Chapter 5
Solving Social Issues Through Industry–Academia Collaboration

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Abstract This chapter illuminates how Society 5.0 will transform our cities and lives through introducing the research works developed by industry–academia collaboration "H-UTokyo Lab," which is a joint undertaking by Hitachi and the University of Tokyo. In this chapter, researchers from the field of engineering discuss the basic thought process behind the research projects aimed at addressing social problems in each section, including those related to the aging population, the need to go carbon free, and the need to regenerate rural communities. In addition to the discussion, the researchers also describe the updates in technical revolution to

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solve the social problems. Each section concludes with an illustration of the image of our lives in future in Society 5.0.

In Sect. 5.1 we provide an overview of social problems in Japan and then propose the basic approach to solve these. In Sects. 5.2–5.4, we explore the approach and direction for technology development that facilitate innovating cities and living spaces in relation to each of the following three propositions. Section 5.2 suggests ideas for better housing support for the 100-year life and development of technologies that are close to human and data-driven services. Section 5.3 introduces technologies that coordinate energy management at different tiers, that is, individual, building, and district level, to contribute to a carbon-free society, which enables people to use minimal energy without sacrificing their QoL. Section 5.4 proposes a data-driven urban planning method, which supports the local community to develop their own community improvement projects.

Keywords Energy and life management system · Data-driven urban planning · Habitat innovation · Healthy aging · Zero-carbon society

5.1 How Will Society 5.0 Transform Cities?

Society 5.0 is a people-centric society that resolves both economic and social issues while ensuring that people live comfortable and fulfilling lives. To that end, how must urban environments change? How should we try to change them? What must we do to effectuate such changes?

This chapter concerns a novel model developed by H-UTokyo Lab., which is a joint undertaking by Hitachi and the University of Tokyo. Rather than following the conventional model of industry–academia partnership, in which a university lab conducts joint research with a private firm, H-UTokyo Lab. seeks to solve social issues through industry–academia collaboration, which involves organizational integration between the firm and the university. Under this approach, researchers from both Hitachi and the University of Tokyo form working groups on separate themes, and work on technologies and policy proposals under these themes. In this chapter, we focus on the discourse related to these endeavors.

The First Thing to Change Is Values

In Chap. 2, we outlined the approach of Habitat Innovation. Habitat Innovation seeks to innovate cities and habitats without being beholden to prevailing social conventions. It is only through such a bold approach that we can transform society. To ensure that flexible, outside-the-box ideas gain traction, we must first and foremost replace, create, and revive values. More specifically, we must do the following:

1. Replace the prevailing values that have held us back
2. Create new values to release us from conventional frameworks by drawing on accumulated knowledge
3. Revive abandoned values

By doing so, we move closer to making Society 5.0 a reality.

It is only when we challenge and replace the very values to which we traditionally adhere that we will ignite the innovation necessary to create a people-centric society, which then will become a motivating force promoting Society 5.0. Stated differently, Society 5.0 is not the logical extension of today's society; Society 5.0 is a revolutionary break with prevailing ideas and practices.

Here, we will consider three propositions (together with solutions) concerning the urban habitat innovations that are necessary to bring about a change in mind-set and acclimatize society to new ways of thinking. The first is that elderly people should be enabled to continue living their own homes. The second is that people should have more choices in their living and working environments. The third is that local communities should take the initiative in identifying their attractive features. These propositions might seem obvious and straightforward, but it is very hard to implement them under conventional ways of thinking. They must be implemented however, if we are to build a people-centric society.

How can we use technological and social innovation—the kind that arises from the convergence of cyberspace and the physical space (real world)—to fulfill these propositions? What technology and policy changes are required for such ends? We will discuss technological approaches and policy proposals later (from Sect. 5.2 onward); first, we will clarify the meaning and challenges of each proposition from residents' perspective.

Enabling Elderly People to Continue Living Their Own Homes

As we mentioned in Chap. 2, Japan's population is graying at an unprecedented rate. There are growing numbers of elderly people living alone, and many elderly people themselves care for other elderly people, which has become a major social issue. The rate of aging is particularly high among the many suburban areas in the Greater Tokyo Area, as well as those in other metropolises in Japan, the development of which peaked during the high economic growth period. Many of the inhabitants of these neighborhoods have resided there since the neighborhoods first developed. With few new residents moving in, the resident population is either stable or declining, and there are an increasing number of vacant properties. Consequently, local services (such as those related to shopping and healthcare) are struggling to meet elderly residents' daily care needs. Hence, it will be no easy task to ensure that elderly people can continue to live in this housing, to which they are so accustomed.

Japanese life spans have lengthened to such an extent that the government has set out the "age of the 100-year life" as a national policy. Accordingly, to ensure that people can continue living comfortably in their familiar neighborhoods, there needs to be systems of support that reflect each resident's health conditions and the circumstances of their neighborhoods. There must also be habitats that enable elderly people to live independently, and so we must develop systems and technologies to achieve that end.

