# People-Centric City Enabled by Digital Platforms

Rapid urbanization is leading to a variety of societal problems, including rising traffic congestion, air pollution, and energy consumption. Hitachi is using consumers' (residents') values as a basis for looking at the characteristics of cities, collecting and analyzing data on residents and making use of data to drive improvements in city planning and operation with the objective of creating a "People-Centric City." This article references case studies of work by Hitachi on city planning and operation, both in Japan and overseas, to present examples of how the core technologies that support data-driven cities are being put in place. It also describes the data infrastructure underpinning people-centric urban development.

**Akiko Sato**
**Shigeyuki Tani, Ph.D.**
**Koji Sasaki, Ph.D.**
**Wujuan Lin, Ph.D.**
**Jun Furuya**
**Chiaki Hirai, Ph.D.**

## 1. Introduction

Cities today cover more of the planet than ever before, with an increasing number of people living in urban areas. According to statistics from the United Nations, 55% of the world's population lived in cities in 2018, a number that is expected to rise to 68% by 2050[(1)]. This rapid urbanization is bringing new challenges not only in housing, transportation, energy, and the environment, but also in employment, health and education.

In Japan, urban concentration into a few big cities and overall depopulation are progressing simultaneously, causing serious depopulation in local cities. A large fall in population puts local services operated by both the private and public sectors at risk due to shrinking demand and income, and as a consequence, makes life more difficult for the people who still live there.

The United Nations' Sustainable Development Goals (SDGs) recognize the need to "make cities inclusive, safe, resilient, and sustainable" as a key global-issue to be addressed. To achieve the global goal will require addressing the problems caused both by overpopulation as well as by depopulation.

Hitachi is developing technology and has embarked on initiatives to put it in place at different locations around the world in order to achieve urban development that is sustainable in both these senses. One example is the establishment of the Hitachi-UTokyo Laboratory with the University of Tokyo and the launch of the Habitat Innovation Project in 2016[(2)]. This is a joint research project aimed at achieving the

principles expressed in the government's Society 5.0 plan (human-centered and data-driven cities) through an industry-academia collaboration.

The creation of data-driven cities is not something that will come about through technology alone. Among the other requirements are public awareness of data governance and privacy protection. As exemplified by Barcelona's work on the participatory smart city and the debate in Toronto about ownership of residents' data, collaborative creation both with residents and the many other stakeholders will be essential to the creation of people-centric cities.

The next section explains what Hitachi means by "people-centric" and "data-driven cities." Subsequent sections reference case studies of work on city planning and operation, both in Japan and overseas, to present examples of how the core technologies that support data-driven cities are being put in place. The final section looks at what sort of public understanding and data infrastructure are needed for participatory urban development.

## 2. Building People-Centric Cities through Data

Cities provide a diverse range of services, encompassing mobility, education, health, entertainment, and public security. The objectives of these services are achieved by a combination of different means.

Looking at the problem of traffic congestion, for example, this involves more than just train and bus services. Enhancing urban safety may prompt people to walk in the neighborhood and reduce vehicle use, or investment in road stormwater infrastructure may create smooth traffic flow by preventing flooding. The problem, then, is how to combine a variety of measures to address various different objectives. In other words, a city can be thought of as a multiple-objective combinatorial optimization problem.

These multiple objectives will include some that are in conflict. And the available resources (budgets and human resources) are dwindling in the face of service demand in both densely populated cities and those with declining populations. Residents are to choose for themselves what sort of city they want to live in and how to go about achieving it. Modern cities have always sought to provide better environments for people. The renewed emphasis on a "people-centric" approach will require further effort to enable residents to take control and participate.

It is data-driven cities that make possible this vision of being "people-centric." If residents are to participate, it is essential that the city's existing circumstances be correctly understood. This is underpinned by using the Internet of Things (IoT) to collect data and make it available. Solving a combinatorial optimization problem requires advanced mathematical techniques for data analysis and simulation. A high level of automation is also needed to implement measures with fewer resources, an area where robots and artificial intelligences (AIs) able to learn from data have a part to play.

