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Research Article

Smart environment practices in Kashiwa-No-Ha (Japan) smart city

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The smart city is a modernization effort that enables cities to use their resources more effectively and to provide better services to their residents. In this study, the smart practices of Kashiwanoha City, Japan, one of the best smart city examples in the world, were examined. The study showed that smart environment applications are designed to improve the quality of life of the citizens and ensure the sustainability of the city. The smart environment applications in Kashiwa-no-ha Smart City include smart mobility, smart technology, smart governance, smart economy, smart living, and smart environment based on transport, energy, and environment. The integration of blockchain technology is a potential solution to address the challenges of urbanisation in smart sustainable city development. The development of Kashiwa-no-ha Smart City is an example of how cities are linking their technological policies and development plans to achieve development while linking the objectives and dimensions of sustainable development to provide the best possible benefit from the available technologies. The most important factor behind Kashiwa-no-ha's success is the cooperation of the public and private sectors and universities. For successful smart city practices, it has been proposed to establish an independent organisation similar to the Urban Design Centre Kashiwanoha (UDCK) with a separate budget and decision-making power.

Keywords: city, urban management, urban design, environment, smart technologies

1 Introduction

In today's world, where technological developments continue unabated, the traces of technological transformation are evident in every aspect of our lives. Developing technology affects our communication tools, business processes, and cities and city administrations. Throughout history, cities have been important centres that have hosted production, innovation, and knowledge with their dynamic structures. As Baz (2019) points out, about 55% of the world's population lives in cities today, while about 80% of the total gross value added is produced in cities. Therefore, urbanisation and economic development are two inseparable processes.

Cities must be constantly updated themselves by incorporating the innovations brought about by technological transformation. Rapid advances in information and communication technologies offer new opportunities in many areas, from urban infrastructure to transportation systems, energy management, and environmental sustainability. At the point we have reached today, cities aiming to combine production, innovation, and technology are looking for rational solutions and applications to ensure sustainability and improve quality of life (Elvan, 2017). The concept of a "smart city" aims to make cities more efficient, sustainable, and liveable by using technological infrastructure and data analytics.

The technological transformation affects not only the physical infrastrutcture of cities but also the quality of life, service delivery, and sustainability. Energy sustainability is one of the most important and challenging issues in humanity's future urban development and is emphasized in the Sustainable Development Goals, particularly SDG 7 (Chen et al., 2022). The main reason for this is that cities with high energy consumption require more than 75% of the world's energy production and in turn account for 80% of greenhouse gas emissions (Lazaroiu & Roscia, 2012).

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1.1 Smart city concept

"Smart Urban" or "Smart City" is a modernization effort that enables cities to use their resources more effectively and provide better services to their residents. Rapid population growth, especially in big cities, brings along many problems. These problems negatively affect the economic and social life in cities and reduce the quality of life of city dwellers. At this point, the smart city approach has come to the forefront in the policy texts of countries and international organisations due to its potential to produce rational solutions to urban problems. This approach, which is based on the logic of self-management of urban infrastructures and networks, especially transportation and energy, without the need for human intervention, aims to significantly improve people's living standards.

There are various approaches in the literature and practice regarding the planning and monitoring of the process of transformation to smart cities. Among these approaches, Cohen's "Smart Cities Wheel (SCW)" methodology stands out. According to this approach, smart cities consist of 6 components: smart mobility, smart living, smart governance, smart environment, smart economy, and smart people (Elvan, 2017; Arroub et al., 2016).

In the view of the European Union (2011), the smart city concept supports the idea of environmental sustainability, as its main objective is the reduction of greenhouse gas emissions in urban areas using innovative technologies. The growing interest in the smart city concept and the need to solve urbanisation challenges lead to various private and public investments in technology development and deployment (Ahvenniemi et al., 2017). Therefore, there has been an increase in studies in the context of smart cities and smart environment applications in recent years. Searching on the applications of smart city and smart urbanism concepts around the world (Khatoun & Zeadally, 2016; Bıçakçı, 2014) point out that old urban plans are not long-term scalable (housing accessibility, sustainable development, transport systems, and growth) and have resource management problems; the concept of smart urbanism is not used effectively in the development of smart cities. In addition, it is seen that there is a strong focus on modern technologies and "smartness" in many applications and there are not enough indicators in the context of environmental sustainability (Ahvenniemi et al., 2017). It is suggested that the overall goal of smart cities is to improve sustainability with the help of technologies, therefore the term "smart sustainable cities" should be used instead of just "smart cities".