First, we must change the mind-set. Figure 5.1 breaks down conventional elderly housing policy into residence status (single living—living with spouse/family members) and the convenience of the neighborhood (transport services, daily living facilities, etc.). The *X*-axis indicates the former while the *Y*-axis indicates the latter. Conventional policies in this area either encourage residents to relocate to more

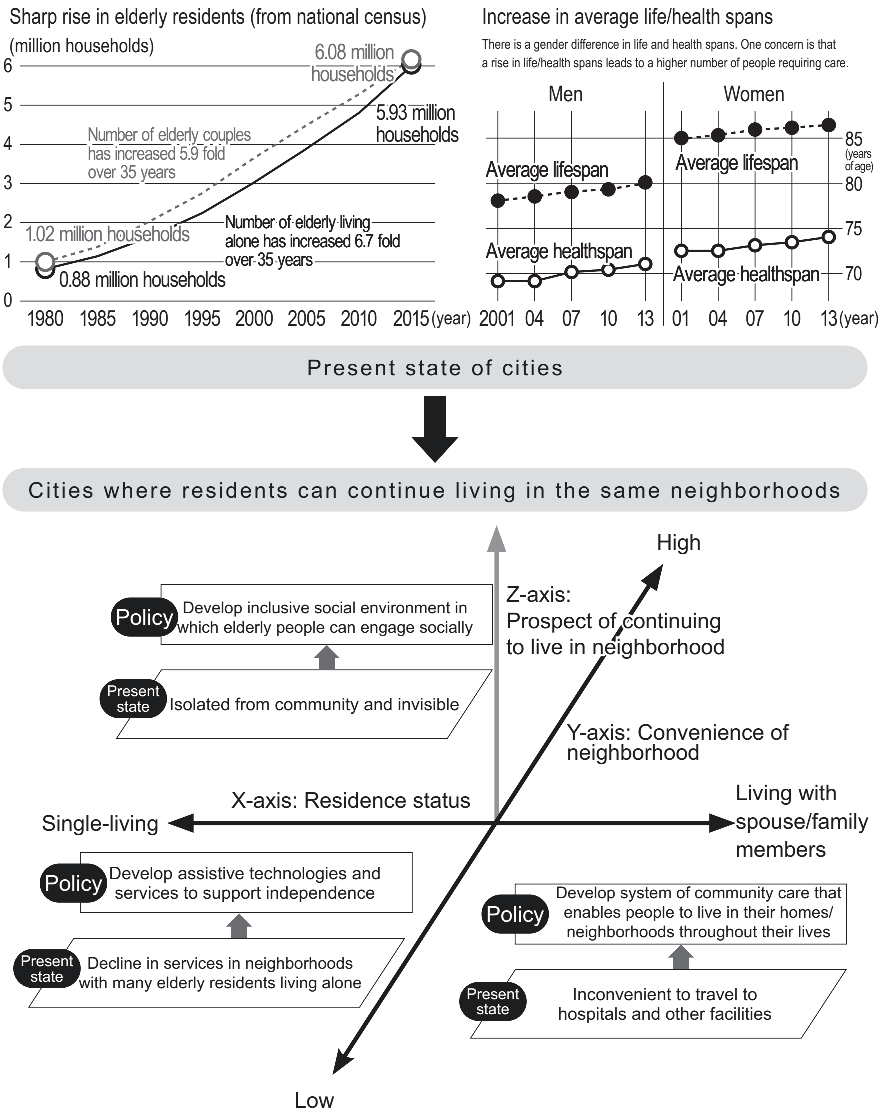

Fig. 5.1 Paradigm shift in supporting elderly people's housing

convenient local areas (the compact city model) or promote elderly care, including social welfare-based care and family-provided care. The fundamental issue though is how to create age-friendly living environments, where the elderly can continue living with peace of mind. Hence, we added a third axis, the *Z*-axis, to indicate the value of elderly residents continuing to live in the house in question. Using this metric, we must reassess conventional approaches to elderly housing, which are designed to reflect age-based changes, and start thinking about new solutions.

Insofar as Society 5.0's people-centric society is one in which people can continue living in the same neighborhoods, it must include cyberspace architecture that can help elderly people to live with peace of mind. Of importance here is the creation of an environment that preempts or minimizes dependency on care—an environment where elderly people's health is carefully managed on a daily basis so as to offset the risks of sudden injury, disease onset, and other risks to health and safety. It is also essential to develop assistive technology to create an environment customized to the person's lifestyle and thus encourage independent living. In Sect. 5.2 of this chapter, we suggest ideas for how this paradigm shift in values can lead to better housing support for the 100-year life and development of technologies that are close to human and data-driven services.

More Choice in Where You Live and Work

The traditional image of a metropolis is a place that houses a cluster of employment centers (such as offices and commercial facilities) in its center and residential areas out in the suburbs, or commuter towns (or "bed towns" as they are called in Japan). As property and land prices in the city center are high, many white-collar workers live in the less expensive suburban areas and endure a lengthy daily commute into the center. Figure 5.2 shows the distribution of the residential population and the employee population in the Greater Tokyo Area. The residential population distribution extends across the suburbs. The worker population, however, is concentrated in the center, reflecting the fact that the white-collar workplaces in the Greater Tokyo Area are clustered in central Tokyo. Thus, the majority live far away from their jobs; they work in central Tokyo, and live in the suburbs.

