future development path of floating cities as smart cities by analyzing the current situation and trend of smart city development.

1. Introduction

With the acceleration of global urbanization and the continuous growth of population, cities are facing more and more challenges and pressures. Traditional urban planning and management methods can no longer meet the increasingly complex urban needs. Against this background, the concept of smart cities has emerged. Smart city realizes the intelligent management and optimization of all city functions through the use of advanced information and communication technologies, in order to enhance the sustainable development of the city and the quality of life of its residents. Floating cities, as an innovative form of smart cities, have the potential to solve problems in urban development[1].

2. Current status of smart city development

Table 1: Current status of smart city development

Smart Area	Data Collection Methods	Data Applications	Benefits
Smart Transportation	Traffic monitoring devices, cameras, vehicle sensors	Optimizing traffic management, improving traffic flow	Enhanced traffic efficiency, reduced congestion
Smart Environment	Environmental monitoring devices	Implementing environmental management measures, improving environmental quality	Enhanced urban environmental quality
Smart Energy	Smart meters, energy monitoring devices	Optimizing energy management, improving energy utilization efficiency	Increased energy utilization efficiency, reduced energy waste
Smart Facilities	Smart transportation systems, parking management systems	Providing convenient public services, optimizing facility	Improved quality of public services, enhanced resident quality of life
Smart Society	Census data, statistical data, social media platforms	Understanding resident needs and behaviors, formulating urban planning and policies	Providing city planning and policies that align with resident needs
Smart Healthcare	Medical institutions, health monitoring devices, mobile health applications	Personalized healthcare services, optimizing healthcare resources	Providing personalized healthcare services, optimizing allocation of healthcare resources

2.1 Intelligent Transportation

Traffic data in cities is being widely collected and analyzed. In China alone, the vehicle intelligence rate has reached 25% by 2022, and the coverage of intelligent transportation facilities is expanding. According to the Ministry of Transportation, by the end of 2022, more than 100,000 traffic monitoring devices have been installed nationwide, covering major road networks. In addition, a large number of cameras and vehicle sensors have been installed in cities for real-time monitoring of traffic conditions[2]. The traffic data collected by these intelligent transportation facilities include information on the number of vehicles, speed, congestion conditions, traffic accidents, and so on. These data are transmitted to traffic management centers through the network, and after analysis and processing, they can provide real-time traffic conditions and forecasts to help traffic management authorities make decisions and optimize traffic flow. For example, based on the analysis of traffic data, signal timing can be adjusted to optimize road capacity and vehicle traffic efficiency. In addition, the analysis of traffic data can help identify traffic bottlenecks and congestion points, and formulate reasonable traffic planning and improvement measures. The collection and analysis of these traffic data not only help to enhance traffic efficiency, but also improve traffic safety. By monitoring traffic accidents and violations in traffic data, traffic management authorities can take timely measures to improve traffic safety. In addition, the analysis of traffic data can also help predict the probability and

location of traffic accidents, provide traffic warnings in advance, and reduce the occurrence of traffic accidents[3], as shown in table 1.

2.2 Intelligent Environment

Environmental data in cities is also being widely collected and analyzed. For example, Chinese cities such as Beijing and Shanghai are equipped with a large number of environmental monitoring devices for real-time monitoring and assessment of environmental indicators such as air quality, noise and water quality in the city. According to the Ministry of Environmental Protection (MEP), by the end of 2022, Beijing has over 500 air quality monitoring stations covering major areas across the city[4]. Similarly, Shanghai is equipped with over 300 air quality monitoring stations covering major areas across the city. The data collected by these environmental monitoring devices include airborne particulate matter concentrations, levels of pollutants such as sulphur dioxide and nitrogen oxides, noise levels and water quality indicators. These data are transmitted to the center of the Environmental Protection Department through the network, and after analysis and processing, they can provide real-time environmental conditions and forecasts to help the environmental management department take appropriate environmental management measures. For example, when the air quality reaches a polluted level, an air quality warning can be issued in time to guide the public to take appropriate protective measures. The collection and analysis of these environmental data is crucial to improving the environmental quality of the city. By monitoring the content of pollutants and noise levels in environmental data, environmental management authorities can take timely measures to reduce pollutant emissions and noise pollution, and improve air quality and the living environment of residents. In addition, the analysis of environmental data can help identify pollution sources and the diffusion path of pollutants, and take targeted environmental protection measures[5,6].