In order to create a truly smart city, heterogeneous data from different sources need to be appropriately provided, integrated, and shared. The scope of planning and operating models within a smart city should consist of five main intervention areas: production, storage, infrastructure, facilities, and transport (Zuccala and Verga, 2017; Calvillo et al., 2018). In this regard, future internet-based developments are particularly important, including digital infrastructures, data management systems, renewable energies, and cloud computing of a regional innovation in the Internet of things (Deakin & Reid, 2018; Jong et al., 2015). The concept and policies of smart cities promote smartness and technological solutions to make cities technologically smarter. Many studies show that advanced technologies, such as zero energy buildings (ZEB) (Kylili & Fokaides, 2015), have increased the extent of technology utilisation through their use in reducing greenhouse gas emissions through sustainable use and energy production.

Developments in smart cities are changing human-nature relations in many ways. Basic human needs, particularly water security, energy security, and food, depend significantly on the interactions between urban and environmental systems (Colding & Barthel, 2017; Garau & Pavan, 2018). By interpreting critical resources and their impact on the environment, it is possible to assess various aspects of urban quality of life. Sustainable resource utilisation can be achieved by considering the indicators in the Smart City Quality Indicator (ISUQ). For example, the use of systems such as online pressure and flow measurement devices, Automatic Meter Reading (AMR), Supervisory Control and Data Acquisition System (SCADA), etc. (Kanakoudis & Muhammetoğlu, 2014) can be listed as effective tools in reducing water losses and ensuring water efficiency.

1.2 Smart environment applications

The most effective solution for improving the quality of life in cities starts with recognizing and defining the environment. Elements of the natural environment not only contain smart city components but also define the city and add visual value. Therefore, as an indicator of the sustainable growth of urban fabric, the environment is the main factor in controlling the delicate balance between natural space and urban fabric.

The smart city concept is the effective use of Information and Communication Technologies (ICT) in the functioning of cities. The smart city concept and policies promote smartness and technological solutions to make cities technologically smarter. Many studies show that advanced technologies have increased the scope of technology use, but do not fully explain how the urban environment becomes smart in a sustainable way (Anguluri and Narayanan, 2017). In this context,

the European Commission has been promoting "smart city" models for large cities in terms of energy efficiency, renewable energy, and green infrastructure (Giffinger et al., 2007). The second most important component of smart city components is the concept of smart environment. The fact that urban activities are the main source of greenhouse gas emissions constitutes the driving force of climate change, which can create an effect that increases disaster risks (While and Whitehead, 2013). The smart environment approach offers effective solutions to these problems with the development of technology. With the help of technology, environmental conditions and quality of life can be taken into consideration with sustainable environmental design, energy, and resources can be managed more effectively with the smart use of technology, and thus adaptation to the changing urban environment can be achieved (Dash, 2016). In addition to reducing technology-based energy consumption and greenhouse gas emissions, it improves the economy of cities. Therefore, city managers and public and private sector actors should work together to design greener and more sustainable cities (Rezafar & Koramaz, 2014).

Vinod Kumar (2020) in his book Smart Environment in Smart Cities defines a smart environment as a green city that a) protects and effectively manages natural heritage, natural resources, and biodiversity, b) provides recreational opportunities, c) has an integrated system to manage water resources, water supply, wastewater, natural drainage, floods, and inundation, especially in the watersheds where it is located, given climate change, d) have an effective system for controlling air pollution and protecting clean air, especially in airsheds; e) have an efficient and effective system for disaster risk reduction, response, recovery, and management; f) have urban resilience against the impacts of climate change; g) can create a low-carbon environment by focusing on energy efficiency, renewable energy and the like. Accordingly, the main smart environment practices can be classified: Energy efficiency, transportation and smart transportation, waste management, water management, green spaces, and ecosystems.