While technology brings convenience, it is the consent and participation of residents that lies at the heart of decision-making on how technology is to be used. This is what Hitachi means by Society 5.0 being "people-centric."

## 3. Example of Participatory Urban Development (Matsuyama City)

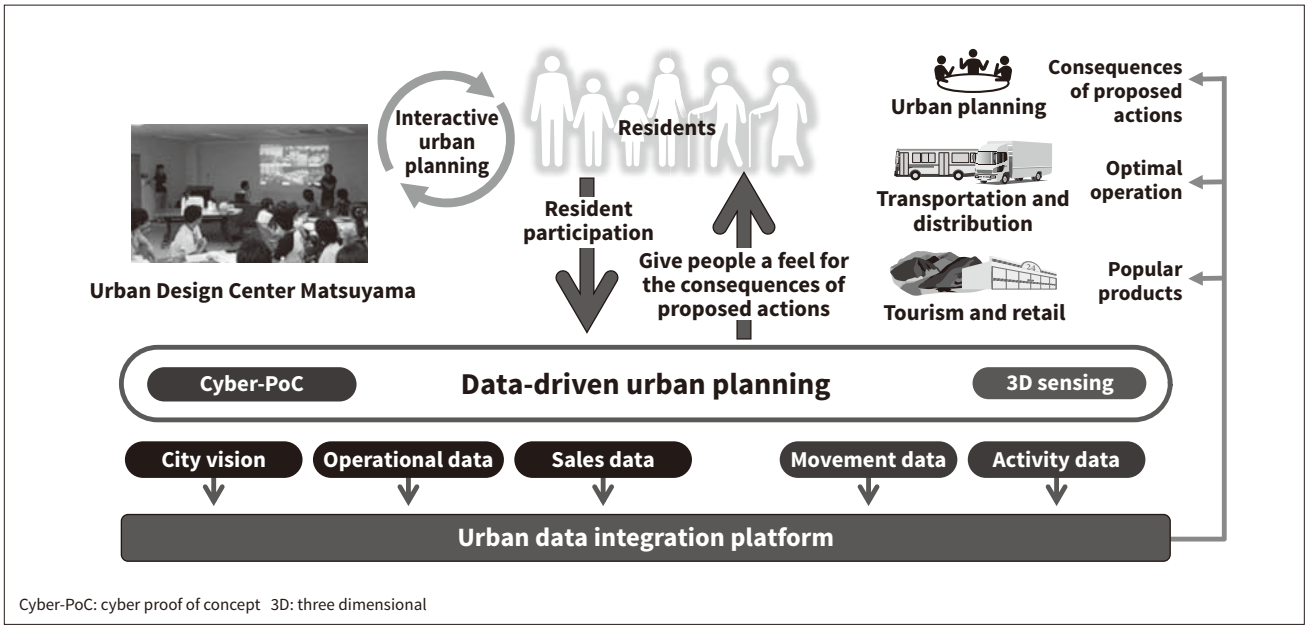
One of the activities that Hitachi-UTokyo Laboratory is engaged in as part of the Habitat Innovation Project is a demonstration project for data-driven urban planning using digital technology that is taking place in Matsuyama City in Ehime Prefecture (see **Figure 1**).

### 3. 1
### What Matsuyama City Wants from Urban Development

Matsuyama City has since 2012 been working on an urban development project that aims to create a pedestrian-friendly city with a mobility design that encompasses lifestyles from child care to old age. This has involved establishing pedestrian spaces in the Matsuyama Ropeway Shopping Street and the Hanazono district around Matsuyama City Station, the aim being to provide residents with a convenient and healthy lifestyle while also encouraging tourists visiting Dogo to get around on foot. Example initiatives included demolishing the old arcade in Hanazono and turning roads into pedestrian spaces.