2.3 Smart Energy

Energy data in cities is also being widely collected and analyzed. For example, Chinese cities such as Guangzhou and Shenzhen have begun to massively promote smart meters for real-time monitoring and recording of energy usage and consumption in different areas. According to the National Energy Administration (NEA), by the end of 2022, more than 120 million smart meters have been installed nationwide, and the penetration rate of smart meters has reached more than 60%. The data collected by these smart meters and energy monitoring devices include the usage and consumption of energy sources such as electricity, natural gas, and heat. These data are transmitted to the energy management center through the network, and after analysis and processing, they can provide real-time energy usage and forecasts to help the energy management department formulate reasonable energy planning and optimize the efficiency of energy usage. For example, based on the analysis of energy data, intelligent energy supply and demand management can be realized to avoid energy waste and unnecessary energy consumption. The collection and analysis of these energy data is essential for optimizing energy management and improving energy use efficiency. By monitoring energy consumption in energy data, energy management departments can take timely measures to reduce energy waste and unnecessary energy consumption and improve energy utilization efficiency. In addition, the analysis of energy data can help identify the causes of energy waste and the focus of consumption, and target energy-saving measures and renewable energy utilization strategies[7,8].

2.4 Smart Facilities

Data on public facilities in cities is also being widely collected and analyzed. For example, Chinese cities such as Beijing and Shanghai have built intelligent transportation systems and parking

management systems for providing convenient public services and optimizing the use of urban facilities. According to the Ministry of Transportation and Communications (MOTC), by the end of 2022, more than 100 ITSs have been constructed nationwide, covering the transportation networks of major cities. The data collected by these ITS and parking management systems include traffic flow, vehicle speed, parking space usage, and other public facility usage. These data are collected through devices such as sensors and cameras and transmitted over the network to traffic management centers and parking management centers, where they are analyzed and processed to provide real-time information on traffic conditions and parking spaces, which helps city administrations optimize traffic flow and the use of parking resources. For example, based on the analysis of traffic data, intelligent control of traffic signals and dynamic scheduling of parking spaces can be realized to reduce traffic congestion and parking difficulties. The collection and analysis of these public facility data is critical to providing better public services and improving the quality of life of residents[9]. By monitoring traffic flow and parking space usage in public facility data, city administrations can take timely measures to optimize traffic flow and parking resource utilization, improve traffic efficiency and reduce traffic congestion. In addition, analysis of public facility data can help identify traffic bottlenecks and parking demand, and target traffic management and parking planning measures.

2.5 Smart Society

Social data in cities is also being widely collected and analyzed. For example, in China, censuses, statistics and social media platforms can be used to collect and analyze the needs and behaviors of urban residents in order to develop sound urban planning and policies. According to the National Bureau of Statistics (NBS), a nationwide population census is conducted annually to obtain detailed demographic data and socioeconomic information. The collection of these social data includes population census, statistical data and social media platforms. Population census is the collection of basic information about the population and their residence through household registration and questionnaires. Statistical data, on the other hand, is collected and organized through government departments and agencies, including statistical indicators in various fields such as economy, education, health and employment. Social media platforms, on the other hand, obtain social data such as the needs and preferences of urban residents through user behavior and interaction. These social data, when analyzed and processed, can provide information about the needs and behaviors of urban residents, which can help urban planning departments formulate reasonable urban planning and policies. For example, through the analysis of census and statistical data, it is possible to understand the structure and distribution of the urban population, so as to decide on the location and scale of new housing and educational facilities. And through the analysis of data from social media platforms, it is possible to understand the evaluation and needs of residents for urban facilities, transportation, environment, etc., so as to improve the public services and quality of life in the city.