Many smart city applications are based on general concepts that are not region-specific. Understanding the effects of climate change, which is one of the biggest environmental problems, and ensuring the resilience of cities to these effects, a holistic approach based on the advantages and disadvantages specific to the region, where smart environment elements will be applied, is needed. Examining a city planned from scratch according to a smart city vision can provide clearer insights into the future of urban development and can be a good starting point for new urban development and sustainability concepts. As such concepts have been around for some time in Asia, it is important to be guided by best practice examples in countries where the smart vision is still in its infancy.

Thus, the primary objective of the study is to examine the smart city practices that have been spreading around the world in recent years to focus on the "Smart Environment" and to examine the smart applications in the Kashiwa-no-ha city in Chiba region of Japan, which is shown as one of the best practices in the world in the context of smart city application. On the other hand, it is aimed to discuss the smart city approach within the framework of regional characteristics and to determine the smart environment applications in Kashiwa-no-ha city in terms of climate change, natural disasters, energy, and sustainability of this location-specific model.

2 Material and methods

The material of the study is Kashiwa-no-ha Smart City, which is a good example in Japan. Kashiwa-no-ha (柏の葉), meaning "Oak Leaf", is a new town settlement located in Chiba Prefecture of Japan, approximately 40 kilometres from the capital Tokyo (Figure 1).

Master plans, information brochures, and presentation slides prepared by on-site planning and development actors were used for analysis. Field observations, oral interviews, photographs, and literature on the subject were used as auxiliary materials.

Most of the smart city developments in Japan have focused on environmental and economic issues. The socially oriented dimension of the smart city does not play an important role in many smart city approaches in Japan; however, one of the features of Kashiwanoha goes against this trend by explicitly focusing on improving the well-being of residents (Trencher & Karvonen, 2019).

The smart city project is a greenfield urban development project (development started in 2005 and will be completed by 2030) in Kashiwa City (over 400,000 inhabitants) in Chiba Prefecture, located on the outskirts of the Tokyo Metropolitan Area. An innovative new city project has been created in collaboration between urban actors to develop a green space model city of sustainable and collaborative urban planning practice in the context of the smart city vision. The Kashiwa-no-ha area is home to the University of Tokyo, Chiba University, and national research institution campuses. The goal of the Kashiwa-no-ha International Campus Town Initiative (2014) is to build a city on a foundation that integrates with the environment, promotes long and healthy living, and fosters industrial innovation. This process is based on the Leadership in Energy and Environmental Design

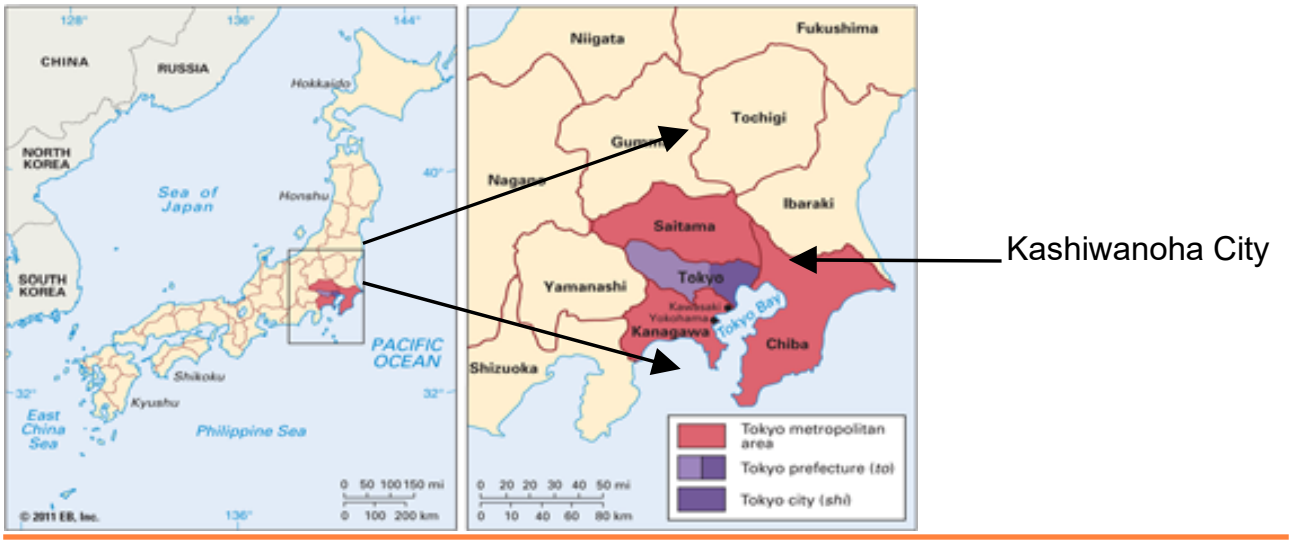


Figure 1 Location of Tokyo Metropolitan and surrounding prefectures/Kashiwanoha city
Source: Encyclopedia Britannica inc., 2023