Figure 5.2 includes a graph with four quadrants in which the *X*-axis indicates where workers in the Greater Tokyo Area live (suburbs vs. central Tokyo) and the *Y*-axis indicates where they work (suburbs vs. central Tokyo). As of 2015, the Greater Tokyo Area has a working population (population of full-time or part-time workers) of 16 million,[1] with 14.5 million for whom the residential and work loca-

[1] "Greater Tokyo Area" refers to the municipalities within the "urbanized areas" and "suburban areas" as defined in the Greater Tokyo Area Development Plan. "Central Tokyo" refers to the 23 central municipalities (often called the "special wards"), Kawasaki City, and the bay area of Yokohama City. "Suburbs" refers to the municipalities in the "suburban areas." In both cases, the statistics are based on 2015 national census data concerning individuals aged 15 or older, who are employed or in school.

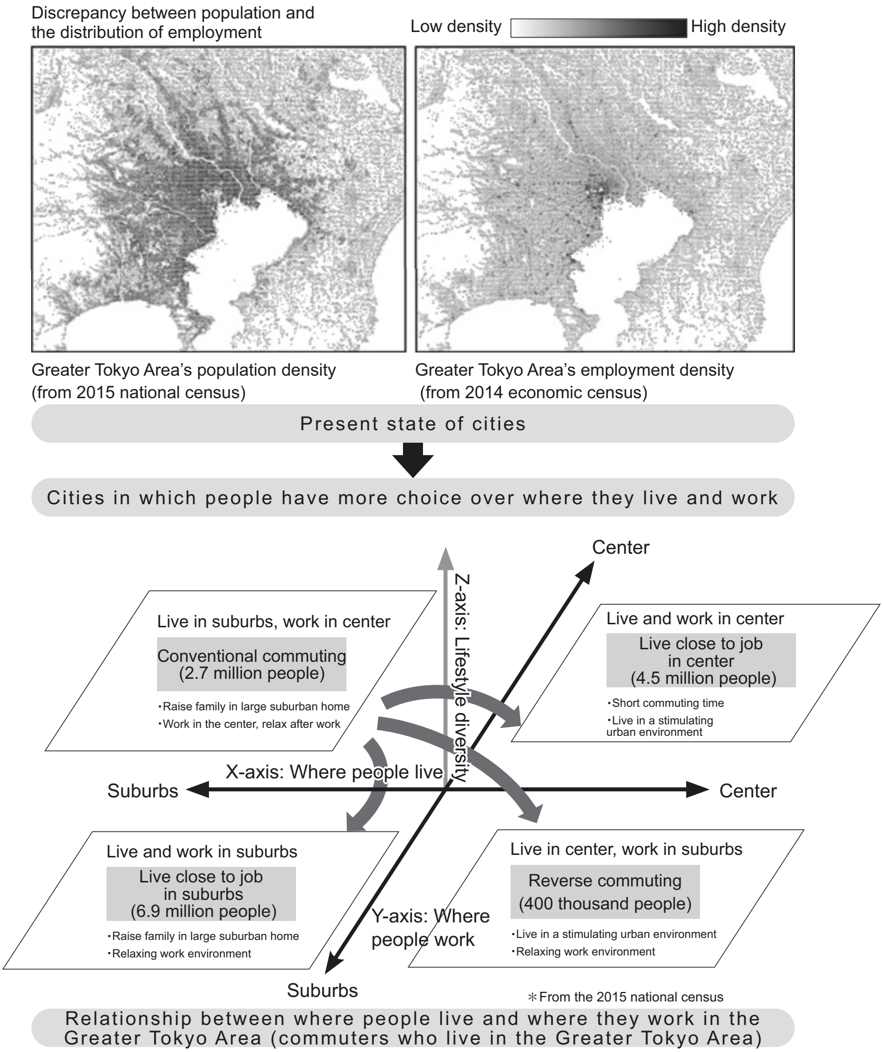

Fig. 5.2 Paradigm shift wherein people live and work in a metropolis

tions are known. Of these 14.5 million workers, an estimated 2.7 million live in the suburbs and work in central Tokyo. Only 400 000 do the reverse (live in central Tokyo and work in the suburbs), a ratio of 1:7.

This trend is reflected in train congestion patterns. During the morning rush, inbound trains (trains running from the suburbs into central Tokyo) are packed while outbound trains have few passengers. The reverse is true in the evening rush hour. Thus, the train networks in Japan's metropolises are still not used to full capacity. The Greater Tokyo Area has an extensive rail network compared to other metropolises around the world, and suburban rail lines radiate out from the terminus stations on the Yamanote line (the railway loop line in central Tokyo). Given this pattern, if more people were to live in central Tokyo and work in the suburbs, it would lead to more effective use of the rail network and raise the capacity of the Greater Tokyo Area.

There is some literature on “reverse commuting” (residents who commute to the suburbs) in overseas cities, including Paris and New York (Aguilera et al. 2009; New York Times 2008). Reportedly, some Google employees live in central San Francisco and commute to suburban Silicon Valley. Some suburban employment centers have also emerged in the Greater Tokyo Area, such as Futako-Tamagawa and Kashi-no-ha Campus. For those who work in engineering and development, it would make a lot of sense to work in a verdant and stress-free suburban environment as opposed to one of the high-rise towers clustered in the city center. Reverse commuting is, of course, contingent upon having affordable housing and land prices in the city center, but if people can work in cyberspace, that would remove the need for employment to be concentrated in the city center and would create greater scope for new lifestyles, such as living in the city center amid a wealth of leisure facilities (such as restaurants and cinemas) and commuting to the suburbs for work. Shifting from the traditional urban model of concentration and specialization to a model that emphasizes decentralization and diversification will be a vital step toward building a people-centric society that accommodates a variety of lifestyle options.