3. Several conjectures about smart cities

Wide application of artificial intelligence: with the continuous development of artificial intelligence technology, smart cities will apply artificial intelligence more widely in the future. Intelligent transportation systems, intelligent energy management, intelligent public safety and other fields will achieve more efficient management and services with the help of AI technology. For example, autonomous driving technology will be widely used in urban transportation, and smart grid will realize intelligent scheduling and optimization of energy.

Popularization of IoT: The future smart city will establish an extensive IoT infrastructure to realize the interconnection of various types of devices and sensors. Through IoT technology, various devices and facilities in the city can realize real-time data collection, transmission and analysis, thus realizing

intelligent monitoring, management and control. Smart transportation, smart environment, smart healthcare and other fields will be further developed.

Data-driven decision-making: smart cities will rely on big data and data analytics for decision-making and planning. By collecting and analyzing a large amount of urban data, smart cities can more accurately understand the operation of the city and the needs of its residents, so as to make more scientific and effective decisions and policies. Data-driven urban planning and management will become an important feature of smart cities.

Participatory urban governance: Smart cities will advocate a more open and participatory model of urban governance. Through digital tools and online platforms, residents can more easily participate in urban decision-making, offer opinions and give feedback on issues. Smart cities will establish digital channels for resident participation and facilitate interaction and cooperation between residents and government, businesses and other parties.

Green and sustainable development: Smart cities will pay more attention to environmental protection and sustainable development. Through intelligent energy management, waste treatment and water utilization, smart cities can minimize the waste of resources and environmental pollution. At the same time, smart cities will also advocate sustainable behaviors such as green travel and low-carbon living to improve the city's environmental quality and residents' quality of life.

4. The Future Destination of Smart City Development - Floating City

With the acceleration of global urbanization, the development of smart cities has become an important issue in many countries and regions. In the future development, floating city is attracting more and more attention as an interesting and potential concept. A floating city is a city built on water or in the air, which realizes sustainable urban development through advanced technology and sustainable resource management.

4.1 Effectively solving the problem of limited urban land

As an innovative urban development concept, floating city can effectively solve the problem of limited urban land. As the global population continues to grow and urbanization accelerates, urban land resources are becoming increasingly tight. Traditional modes of urban expansion often require large amounts of land. However, floating cities can be built on water or in the air without taking up large areas of land, providing a new solution for sustainable urban development. The construction of floating cities can utilize water or air space to expand urban space into areas that would otherwise be unavailable. For example, floating cities built on water can utilize water resources such as rivers, lakes, and oceans to make full use of underwater space and provide additional residential and commercial land. Floating cities built in the air, on the other hand, can utilize structures such as high-rise buildings and sky bridges to extend urban space upward and create more residential and commercial space. Floating cities can also be built with the flexibility to expand and adapt to changing demographic needs. Floating cities are more flexible and malleable than traditional cities. When population growth leads to increased demand, it can be met by expanding the size of the floating city or adding more floating buildings. Conversely, when the population decreases or demand falls, the size of the floating city can be reduced or the building structure can be adjusted to accommodate the change. This flexibility allows floating cities to better cope with the uncertainty of urban development and achieve sustainable development. In addition, the construction of floating cities can provide more ecological space and urban landscape value. Because they are built on water or in the air, floating cities can reserve large areas of land for green spaces, parks and nature reserves. These ecological spaces can not only provide recreational places for urban residents, but also increase the landscape value and ecological quality of the city. The construction of floating cities can also combine natural

and artificial landscapes to create a unique urban landscape and provide residents with a livable living environment.