for Neighborhood Development (LEED-ND), a green building certification system. It has a unique synergy with the objectives of Version 4 and was used as a framework to set qualitative and quantitative targets to guide and implement LEED ND decision-making processes.

The Kashiwa-no-ha International Campus City Initiative plan places a multi-use district called "Innovation Campus" around a large catchment pond on the north side of the station to promote R & D, commercial, and other non-residential uses. The plan also aims to develop the area extending to Chiba University's Kashiwa-no-ha Campus and the University of Tokyo's Kashiwa Campus II as a multi-purpose, compact central district, adding spaces for R & D, commerce, and public use to the existing advanced educational and research facilities, and a beautiful living environment. After the opening of the Tsukuba Express subway line connecting Tokyo and Tsukuba in northeastern Japan, the area surrounding Kashiwa-no-ha Station was primarily developed as a high-rise residential district. Subsequently, it was diversified to support broader economic and urban activities with offices, hotels, conference halls, and retail, and non-residential uses after the completion of the Gate Square area redevelopment in 2014, a development of residential and other commercial uses.

The methodology of the study was determined in line with the aims and objectives of the research. The research presents a case study to address the demand for future urban development models that promote the advancement of sustainable cities. In Asia and especially in Japan, smart city projects are much more established and developed than in European countries. In this context, the smart environment practices in the Kashiwa-no-ha smart city in Chiba Prefecture, Japan, which is shown as one of the best practices of smart city implementation in the world, are analysed in detail on site. In this context, a) Environmentally friendly urban planning and buildings b) Urban ecosystems and open and green space systems, c) Energy saving, d) Advanced air pollution monitoring systems, e) Solid waste management, f) Smart water management and drainage systems and other environmental issues are addressed.

2.1 Findings

2.1.1 Kashiwa-no-ha smart city organisational structure

Kashiwa-no-ha Smart City is one of the best examples of public, private, and university cooperation in the world. In this context, the Chiba Prefectural Government, Kashiwa Township Government, and NGOs representing the public sector; the University of Tokyo and Chiba University representing universities; Mitsui Fudosan (2014) and some other companies representing the private sector collaborated in the development of the smart city.

The Kashiwa-no-ha Smart City aims to create a new vision for cities of the future that coexist harmoniously with nature, promote the health and longevity of their inhabitants, and encourage the creation of new industries. In this context, three urban development concepts were formulated. The first concept is to create an environmentally friendly "Eco-Symbiotic City" to address climate change. The second concept is a new generation "Industrial Concept" to address low economic growth, focusing on promoting growth areas that have become a new source of vitality for Japan. The third concept is

the "Healthy and Longevity Concept" to address an over-aging society and is about people of all ages living in a healthy and safe environment.

For the Kashiwa-no-ha International Campus Town Initiative (2014), the plan was to create an "Innovation Campus" promoting R & D, commerce, and other non-residential uses. The plan also aimed to develop the area along the Kashiwa-no-ha Campus of Chiba University and the Kashiwa Campus of the University of Tokyo as a multi-purpose, compact central district. The aim was to make the Kashiwa-no-ha area more comfortable, healthier, and happier for people living and working thereby enabling more diverse participation in home and work life while encouraging everyone to take an active role. The Innovation Campus also aims to create neighbourhoods with distinct identities that can be used day and night, and to create quality places with active and living streets and tree-lined avenues and boulevards connecting public squares.