**Figure 1 — Data-driven Urban Planning**

Consensus-building in urban development is supported by using the measurement and simulation of things like pedestrian behavior as a basis for predicting the consequences of proposed actions. Data visualization techniques suitable for non-experts are also used.




Cyber-PoC: cyber proof of concept 3D: three dimensional

The Urban Design Center Matsuyama (UDCM) has played a central role in this work. They have engaged in ongoing consultation with residents at workshops and elsewhere as well as drawing on the expertise of the University of Tokyo to conduct traffic volume surveys and predict how the changes would affect future traffic flows, using this as a basis for reaching a consensus with residents and landowners[3].

### 3. 2
### Data-driven Urban Planning

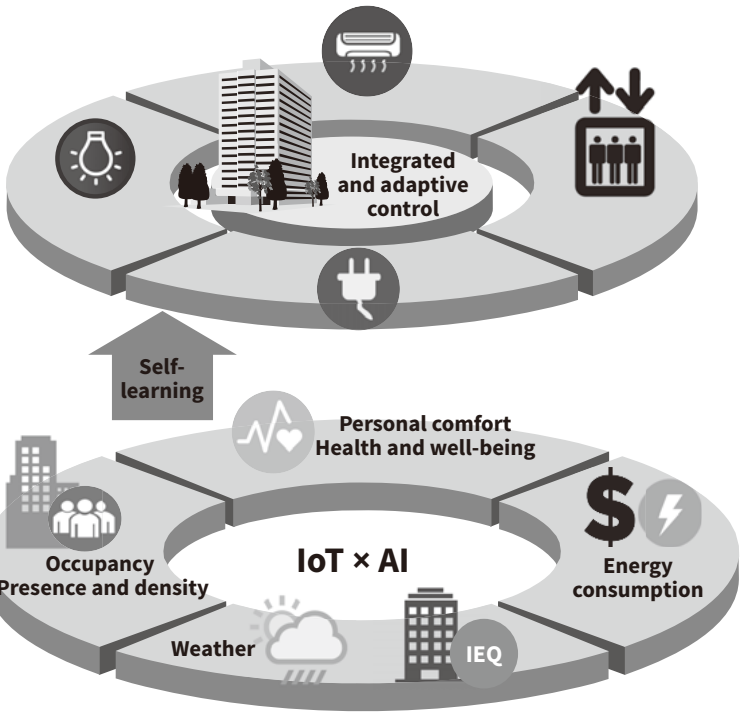
The effective formulation and implementation of measures to encourage more people to get out and about in urban areas requires measurement of people's movements before and after the changes, predicting the consequences of proposed actions, and ways of reaching consensus on what those actions should be. While Global Positioning System (GPS) data is of some use in measuring the movement of people, this is still mainly a manual activity and there is a strong need for automation. Meanwhile, modelling of pedestrian behavior is needed to predict the consequences of proposed actions. It is also the case that no methodology has yet been developed that can use these measurements to identify the issues and how to resolve them, and to utilize these findings in urban development processes that allow residents to participate.

Accordingly, an initiative by Hitachi-UTokyo Laboratory involved a trial of people-flow measurement, with three-dimensional (3D) sensing (a people-flow measurement system that used stereo cameras) being installed in the Dogo Shopping Street in 2017 with the cooperation of Matsuyama City stakeholders. The data was then utilized in the development of a pedestrian behavior model by the University of Tokyo. In February 2019, data on the pedestrian behavior of residents and tourists was presented at the NEXPERIENCE/Cyber-PoC for Cities established at UDCM and utilized in a study of consensus building in urban development[4].

## 4. Smart Buildings (Singapore)

Due to the hot and humid tropical climate in Association of Southeast Asian Nations (ASEAN) countries, buildings account for 60% of total electricity consumption[5], mostly used for air conditioning to improve occupant comfort. Reducing building energy consumption while maintaining occupant comfort has become a regional societal challenge for sustainable city development and quality living.