4.2 Realize energy self-sufficiency

Floating city can use renewable energy to realize energy self-sufficiency, which is one of its unique energy advantages. By utilizing renewable energy sources such as solar and wind, floating cities can reduce their dependence on traditional energy sources, thereby reducing carbon emissions and environmental pollution. This energy transition not only helps protect the environment, but also improves the energy security and sustainability of cities. First, floating cities can utilize solar energy as their primary energy source. Since floating cities are built on water or in the air where there is plenty of sunlight, solar energy can be more fully utilized. By installing solar panels on buildings and facilities in floating cities, sunlight can be directly converted into electricity. These solar panels can provide the city with the power it needs, including electricity for residential use, power for commercial facilities, and the operation of public facilities. At the same time, excess solar power can be stored for use at night or on cloudy days, achieving a balanced and stable supply of energy. Secondly, floating cities can also develop special energy resources such as marine energy and airborne wind energy. Because they are built on water or in the air, floating cities can make better use of ocean energy and airborne wind energy. Ocean energy, including tidal energy, wave energy and ocean current energy, can be developed and utilized through appropriate equipment and technology. Floating cities can install tidal generator sets underwater to utilize tidal energy for power generation. At the same time, floating cities can utilize wave energy and ocean current energy to generate electricity and collect energy through equipment such as buoys and turbine generators. In addition, floating cities can utilize airborne wind energy to generate electricity, and achieve energy self-sufficiency by installing wind turbines to capture wind energy at high altitudes. By utilizing renewable energy sources, floating cities can achieve energy self-sufficiency and reduce dependence on traditional energy sources. This not only helps to reduce carbon emissions and environmental pollution, but also improves the energy security and sustainability of the city. Floating cities can also serve as testing grounds and demonstration projects for renewable energy technologies, promoting the innovation and application of renewable energy technologies. By continuously promoting the development of renewable energy, floating cities can provide sustainable energy solutions for future urban development.

4.3 Recycling of resources and environmental protection

Floating cities can also adopt advanced waste treatment and water treatment technologies to achieve resource recycling and environmental protection, which is another important aspect of their sustainable development. By introducing intelligent waste recycling systems and water treatment facilities, floating cities can minimize the generation of waste and the waste of water resources, and achieve sustainable resource utilization and environmental protection. First of all, floating cities can adopt advanced waste treatment technology to realize waste recycling. By establishing an intelligent waste classification and recycling system, floating cities can classify waste into different categories, such as recyclables, organics and other waste, and treat and recycle them accordingly. Recyclables can be recycled or recycling processed, for example, by recycling plastics to make new products, or making paper from waste paper. Organic matter can be composted and converted into organic fertilizer for agriculture or horticulture. Other waste can be processed using advanced waste treatment technologies such as incineration, gasification or landfill to minimize the impact on the environment. Secondly, floating cities can also introduce advanced water treatment technologies to realize the recycling of water resources. By establishing efficient water treatment facilities, floating cities can

treat and purify wastewater and convert it into reusable water resources. Advanced water treatment technologies, such as biofilters, reverse osmosis and ultraviolet disinfection, can effectively remove pollutants and hazardous substances from wastewater, improve water quality, and bring wastewater into compliance with reuse standards. The treated water can be used in areas such as landscape irrigation, industrial water or cooling water to reduce the demand for freshwater resources. In addition, floating cities can collect natural water sources such as rainwater and melted snow, purify and treat them for reuse, further improving the efficiency of water use. By adopting advanced waste treatment and water treatment technologies, floating cities can achieve recycling of waste and sustainable use of water resources, thus minimizing environmental pollution and waste of resources. This not only helps to protect the environment, but also improves the sustainable development of the city. Floating cities can serve as an innovation and demonstration platform for waste treatment and water treatment technologies, promoting the development and application of related technologies. By continuously promoting the advancement of waste treatment and water treatment technologies, floating cities can provide sustainable resource management and environmental protection solutions for future urban development.