The Urban Design Centre Kashiwa-no-ha (UDCK) coordinated the implementation of the Kashiwa-no-ha Smart City. Established in November 2006, this centre is a collectively managed organisation by 8 constituents. The UDCK is the first urban design centre in Japan that includes all "actors" including universities, research institutes, government, residents, companies based in Kashiwa-no-ha, and companies interested in participating in new projects; it is a multidisciplinary centre that acts independently of public institutions in the context of urban development planning and has three mass stakeholders. These stakeholders are categorised as private sector, public sector and academic:

Public: Government, municipalities, prefecture and NPOs – responsible for public services necessary for the local community (Kashiwa City, Chiba Prefecture, Kashiwa Community-Building Public Corporation, General Incorporated).

Private: Residents and businesses that conduct economic activities – responsible for the enhancement of regional vitality and attractiveness (The Kashiwa Chamber of Commerce and Industry, Tanaka Region Hometown Council, Mitsui Fudosan Co., Ltd., Metropolitan Intercity Railway Company, TX Entrepreneur Partners).

Academic: Experts and education/research institutes like universities – responsible for pioneering activities based on professional/objective knowledge and technologies (The University of Tokyo, Chiba University, AIST [National Institute of Advanced Industrial Science and Technology] Kashiwa).

With the launch of the Kashiwa-no-ha Smart City, the coordination of this work has been taken over by the UDCK. UDCK has three functions:

1. A think tank function in the context of "research and proposal development" for smart city development; this function focuses on learning, research, and formulation of proposals for urban development.
2. A coordinating agency function in the context of "coordination and support" for development; this function is to serve as an intermediary linking key "players" and supporting sustainable actions by creating plans to translate policy into action, explore commercialization and coordinate actual implementation.
3. The function of being a source of information in the context of "information dissemination" to enable participation; this function will serve to promote understanding of urban development and invite participation and disseminate information widely about various initiatives through websites, print media, press releases, forums, and other communication and participation tools.

UDCK is a voluntary organisation jointly governed by a seven-member Board of Directors from the public, private, and academic sectors. Members are elected from among them for a "Steering committee" that decides on key management issues. The chair of the Steering Committee is also the chair of the Centre. The Centre's expenditures are shared among the participating institutions. For the projects carried out within the Centre, teams of an "Administrative structure" are established, consisting of elected members from the constituents as well as members of the "Cooperation bodies" (relevant public institutions and specialized agencies). These teams include members of the board of directors as well as representatives of the institutions contributing to the centre. For each team, a chairperson, a vice-chairperson, and a project manager are appointed, who together with other members carry out various projects at Kashiwa-no-ha.

2.1.2 Kashiwa-no-ha smart environment applications

In the context of smart environmental practices, Kashiwa-no-ha aims to create a futuristic city where people and the environment are in harmony by implementing next-generation transportation systems and green space programs to maintain safe lifelines, utilizing natural resources to save, create, and store energy. To achieve this, 8 visions and 27 sub-policies have been identified; creating a garden city with a symbiotic relationship with the environment, creating creative industrial areas, creating an international academic,

educational, and cultural space, creating a sustainable and low-carbon transportation system, designing high-quality urban space, implementing space management through public-private-academic partnerships, adopting a healthy lifestyle and creating an innovation space city (Kashiwa-no-ha International Campus City Initiative, 2014).

2.1.3 A city adapting to energy efficiency

2.1.3.1 Area energy management system (AEMS)

The Kashiwa-no-ha smart city optimizes energy use for the entire city. The Area Energy Management System (AEMS), which utilizes an independent power grid, plays a crucial role in this setup. It is designed to contribute to innovative smart grids through energy generation, energy saving, and energy storage. While traditional energy management is carried out at the level of individual facilities, the AEMS enables the efficient use, monitoring and control of local energy in a variety of ways. To do this, AEMS centrally manages the area's energy use, as well as solar power generation, storage batteries, electricity exchange equipment, and other elements, and estimates the power requirements of each facility. By sharing electricity across district boundaries, the system reduces CO_2 emissions and makes energy information visible.

Energy generation: Solar power plants, wind power generation, hot water sources, biogas energy production from food waste, exhaust heat generation, solar water heating.

Energy conservation: Reducing CO_2 emissions by monitoring each household's electricity, gas, and water consumption with HEMS (Homes Energy Management System), introducing LED lighting and other high-efficiency appliances, defining tasks to reduce energy consumption; ambient lighting, air conditioning, etc.