The key to realizing this shift in urban design is to disincentivize urban centralization. Traditionally, urban centralization is held to benefit society, in that having offices concentrated into the same geographical area offers greater economic efficiency and more efficient energy use. The downside, however, is that workers spend many hours a day commuting under packed conditions, depriving them of disposable time. This situation runs counter to the people-centric society of Society 5.0. There are a number of proposals for addressing the problems created by living far away from one’s job. Telecommuting and small office/home office (SOHO) are examples of this. Thus, progress is being made in developing technologies and environments that remove the need to commute to a physical office every day; for example, workers can work in decentralized office environments connected in cyberspace. However, decentralized office environments lead to increased and less efficient energy consumption, problems that may deter progress. Thus, no fundamental breakthrough in this issue has yet been made. Recently, we have started seeing the practical application of energy management systems for Building/Community Energy Management Systems (BEMS/CEMS) , but to create environments that function flexibly and operate across the whole of the Greater Tokyo Area, it is necessary to develop technology based on energy management systems that is not tied to the geographical concentration of business clusters and, as such, can minimize energy consumption across the whole of society. In other words, we must apply the symbiotic autonomous decentralized system throughout the Greater Tokyo Area (more on this in Chap. 4).

The third section of this chapter introduces technologies that coordinate energy management at different tiers (individual, building, district, Greater Tokyo Area) to contribute to a carbon-free Japan. These technologies will help effectuate the shift from traditional urban models that emphasize economic efficiency toward an urban model that supports diverse lifestyle choices (and thus supports Japan’s work style reforms) and enables people to use minimal energy without sacrificing their QoL.

Local Communities Taking the Initiative in Identifying Their Attractive Features

A staggering number of local governments in rural areas are at a loss in how to deal with shrinking populations. Many of these local governments have set out policies designed to maintain or increase the resident population and nonresident population (tourists, visitors, sojourners) by deploying the area's tourist resources and the abundant natural environment. However, given the long-term decline in Japan's overall population, local governments are fighting over an ever-smaller pie. A more fundamental task is illustrated in Fig. 5.3: local communities must examine past data on nonresident and resident populations and then derive a sustainable future vision that suits the locality. They must then implement effective policies to achieve the vision.

Some local communities have seen their resident population decline but have also seen their nonresident population increase. What should such communities be doing in their effort to make themselves sustainable? Should they seek to bolster the nonresident population by drawing further upon their attractive features? The Society 5.0 solution is to use cyberspace to analyze data (including plenty of case data) and compare different scenarios for alternative future visions. Cyberspace provides local communities a tool for making informed decisions on their future direction.

At present, however, local governments do not always have access to the simulation tools and data they require for conducting fact-finding surveys or forecasting the outcomes of policies. Local governments can ascertain the facts on the community concerned by accessing public statistics such as national and economic censuses. They could also access the basic city planning surveys prescribed under the City Planning Act or nationally conducted household travel surveys ("person-trip" surveys). The problem with these public resources, however, is that the surveys are carried out infrequently, at 5- or 10-year intervals. The granularity of the data is limited too; the data are collected in meshes or at a municipality, district, or subdistrict level. In other words, the public data do not adequately capture the dynamics of municipality, where changes occur frequently and locally. This data cannot, for example, help local governments forecast the outcomes of widening a road or laying down a new road, or running a precise after-evaluation of policies or pilot experiments. Local governments lack the data and analytical tools with which to smoothly run plan–do–check–act cycles. We no longer live in an age where local governments should wait upon the national government to supply them survey data; local governments should waste no time in accessing Big Data, including satellite imagery data and mobile spatial data, and then use this data to build cyberspace architecture.

To proceed with town building projects (such as road development) flexibly while forecasting the outcomes of the plans, local governments in the course of such projects should gather and use data on the project zones and the peripheral zones. To this end, local governments require platforms that integrate effective Big Data.

