Global Perspective for Data-Leveraged Smart City Initiatives

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Abstract

This paper gives an outlook of recent smart city activities in Europe and North America which leverage interchange and utilization of cross-sector data. In these regions, cities are now focused on achieving digital transformation of the city management after experiencing many challenges in the earlier smart city efforts. And now the goal for the smart city has become to build a more sustainable and citizen-centric community via cross-cutting, problem-solving, and flexible approach. Such an innovation agenda calls for an open and agile nature for the data exchange platform and an EU-originated open source software called FIWARE, which is rapidly gaining its visibility as the de-facto standard smart city IoT platform, is highlighted. Furthermore, some important clues in achieving digitalization of cities, including non-technical aspects, are also discussed.

Keywords
digital smart city, data utilization, sustainable city management, digital innovations, FIWARE, startup support, innovation hub, living lab

1. Introduction

While the world population is continuing to grow, the population in urban areas is increasing much more rapidly and, by the year 2050, two thirds of the world population is predicted to live in urban areas. This trend has become the source of various social issues, including delays in infrastructures preparations, widening gaps in life expectancy levels and insufficiency of resources (foods, water, energy, rare metals, etc.). On the other hand, in the regions where the industrial development has matured, such as in Europe and Japan, another set of issues are emerging that accompany the increase in the aging population and the aging of urban infrastructures. Aiming at solving these issues by 2030, the United Nations has defined 17 goals and 169 targets to be comprehensively achieved by 2030 and has compiled them into the Sustainable Development Goals (SDGs). The SDGs were unanimously adopted at the 2015 General Assembly by the 193 member states. Countries in the leading position have recently taken the approach of achieving the targets via a digital revolution and the projects of advanced smart cities are attracting attention because of the possibility that they will contribute substantially to sustainable city management.

2. Worldwide Expansion of Digital Smart Cities

The projects associated with the smart city were begun in Europe and are currently being expanded worldwide (**Fig. 1**).

Smart city initiatives in their initial period have been focused on enhancing the efficiency of specific service domains such as for power supply or traffic infrastructures. However, since the problems of cities affect each other across the domains, a more holistic approach is necessary in order to create a sustainable city. Also, in the initial period, smart city projects tended to focus on introducing new technologies by working with global technology providers. Consequently, the outcome of those projects were seriously questioned as to whether they really improved citizen's lives. There is also the issue that many projects are still in the pilot stage. Even when a smart city in an early stage is developed via government funding, it cannot be expanded unless a more sustainable financial mechanism is established

Fig. 1 The Major Smart City Projects = Worldwide (★: Projects participated by NEC).

that assures continuous operation.

The use of recently emerging digital technologies such as AI and IoT is currently raising great expectations. It is however required to convert the approach to smart city implementation into a problem-solving type approach, instead of simply prioritizing the use of new technologies. We must also try to maintain financial sustainability for the various stakeholders.

Based on the recognition of issues as described above attempts to convert smart city projects to next-generation ones are now beginning to emerge.

In Europe, the European Commission has defined the high-level strategy of "Digital Single Market (DSM)". And as the related agenda, initiatives such as Digitizing European Industry and the e-Government Action Plan were established in 2016. In this way, cross-cutting data utilization is now making steady progress as seen, for instance as the consolidated Open Data Portal that gathers the open data of member countries.

In the United States, the Global City Teams Challenge (GCTC) was started in 2014. This is a program under the leadership of the National Institute of Standards and Technology (NIST) that aims at deploying IoT technologies to smart cities. Based on cross-cutting linkages of various fields including those for traffic management, energy, and health, the local governments, academic institutions, enterprises and NPOs are organizing teams called action clusters to solve these issues. This program also attracts participants from countries other than the United States, including Japan.