Energy storage: Electric car sharing also serves as an electricity storage (battery) system for the entire city. Large-scale electricity storage (battery) systems and heat storage devices reduce air conditioning (Figure 2) power load during energy-intensive periods.

2.1.3.2 Smart applications centre (the smart energy system in case of disaster)

The role of this centre is to oversee energy operations for the region and manage energy during disasters. By providing a stable source of renewable energy through the combination of solar power generation and storage batteries, in the event of a major power outage, AEMS systematically switches energy sources across the entire city to protect lifeline facilities so that daily life can continue. The centre monitors electricity use in residences, commercial facilities, offices, and other locations and provides information to help people living and working in the area use energy efficiently (Figure 2). A system that can effectively manage energy during disasters has been established. Security is ensured by utilizing renewable energy and batteries. This installation ensures the continuity of business and daily life. In the event of a power outage, it can meet 60% of the Gate Square area's normal power requirements and maintain supply for three days. It can also power emergency elevators, lights, and common areas in residential buildings. Water can be supplied by groundwater pumps.

2.1.4 A city that realizes energy-saving lifestyles

2.1.4.1 Home energy management system

Home energy management systems (HEMS) display energy consumption so that residents are more aware of their power usage and the system promotes environmentally friendly lifestyles. Personal computers, smartphones, and other devices emit carbon dioxide



Figure 2 Kashiwanoha Smart Applications Centre and Lithium-Ion Storage Battery System
Source: HITACHI, 2017

(CO_2) emissions from residential buildings. HEMS uses artificial intelligence for purposes such as recommending energy use and ensuring the effectiveness of energy-saving approaches. HEMS also helps residents to use less power in emergencies. The system allows residents to control lighting and air conditioning settings from outside the dwelling.

2.1.5 Carbon reduction roadmap

To improve living comfort and reduce CO_2 emissions, a roadmap has been set out that creates a long-term vision for Kashiwa-no-ha. Considering the Kashiwa City Global Warming Countermeasures Plan and discussions on the international framework of the Post-Kyoto Protocol, the goal is to reduce the carbon footprint by reducing emissions by 60% by 2030. The first policy is to create and protect an ecological axis to realize an environmentally friendly city that can sustain the rich natural environment that has been cultivated for generations in the local area by protecting the surrounding water systems; protecting topography, green spaces, and agricultural land as important resources; and creating and strengthening a green network that connects them. The strategy developed to achieve this is as follows:

1. develop an "urban space framework" that includes buildings, roads and vacant lots;
2. form a "creative environment" network in which green campuses can harmonize with the city;
3. define a strategy based on the three principles for forming spaces of urban activity that foster cutting-edge knowledge, industries and culture and develop high-quality space designs.

The second policy was to combine the most advanced environmental technologies with smaller environmental burdens, providing a highly sustainable and environmentally friendly urban form with a 35% CO_2 reduction compared to conventional land development, and to popularize this urban model as the "Kashiwa model". A comprehensive policy has been developed to reduce transportation-related CO_2 emissions by raising residents' awareness, introducing environmentally friendly vehicles such as electric cars, and structuring sharing and park-and-ride systems that control automobile access.

2.1.6 Sustainable design

The sustainable design uses natural heat and air, reducing dependence on electricity and other artificial energy sources. Two of Gate Square's buildings incorporate Japan's world-renowned green building technology. By combining sustainable design and AEMS for each building at Gate Square, CO_2 emissions from residential buildings have been reduced by around 40% and emissions from shops and offices by around 50%.

Green spaces have also played an important role in the context of sustainable design. Due to their important role in mitigating the effects of the urban heat island and significantly reducing the energy consumption of buildings, various types of green spaces have been implemented. These include new and innovative practices such as tree-lined streets and boulevards, rooftop gardens, and facade greening (biophilic design) (Figure 3). Outdoor metering equipment measures the outdoor environment of the entire city, such as temperature and humidity, to provide services for residents, such as facility outdoor management, zoning planning, and measures to combat hot summers in urban development.



Figure 3 Vertical Garden, biophilic applications and outdoor sensor; Lalaport Building
Source: Original, 2019

2.1.7 A city that utilizes renewable and unused energy sources

Kashiwanoha utilizes solar panels, wind power equipment, well and rainwater, and other renewable energy sources. It aims to reduce carbon emissions by utilizing waste biogas, exhaust heat from cogeneration systems, and other unused energy sources (Figure 4).