In 2009, Singapore set national goals of 80% of buildings to become green buildings and a 36%




IoT: Internet of Things AI: artificial intelligence IEQ: indoor environmental quality

**Figure 2 — Human-Centric Smart Building Solution**

The solution coordinates the control of multiple building sub-systems and adapts to the building dynamics in relation to the function of spaces, occupant activities, and personal comfort.

reduction in greenhouse gas emissions by 2030[6]. To achieve these goals, the government has introduced various incentive programs, such as the Green Buildings Innovation Cluster (GBIC)[7], with the aim to promote the development and adoption of energy-efficient building technologies. The government also developed the new Green Mark Scheme[8] to place greater emphasis on occupants' health, well-being, and comfort as well as on environmental sustainability.

### 4. 1
### Challenges in Building Energy Optimization

Modern buildings are equipped with advanced technologies for individual sub-systems (such as air-conditioning, lighting, power plugs, and elevators). However, these technologies work independently without interconnectivity, and do not adapt to changing circumstances such as the presence and density of occupants and personal comfort.

The presence and density of occupants in a commercial building may vary dynamically within a typical business day depending on its business activities. It is common to find spaces partially occupied or even unoccupied for significant time periods. Average occupancy in office buildings may be as low as 50% of their design occupancy, even at peak times of the day[9].

Personal thermal comfort may vary depending on factors such as gender, age, and body mass. Traditional canonical models [such as the predicted mean vote (PMV) model and adaptive model] that use a limited number of environmental parameters are inadequate for evaluating human thermal sensation[10]. Better thermal comfort modelling is needed, utilizing more environmental parameters and human vital signs.

This diverse space usage and the differences in personal comfort pose significant challenges for building energy optimization.

### 4. 2
### Human-centric Smart Building Solution

In February 2019, Hitachi received a two-year national research grant in Singapore to develop a smart building and digital twin solution, leveraging IoT and AI technologies.

The solution will enable a human-centric automated building management solution that coordinates the control of multiple building sub-systems and adapts to the building dynamics based on the function of spaces, occupant activities, and personal comfort (see **Figure 2**).

As energy demand increases, energy efficiency is one of the critical factors for the development of Singapore's economy in the immediate and long-term future. This solution demonstrates great potential for building energy saving, without requiring a building retrofit and without compromising personal comfort. It will serve as a reference model for achieving high-rise super-low-energy buildings (SLEB) in the tropics.

## 5. Challenges for Digital Cities

This section discusses the data infrastructure for participatory urban development.

### 5. 1
### Data Governance

In Toronto, Canada, Sidewalk Labs, a subsidiary of Alphabet Inc., is working with the public organization Waterfront Toronto on an urban development project called Sidewalk Toronto, which aims to use digital technology to resolve issues facing the city[11]. While the collection and analysis of data on residents' activities is central to the Sidewalk Toronto project, a Data Governance Advisory Working Group made up of local representatives and experts has been established and is seeking to formulate a policy on responsible data use based on principles that include social objectives, transparency, openness, active engagement with residents, community trust, and putting people first. Behind this lie increased public concerns about the issue of privacy with regard to the civic data collected and used by a single private company. Sidewalk Toronto is currently taking active steps to assuage these concerns, while announcing that resident data management will be handled by a third party, Civic Data Trust[12].

In Barcelona, Spain, meanwhile, an increased emphasis is being placed on civic participation in data use with the aim of shifting to a resident-centered approach to smart cities rather than the technology-centered approach of the past[13].

The Decentralized Citizens-owned Data Ecosystem (DECODE), a demonstration project currently in progress, has provided residents with the ability to control the confidentiality and sharing of personal data for themselves. This enables people to allow public transportation agencies to access data on their movements while keeping it from insurance or advertising companies, for example[14].