In the UK, the Smart City Framework (SCF) was issued as a guide to assist city leaders in their efforts for achieving innovations that can overcome social issues. The British Standards Institution (BSI) has formulated it as the Publicly Available Specification (PAS-181: 2014)[1] in which an integrated operation model is defined, aiming at breaking away from the "silo mentality" and offering services based on citizen-centric designs (**Fig. 2**).

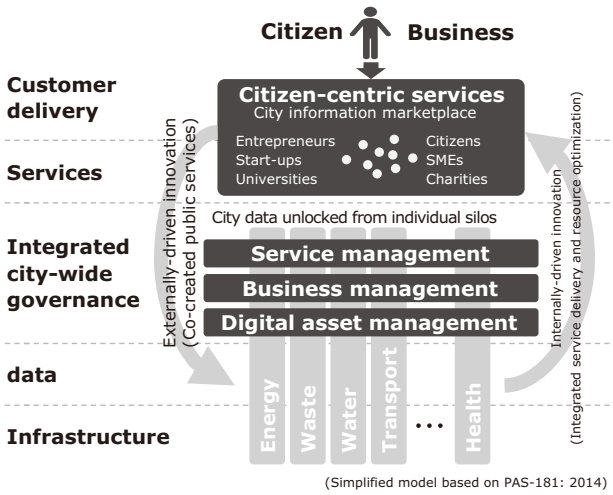

Fig. 2 New integrated operation model for smart city.

In the present paper, we refer to the next-generation approach as the digital smart city. The objective of this approach is the digital innovation of cities by solving issues of the smart cities emerging in the initial period as described below (**Fig. 3**).

The first step is to transform the approach into the problem-solving type approach without presupposing specific technologies and to prioritize cross-cutting data utilization. Open data allows the administrative information of various fields to be used and the application of IoT combines real-world data so that data obtained from diversified sources can be applied collaboratively.

The services to be provided in the next step presuppose evolution brought about by innovations. The standardized Application Programming Interface (API) is

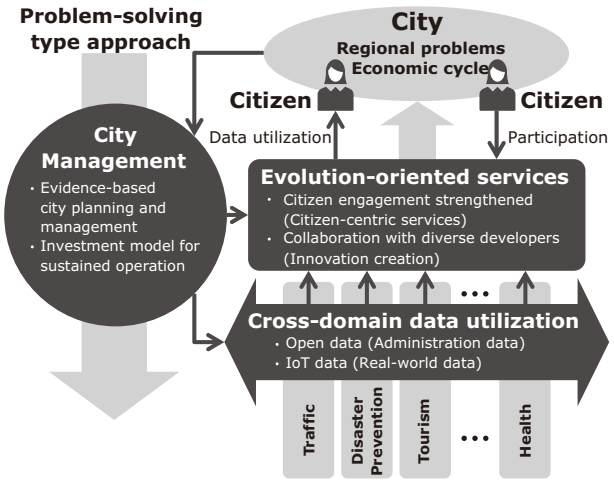

Fig. 3 Requirements for the digital smart city.

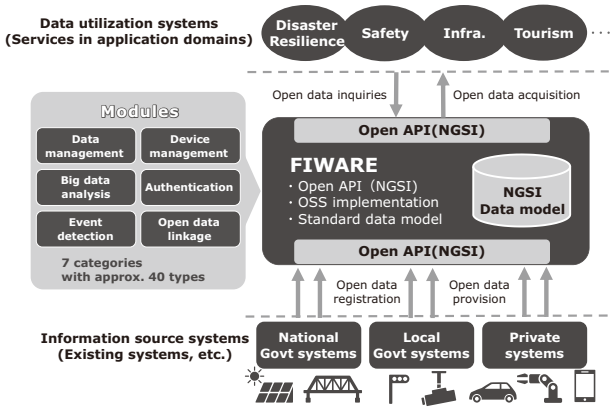

Fig. 4 Features of FIWARE.

open so that the various developers can participate. The data utilization systems that become the contact points with citizens are designed as citizen-centric city management design (design thinking approach) in order to encourage the engagement of citizen groups.