4.4 Responding to natural disasters and climate change

Floating cities can also respond to the challenges of natural disasters and climate change, which is another important advantage in terms of sustainable development. Being built on water or in the air, floating cities are better able to withstand the threat of natural disasters such as flooding and sea level rise. In addition, floating cities can utilize advanced weather monitoring and early warning systems to predict and respond to extreme weather events in advance, in order to safeguard the safety and quality of life of residents. First of all, the buildings and infrastructure of floating cities are highly resistant to flooding. Being built on water or in the air, floating cities can better withstand flooding. Buildings in floating cities can have high flood resilience by using flood-resistant designs and materials. For example, buildings can be constructed with watertight structures to prevent floodwater intrusion. In addition, the infrastructure of a floating city, such as water supply systems, drainage systems and transportation systems, can be designed and improved accordingly to operate and cope under flood conditions. Secondly, floating cities can respond to the challenges posed by climate change such as sea level rise. With global warming, sea level rise is becoming a serious problem. Floating cities can be adapted to sea level rise through appropriate design and construction. For example, buildings in floating cities can be designed with adjustable height or buoyancy to adapt to changing sea levels. In addition, floating cities can utilize marine engineering facilities such as dykes and breakwaters to protect the city from the effects of ocean intrusion. In addition, floating cities can utilize advanced weather monitoring and warning systems to predict and respond to extreme weather events in advance. Floating cities can install meteorological monitoring equipment to monitor weather changes and meteorological parameters in real time. Through cooperation with meteorological departments and scientific research institutions, floating cities can obtain accurate weather forecasts and early warning information and take timely measures to protect the safety of residents. For example, when extreme weather such as typhoons or heavy rains are predicted, floating cities can ensure the safety and quality of life of residents through evacuation plans and emergency rescue measures. By responding to the challenges of natural disasters and climate change, floating cities can improve the resilience and adaptability of cities and ensure the safety and quality of life of their residents. Floating cities can also serve as an innovation and demonstration platform for disaster prevention and climate change adaptation technologies, promoting the development and application of related technologies. By continuously promoting the advancement of disaster prevention and mitigation and climate change adaptation technologies, floating cities can provide useful experiences

and lessons for future urban planning and construction.

5. Conclusions

Overall, floating cities have many potential advantages and innovations as a possibility for the future development of smart cities. However, the realization of floating cities still faces technical, economic, and social challenges and requires continuous research and cooperation to advance its development. Through continuous innovation and exploration, floating cities are expected to become a viable option for future smart city development, providing safer, more efficient and more livable urban environments.

References

[1] Izabela Jonek Kowalska & Radosław Wolniak (2023). Smart Cities in Poland:Towards sustainability and a better quality of life?. Taylor and Francis.
[2] Alok Kumar Mishra (2023). Smart Cities and the Poor: Towards an Agenda for Inclusive Urbanisation in India. Taylor and Francis.
[3] Kustu Tacettin & Taskin Alev. (2023). Deep learning and stereo vision based detection of post-earthquake fire geolocation for smart cities within the scope of disaster management: İstanbul case. International Journal of Disaster Risk Reduction.
[4] Zheng Yuntian, Li Zeyuan, Zeng Zhiwen, Zhang Shaobo & Liu Anfeng. (2023). CITE: A content based trust evaluation scheme for data collection with Internet of Everything. Information Sciences.
[5] Kumar Goyal Manish, Poonia Vikas & Jain Vijay. (2023). Three decadal urban drought variability risk assessment for Indian smart cities. Journal of Hydrology (PA).
[6] Yang Huiwu, Zhang Suogen, Zeng Jinsheng, Tang Shengcai & Xiong Shunbin. (2023). Future of sustainable renewable-based energy systems in smart city industry: Interruptible load scheduling perspective. Solar Energy.
[7] Tang Yanan, Qi Yong, Bai Tingting & Zhang Chi. (2023). Smart city construction and green technology innovation: evidence at China's city level. . Environmental science and pollution research international.
[8] Cifuentes-Faura Javier. (2023). Ukraine's post-war reconstruction: Building smart cities and governments through a sustainability-based reconstruction plan. Journal of Cleaner Production.
[9] Yaqoob Ibrar, Salah Khaled, Jayaraman Raja & Omar Mohammed. (2023). Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions. Internet of Things.