These leading-edge digital city initiatives are placing a high priority on ownership and participation by residents being built into their systems. Privacy protection and data ownership with people at its center are among the essential requirements for making digital cities a reality.

### 5. 2
### Approach to Achieving Data Governance

While making residents' data (personal information) available so it can be used to help improve and optimize city services is a major part of the digital city, concerns about potential leaking of this personal information are a problem. Consent for data use would be easier to obtain were technology available that would enable this data to be used without compromising privacy, thereby expanding the potential of the digital city.

One idea that Hitachi is working on to help achieve this is a technique for analyzing data confidentially. This means analyzing the data without decrypting it and is able to extract correlations from data in encrypted form. As only data owners who possess the encryption password are able to interpret these correlations, this makes it possible to use (analyze) the data without compromising privacy[15].

Surveillance camera footage is an important form of city data. In the case of the Eki-Shi-vision* service provided by Tokyu Lines Application, a mobile app, the use of raw surveillance camera images to provide real-time updates on the level of crowding at railway stations would violate the privacy of station users. The app gets around this problem by using an image processing technique from Hitachi. As shown if **Figure 3**, an intuitive representation of the level of crowding is provided by superimposing icons representing people's direction of movement on a background image, thereby also protecting the privacy of the people in the images[16), (17].

In this way, Hitachi is developing the various technologies needed to ensure data ownership and

* Eki-Shi-vision is a registered trademark of Tokyu Corporation.


**Figure 3 — Example Eki-Shi-vision Screen**
Information about the degree of crowding at railway stations is extracted from camera images and distributed in real time. Displaying icons that indicate people's direction of movement presents the information in an intuitive way without compromising the privacy of the people in the images.

privacy protection in a digital city. The Hitachi-UTokyo Laboratory meanwhile is working toward the data-driven city by collaborating with researchers in the humanities and social sciences to study what is needed to make data use acceptable to society, having embarked on a participatory design project called the Future Living Lab that intends to implement and trial their findings.

## 6. Conclusions

This article has presented examples from Japan and overseas of data-driven cities that are collecting and analyzing data from the city and its residents, using it to drive improvements in urban planning and operation. It has also explained about data governance and data privacy, solutions needed to prevent misuse of this city data. Given the emergence around the world of societal challenges such as aging populations, low birthrates, and ongoing urbanization, measures for dealing with these will become more important than ever in the future. Hitachi intends to continue contributing globally to sustainable urban development.

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## Authors

**Akiko Sato**
Customer Front Project, Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd. *Current work and research:* Research and development on digital cities, urban ecosystems, food chain. *Society memberships*: The Information Processing Society of Japan (IPSJ) and the Japan Society for Research Policy and Innovation Management (JSRPIM).

**Shigeyuki Tani, Ph.D.**
Systems Architecture Research Development, Center for Technology Innovation – Systems Engineering, Research & Development Group, Hitachi, Ltd. *Current work and research:* Research and development of social systems. *Society memberships*: The Society of Instrument and Control Engineers (SICE) and Japan Association of Real Options and Strategy (JAROS).

**Koji Sasaki, Ph.D.**
Vision Design Project, Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd. *Current work and research:* Vision design project activities. *Society memberships*: Project Senior Researcher of Keio Research Institute at SFC Keio University, a member of the Japanese Society of Cultural Anthropology (JASCA) and the Japanese Association for Migration Studies (JAMS).

**Wujuan Lin, Ph.D.**
Research & Development Center, Hitachi Asia Ltd. *Current work and research:* Research and development of smart city solutions.

**Jun Furuya**
Customer Front Project, Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd. *Current work and research:* Habitat Innovation Project at Hitachi-UTokyo Laboratory.

**Chiaki Hirai, Ph.D.**
Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd. *Current work and research:* Research on service engineering. *Society memberships*: IPSJ, the Society for Serviceology, the Institute of Electrical Engineers of Japan (IEEJ), and the Society of Project Management (SPM).