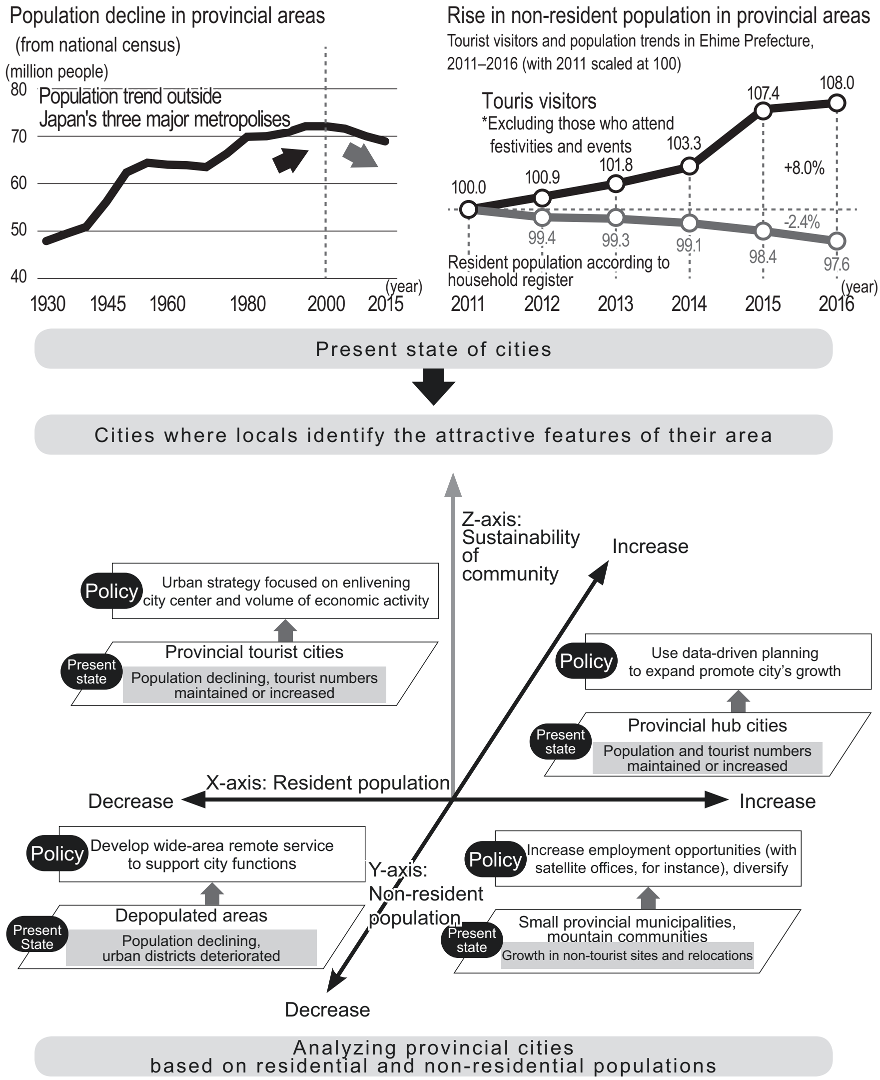

Fig. 5.3 Paradigm shift in sustainability of provincial cities

Hence, the fourth section of this chapter explores the necessity and potential of data-driven local planning and its associated tools.

Local governments must work out how they will gather local data on the physical space (real world), such as data on roads, buildings, people flows, and traffic, and how they will address the technical challenges in the building of a cyberspace infrastructure. No less important, however, is the issue of how the local community will use the cyberspace architecture. If provincial municipalities can establish a method for gathering Big Data on people flows, vehicular traffic, and the like, it would mean that we are approaching an age where data imagery systems are used to recreate urban conditions in real time. However, knowledge will go to waste if this process remains the sole preserve of a handful of experts. Cyberspace architecture can only serve its role of contributing to community building if there are occasions for governmental/public institutions, private firms, and local residents to talk about future visions of the community. In this way, the convergence between cyberspace and physical space (real world) will help create a truly citizen-led community.

The Role of Cyberspace in Community-Based Planning

If we think of the three propositions as logical extensions of traditional community building, then we will fail to derive broadly applicable solutions. If, on the other hand, we attempt to address these propositions using the Society 5.0 methodology, which emphasizes cyber-physical convergence, it becomes clear that we must change the traditional approach to community building. Once we replace values (the prevailing values that have held us back), create new values (draw on accumulated knowledge to create new values that release us from conventional frameworks), and revive abandoned values, we will begin to see how the vision of Society 5.0 goes hand in glove with the resolution of the three propositions. Changing values is not sufficient in itself; methodology is needed to produce solutions. Society 5.0 serves the role of providing broadly applicable tasks with a methodology that is combined with an approach to changing values.

Cyberspace has three roles in innovating cities and living spaces. First, cyberspace offers each resident an alternative office environment. In doing so, it gives people greater choice as to where they work. Second, in giving people greater freedom of choice as to where they live and work, cyberspace helps to hold in check or to reduce inefficiencies and energy consumption. BEMS/CEMS are examples of this potential. Third, cyberspace facilitates citizen-led community-based planning by allowing citizens to gather and collate Big Data (e.g., mobile spatial data or people-flow data) so as to share or evaluate future visions.

Cities and living spaces can be innovated by using cyberspace to digitize data from the physical space (real world) and then integrate the data back into the physical space. There is still some way to go until we see the full practical application of this process. In Sects. 5.2–5.4 below, we will explore the approaches and directions for technology development that facilitate innovating cities and living spaces in relation to each of the above three propositions.

5.2 Building a Habitat to Support the 100-Year Life

Society 5.0 and Habitat Design

The theme discussed in this section is how to design habitats to address the problem of the shrinking and aging population.

First, we should clarify the relationship between Society 5.0 and habitat design.

Human habitats are cultivated by two major forces: the market and government; however, these two forces alone can no longer cultivate the habitats adequately, so a third force is necessary. This is where Society 5.0 comes in: its role here will empower local communities/civil society to take responsibility for their habitats and thus ensure that habitats develop in accordance with the will of the people.

The development will be an inevitable outcome of three factors.

The first factor is that we are moving beyond the materially overabundant society.