Meanwhile, the establishment of monetization mechanism is necessary in order to carry out sustainable operations under limited financial investment. The objective is to develop the investment and economic growth models and scale them in a sustainable manner. By implementing the capability of assessing the outcomes of projects based on measured data, the evidence-based city management may be implemented.

Composite efforts as described above may not only solve problems in individual fields but may also promote the creation overall of new social values. Innovations for flexibly dealing with various environmental changes lead to the birth of new industries, and the resulting economic growth will make it possible to implement a sustainable city.

3. FIWARE as the Data Interchange Platform

In Europe known as an advanced region of smart cities, the Data utilization platform FIWARE has been developed starting from 2011 and has been financed under the next-generation Future Internet-Public-Private Partnership (FI-PPP) program. NEC has been participating in this program from the initial phase.

The core function of FIWARE is the "context information management" that provides application systems with various IoT data at desired timings. One of its main features is that it implements this function as the open source software (OSS) of an API, conforming to the international standard (NGSI-9/10). The nature of its open architecture enables extension of the systems without relying on a single ICT vendor. In addition, the modular structure enables quick startup by freely combining the modules required for each city. The developed modules can be replicated and reused in another city, so that flexibility is very high.

When FIWARE is used as the core method for connecting various information source systems and application systems, it will be possible to utilize data efficiently by means of the cross-cutting approach (**Fig. 4**).

In 2016, the FIWARE Foundation was established as a non-profit organization for promotion under private leadership. It holds a FIWARE Summit series as the place of exchange between stakeholders: including developers, entrepreneurs and governmental officials. It also activates promotion activities by organizing a business-focused ecosystem as described below.

The foundation works together to align the reference architectures with smart city consortia such as the OASC (Open & Agile Smart City) and TM Forum. The TM Forum is the association that issued the City as a Platform Manifesto in 2017 and defined ten common principles driving smart city achievements. These principles include the need to be grounded in open architectures and to have the support of goal 11 of the SDGs (Making cities and human settlements inclusive, safe, resilient and sustainable).

The foundation is also endeavoring to disseminate FIWARE by supporting the acceleration of start-up enterprises as well as by enhancing collaborations with investment institutions while offering technical support.

Furthermore, under the collaboration with standardization organizations such as the International Telecommunication Union (ITU) and European Telecommunications Standards Institute (ETSI), harmonization of API specifications is underway. These efforts are making the

FIWARE the de-facto standard in Europe. As of 2018, FIWARE has already been adopted by more than 115 cities including some from outside Europe.

With the consideration that the endeavors of the FIWARE community as described above are indispensable also for Japan to achieve its Society 5.0 policy, NEC became the first Japanese enterprise member of the highest-class (Platinum) of the FIWARE Foundation in March 2017. Acting as a member of the Board of Directors (BoD) and Technical Steering Committee (TSC), NEC is leading the promotion of the enhancement and the extension of the functions of FIWARE.

4. Mechanisms for Promoting Digitalization

4.1 Cases of frontrunner smart cities

In reality, to simply introduce digital technologies cannot alone advance digital innovation. Smart cities need to implement mechanisms that can promote digital innovation.

In Amsterdam (Netherlands), the Amsterdam Smart City (ASC) was established as the government-private investment-based consortium for promoting the creation of an intelligent city. In 2014, the municipality installed the Chief Technology Officer (CTO). With the ASC occupying the core position, more than 70 enterprises and organizations are gathered to advance digital innovations by respecting the bottom-up approach by involving the citizenry. At the same time as the ASC assumes leadership in start-up support activities, the municipality runs a data lab and implements more than 200 projects. After a year or two, when actual results are confirmed, the target areas are to be expanded.