2.1.8 Chiba University plant factory

Plant factories use advanced technology to ensure food sustainability. The plant in Kashiwanoha, owned by Chiba University, is the largest of its kind in Japan, using natural and artificial light in high-throughput production experiments. Mitsui Fudosan (2014) has collaborated with the university's Mirai Agribusiness start-up project, contributing to its commercialization (Figure 5). In collaboration with the Chiba University plant factory, a new type of urban agriculture is being developed through the distribution of products within the region and civic-based commercialization of the plant factory.

In the areas around Kashiwa-Tanaka station, "the development of a rural city coexisting with urban agriculture" was targeted, and an urban development centre "Environmental Products Market" was established in the station park. By supporting the management of farms that provide agricultural experience and organizing agriculture-themed events, an attempt was made to create an urban environment that includes the original landscapes of agricultural settlements.

2.1.9 Aqua terrace

The drainage basin in the centre of the new development area on the south side of Campus Station has been reinterpreted as a waterside open space that encourages socialization for residents, creating water-friendly



Figure 5 Chiba University college of agriculture facilities
Source: Mitsui Fudosan, 2014

spaces for events and a variety of areas for relaxation (Figure 6). The central common area of Aqua Terrace also incorporates rainwater management. This has added value to the area both ecologically and economically and socially. Maintenance and management responsibilities are shared between the city of Kashiwa and local organisations.

2.1.10 Other projects

Some other projects have also been implemented in Kashiwa-no-ha in the context of smart environmental practices. Some of these are Chiba University Kashowanoha College Link Program, Kashiwanoha eco-City Promotion Council, Town Planning Embracing Agriculture, Kashiwanoha Honey Club, Kashiwanoha Eco-Design Tour and Kashiwanoha Eco club.



Figure 4 Solar panels and wind energy devices
Source: Mitsui Fudosan, 2014



Figure 6 Aqua terrace
Source: Original, 2019

3 Results and discussion

Kashiwa-no-ha Smart City is one of the most successful examples of implementation in Japan. It has been observed that the most important factor behind this success is the cooperation between the public, private sector, and universities. It has been observed that the Kashiwa-no-ha Urban Design Centre (UDCK), an independent organisation formed by a total of 7 institutions and organisations belonging to these three segments, is a successful model that coordinates all studies on smart cities and smart environment applications.

The work in Kashiwa-no-ha was found to be more detailed. In addition to general energy management, more detailed approaches such as home energy management systems and disaster energy management systems were developed. Because disasters such as earthquakes and floods are becoming more frequent all over the world, it would be useful to develop energy management systems in case of disasters in areas with high disaster risk.

Sustainable design, another practice initiated in Kashiwa-no-ha, reduces dependence on electricity and other artificial energy sources by using natural heat and air. In this context, green building designs as well as urban green spaces have played an important role. Due to their important role in mitigating the effects of the urban heat island and significantly reducing the energy consumption of buildings, various green space practices have been implemented in Kashiwanoha. These include new and innovative practices such as tree-lined streets and boulevards, rooftop gardens and facade greening (biophilic design). Food security is an issue for all countries today. Kashiwanoha uses advanced technology to ensure food sustainability. In collaboration with the Faculty of Horticulture at Chiba University, high-yielding, high-tech agricultural practices are being implemented. Private companies also provide financial support for this initiative. For studies to be carried out in the context of smart cities in the world, it is recommended to establish an organisation that will undertake similar functions to the Kashiwanoha Urban Design Centre (UDCK), with a separate budget and independent in decision-making processes.

4 Conclusions

In conclusion, the success of Kashiwa-no-ha Smart City is a result of the collaboration between the public, private sector, and universities. The Kashiwa-no-ha Urban Design Centre (UDCK) serves as a successful model for coordinating studies on smart cities and smart environment applications. The implementation of more detailed approaches to energy management, disaster management, sustainable design, and food security has significantly reduced the energy consumption of buildings, mitigated the effects of the urban heat island, and ensured food sustainability. The establishment of similar organisations in other cities could facilitate collaboration and lead to the development of more sustainable practices.

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