Nowadays, the desire to acquire things as one's own and to experience things in one's own private space has been satiated. On the other hand, there is a mounting desire for (or a dissatisfaction with) experiences in public spaces, which one cannot acquire by one's own efforts. To give an example, many Japanese people lived in very cramped housing, often dubbed "rabbit hutches," in the 1980s, but living spaces have now become adequately spacious. Nowadays, the sources of people's frustration are things like the inadequacies of street environments, spaces for pedestrians, and public transport environment, and the lack (or poor quality) of places where people can gather and interact, such as shopping spaces, cafes, cultural facilities, and parks. However, when it comes to public products, such as public space designs and public policy drafting, the market principle does not apply. We therefore need a separate approach—namely citizen-led governance. Thus, Society 5.0 has the task of embedding into society a co-creation process, one that ensures that the will of the people is incorporated into the design and management of public products, including public space designs.

The second factor is that action on climate change can no longer be put off.

The ultimate public space is the planet Earth, and safeguarding our terrestrial home is a matter of paramount urgency. The governance of human activity and habitats (living spaces) can no longer be entrusted to markets and government alone; citizens must take the initiative and manage their habitats autonomously and systematically.

The third factor is that global digital networks and Big Data are enabling us to visually model complex living and activity spaces and to manage them instantaneously and organically. These technologies are also enabling the will of the people to be consolidated in real time.

Thanks to these three factors, human activities and living environments can now reflect the will of the people. In other words, Society 5.0, by deploying ICTs, AI, Big Data, and the like, opens up the possibility of managing the activities of civil society, private business, and government together with human habitats in an effective, autonomous manner that aligns with the will of the people.

The 100-Year Life: The Problem of the Shrinking and Aging Population

Japan has the highest rate of aging in the world. By 2050, almost 40% of the population will be aged 65 or older. People speak of the "ultra-aging society," a society where the elderly account for over a third of the population. As alarming as this may sound, insofar as we are heading toward an age of 100-year life spans, a graying population is only a natural outcome of longer life spans, and one that would happen even without a falling birthrate. Thus we really should not be so alarmed and dismayed at the prospect of this eventuality. After all, the prospect of living a fulfilling life until the age of 100 is something humanity has dreamed of since time immemorial. Thus, the high rate of aging should not, in and of itself, be a cause for chagrin—quite the opposite.

The real problem is how society can shoulder the growing number of people in need of care. As of 2010, there were 20 people of working age for every person with age-related care dependency. Assuming that the onset ratio of age-related care dependency remains at the 2010 level, there will be only ten working-age people for every care-dependent person in 2030, and this will decrease to five by 2060. This is indeed an alarming prospect. Long-term care insurance-based services have expanded, but family members care for dependents in two-thirds of cases, and few neighborhoods have access to round-the-clock in-home services. As family members become increasingly exhausted with their care burden, many elderly are forced to care for other elderly persons, many are forced to give up their careers, and some even start abusing their dependents.

Accordingly, the habitat design for the age of 100-year life spans must aim to achieve the three objectives shown in Fig. 5.4.

Supporting Autonomy in the Activities of Daily Living

What kinds of environments reduce the risk of becoming dependent on care? As of 2013, the following are the three biggest causes of care dependency:

1. The first is cardiovascular disease (stroke and heart disease), which explains 25% of cases.
2. The second biggest cause is motor impairment (fractures, joint disorder), which explains 21% of cases.
3. The third biggest cause is cognitive impairment, which explains 16% of cases.

It is now understood that cognitive impairment is related to cardiovascular disease.

Cardiovascular disease and cognitive impairment are lifestyle diseases, while fractures and joint disorders are the result of muscle degeneration, osteoporosis, and

(1) Maximize healthy and independent life spans: Minimize number of care-dependent persons and duration of care dependency	Living environments that encourage elderly residents to adopt healthy habits (healthy diet, mental/physical exercise, rehabilitation) and reduce risks of accident
	Local social environments that encourage elderly residents to engage socially in the local community, instead of confining themselves indoors.
(2) Local social environments that empower elderly residents to live independently in their homes even when they grow physically frail	Integrated local care systems and supportive environments that empower care-dependent elderly to live independently in their homes
	Public institutions, residents, and private firms collaborate in monitoring and assisting elderly residents (either self-help or public-help alone is no longer sufficient)
	Develop techniques that support independence (rehabilitation) and effectively prevent care dependency from worsening
(3) Increase working population	A society where older people can remain in employment: A society without a mandatory retirement age and one that accommodates a broad mix of workstyles and lifestyles
	A society of lifelong learning, where higher education or vocational training can be undertaken at any age and as many times as desired
	Universal design in living and work environments, whereby employees can contribute even if they experience disability
	Action against the falling birthrate Strategy to mitigate burdens of raising a family: As well as easing financial burdens (e.g., mortgage, schooling), aim to help parents balance career with raising a family (work-life balance) and ease the strains of child care.
	Strategy to accommodate immigrants: Multicultural society

Fig. 5.4 Three objectives for creating a vibrant society in a time of ultra-depopulation

deficiencies in the living environment. As such, the risk factors of these conditions can be minimized by better diet, exercise, rest, and living environments.

A well-designed living environment will reduce the risk of accidents occurring in the first place, and in cases where the person has suffered an accident-caused paralysis or other motor loss, such a living environment will support independent living through assistive technology. Notably, unforeseen accidents are the sixth biggest cause of death in Japan, and 75% of such deaths occur in the home.