Helsinki (Finland) is improving the start-up support by aiming at transforming the city into an innovative hub. The municipality opened the Helsinki Region Infoshare (HRI) in 2011 to enable free use of open data in a wide range of categories from traffic to buildings, economy, taxes, cultural and health matters. The Helsinki Region Transport (HSL) that was organized in 2010 by several local governments including the Helsinki municipality supports startup enterprises by providing open data and open API. Several enterprises utilize the open data to develop services such as Mobility as a Service (MaaS) including route guidance, and more than 30 services have already been registered.

The characteristics commonly observed in cities such as the above are; 1) the high-level goals that each city should aim for are defined explicitly and shared by crossing the barriers of efficiency improvement per department, and; 2) there exists an organization that can facilitate the various stakeholders to stimulate the inception of innovations regionally, even at the technological level while aligning the direction to the mayoral level goals as detailed above. In addition the FIWARE Foundation installs regional city co-creation centers called iHubs or Innovation Hubs for use as places of exchange between stakeholders; including regional enterprises, universities, public institutions and entrepreneurs. An example of iHub in Malaga (Spain) provides an environment for app development using various in-city data accumulated on the FIWARE and uses a shared office for the guidance of business models to prepare startups and arrange exhibitions to demonstrate the developed products.

The living lab is one of the active value verification mechanisms of the IoT era that is attracting attention as the place of verification for the validity of solutions. The most well-known living labs include the DOLL[2)] and ENoLL[3)]. The DOLL (Denmark) is a place for encounters and experience of the developers and purchasers of smart city solutions. Three laboratories including the Living Lab (place of experience), Quality Lab (testing environment) and Virtual Lab (virtual development environment) are organized there. ENoLL or the European Network of Living Labs is an international association of living laboratories worldwide, and particularly in Europe. After starting up in 2006, it began the concept of the "open ecosystem" that enables mutual benchmarking between participants by providing experiment facilities and best practice information exchange opportunities.

4.2 Common points in digital technology promotion

Based on the projects outlined above, this section enumerates the points commonly required for the promotion of digitalization. To begin with, declaration of the vision aimed at by each city in a written form and strong leadership of the chief executive are the minimum conditions. But this is not enough to arouse the courage of challenging new concepts in the field or for changing the procedures that have been inherited with the "silo mentality". Therefore, advanced smart cities are adopting the four functions of: facilitation, startup support, innovation hub and living lab.

Facilitation refers to a post or organization that leads the cross-cutting smart city implementation, including data strategy, in place of the chief executive. This post may be called the CTO or CDO (Chief Digital Officer) who should assume responsibility for what is achieved. Verifications of hypotheses based on data are repeated from the policy candidate phase by setting the Key Performance Indicators (KPIs). What is important is that the appropriate municipal official continuously oversees

the work as the staff commander, in place of relying on outsider control.

The startup support is to create an environment for fostering entrepreneurs who can function as the motive force for promotion of the regional economy. This support includes training programs for the utilization and monetization of data, introduction of mentors and network development.

The innovation hub is the place of exchange for driving bottom-up innovations. It changes the urban services from those exclusively belonging to the administration and builds new local business ecosystems. Exchange of ideas of multiple stakeholders including the administration, citizens, universities, enterprises and NPOs aims at the creation of services by using the design thinking approach.

The living laboratory provides the place for verification experiments to enable the initial startup of the new services. It provides actual environments for testing the IoT services, partitioning them by period and area. This makes it possible for an introductory start of open and agile developments.

The leading smart cities combine mechanisms as described above to tackle digital innovations targeting sustainable, citizen-centric city managements.

5. Conclusion

The perspective for development of digital smart cities worldwide is given. The trends are recently shifting from the enhancement of the smartness of individual fields to smart cities based on cross-sectional data utilization. Although many projects are still at the experiment verification stage, common points required for advanced innovations are now taking on a clear shape.

In Japan, the national government has started to take the leadership in promotion of data utilization aiming at the implementation of Society 5.0. We aim to avoid these efforts from becoming sporadic and to enable sustained innovation based on each region's own leadership. We also anticipate that the approaches as introduced above that are ongoing worldwide, will offer a worthy reference.

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