Fewer than 4000 deaths in Japan are related to traffic accidents, while as many as 15,000 occur in the home—as a result of either falling or drowning in the bath. Even when domestic accidents are not fatal, the resulting fracture often means that the person becomes dependent on care (this is especially true among women). Strokes often occur while the person is in the toilet or bath, which is sometimes attributable to heat shock response. Accordingly, efforts to reduce the dependency risk factors in the living environment should focus on home installation and facilities that avert the risk of dizziness-triggered falls or heat shock responses. Another effective strategy is to introduce an AI-based system that can detect an emergency, such as a fall or cerebral infarction, and then summon an ambulance. This system would be particularly desirable in the case of cerebral infarction, as treating the condition within a few hours can significantly reduce sequela.

The Importance of Supportive Social Environments

Elderly people may recognize how important a healthy diet and exercise are in maintaining their activities of daily living. However, if they live alone, they may struggle to sustain healthy behaviors. Indeed, it is hard to sustain exercise regimens on your own and people tend to have poorer meals when they live alone. Rather than confining themselves to their homes, single-living elderly people should spend time outdoors socializing and dining with others, as such behavior is essential to their mental and physical health. This is starkly illustrated by a well-known statistic: compared to those who go out every day, people who go out only once a week are 4 times more likely to experience gait abnormality and 3.5 times more likely to sustain cognitive impairment.

Thus, when it comes to prolonging healthy life spans, in addition to (1) a healthy diet, exercise, and adequate rest, and (2) a safe living environment, a third component is necessary: (3) a local social environment that encourages elderly people to spend time outdoors engaging socially with the local community.

WHO's Healthy Aging Policy

The World Health Organization advocates a framework for preventing a decline in elderly people's capacities through local supportive environments. As Fig. 5.5 shows (World Health Organization 2015), the focus of public-health action changes depending on the phase of age-related decline, of which there are three. During the high and stable capacity phase, the focus is on promoting capacity-enhancing behaviors. During the declining capacity phase, the focus extends to reversing or slowing declines in capacity and supporting capacity-enhancing behaviors. Finally, during the significant loss of capacity phase, the focus extends to managing advanced chronic conditions and ensuring a dignified later life. Public-health action during this final phase also focuses upon removing barriers to participation. To this end, WHO advocates assistive devices such as wheelchairs, walking aids, and robotic assistance that provide frail individuals with as much independence as possible.

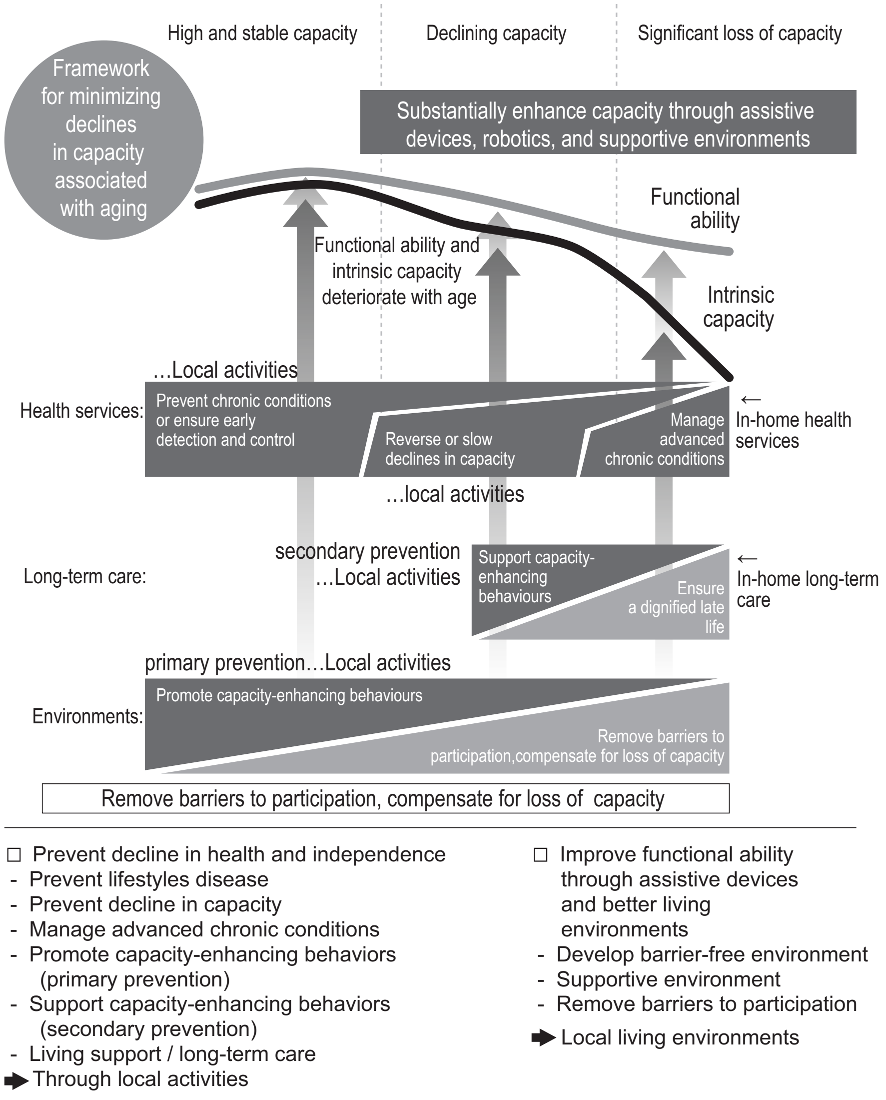

Fig. 5.5 WHO's healthy aging strategy. Source: WHO "Summary: World report on ageing and health" (2015)

Assisted Living Environments

The habitats that we should aim for are what WHO (in the above framework) refers to as "supportive environments"—environments that support elderly people's independent living and that encourage them to engage with their local communities. In this book, we describe this concept with the term "assistive living environments" and define these environments as follows.

Age-related decline in capacity necessitates care in six areas: mobility, bathing, toileting, cognition, sleep, and mealtimes.

Elderly people in Japan were once cared for exclusively by family members or by traditional communities. Elderly care has now been socialized with the introduction of social welfare. However, the quality of elderly care services is limited due to cost issues and lack of staff. Thus, it is essential to minimize the care burdens upon family members and society by building assistive living environments, in which elderly people's independence is supported by ICTs, AI, and robotic technology. Such ambient cyber infrastructure[2] will enable public institutions, residents, and private companies to co-create assistive living environments.

We propose that cyber infrastructure should be the foundations and that we should build three local infrastructural tiers upon these foundations: physical environments, care service environments, and social environments. Through such multilayered infrastructure, elderly people will access a full spectrum of care to support their independent living in the six areas mentioned above. The support will include, for example, elderly monitoring and communication services (cognition), mobility support (mobility), long-term care services (bathing, toileting, sleep, mealtimes), social engagement support, work style support, and childcare support.

Part of the mission of habitat design is to enable individuals to balance childcare with careers. As such, habitat design should be concerned not only with local (neighborhood) environments but also with social and spatial designs at a city and national level that will promote choice in work styles. Specifically, habitats must be reconfigured to enable more people to work shorter hours, engage in work-sharing schemes, work from home, work in satellite offices, or live close to their jobs. This radical reconfiguration in spatial and travel structure must be implemented on a large scale—that is, at the scale of the world's largest metropolis, Tokyo—and then rolled out to other cities and regions of Japan. Without doing so, we will struggle to solve the problem of the declining birthrate.

First, Set Out the Objective

In the previous section, we presented a rough framework. Of the support services in this framework, H-UTokyo Lab. has decided to focus first on developing elderly monitoring and communication services.

Specifically, we are developing ambient intelligence that analyzes imagery and audio data to make an informed decision on the user's status and provide cognitive and communication support/guidance infrastructure (from the user's perspective, the infrastructure resembles a robotic pet).

[2]Ambient cyber infrastructure is a network of sensors, robotics, and information devices that envelops the environments of human activity. Furnished with this infrastructure, a habitat can function as a robot monitoring and supporting human environments and human activity.

H-UTokyo Lab. (which commenced its work in 2016) decided that in its first 3 years of operation ending in December 2019, it will aim to develop a prototype of an in-home elderly monitoring system.

Objective

When elderly people suffer accidents in the home (such as falls or bathing accidents) or experience a stroke or cerebral infarction, the speed and effectiveness of the response have a critical impact on determining survival and prognosis. Moreover, a system that can effectively monitor elderly people who live alone (or who are alone during the day) is desperately needed to improve the QoL of caregiving family members and to prevent situations where family members give up their careers to care for the dependent. Thus, as a first step to supporting assistive habitats, where inhabitants can dwell in peace of mind, we will develop a prototype of an AI-based elderly monitoring system that can detect accidents or the onset of life-threatening conditions and then respond appropriately (such as by alerting emergency services). The system will be installed in the homes of elderly people who live alone (or who are alone during the day), in assisted living residences, and in care facilities.

Requirements

1. Must detect falls using imagery and audio data, and then alert emergency services.
2. Must use non-tactile sensing to detect the onset of cerebral or cardiac infarctions and then alert emergency services.
3. Must speak with the user so as to prevent false alarms.
4. During conversations with the user, the user's characteristics must be taken into account (this is particularly important given that the system is intended for elderly users). For example, the user's diction might be unclear if they remove false teeth at bedtime or bath time, and the user might also be hard of hearing. The system must also be able to distinguish the user's voice from other voices, such as those coming from the television or radio (perhaps the system can accomplish this by spatially mapping voices or by analyzing the characteristics of the voices).
5. Must detect accidents or onsets in noisy environments such as bathrooms and toilets (the user will be awake and active in these environments, so the system must function even with frequent calls).
6. The system will consist of an array of cameras, microphones, and speakers installed throughout the house, but the main interface, with which the user will converse, will be robotic pets (ideally, like cuddly toys) such as dogs, cats, and birds. For now, these can be immobile. In the bathroom, the interface can be a small LCD.
7. When sending an alert, the system must send imagery and audio data to the designated emergency contact (in general, this means connecting the home with the emergency contact by videophone).

8. Must send emergency alerts, manage the home environment, make calls, and make inquiries as instructed by the user (in general, this means having a smart speaker that can make videophone calls).

5.3 Carbon-Free Society: "Energy" × "Life" Management

A Masochistic and Non-masochistic Approach to Energy Saving

It has become customary to set room temperature for cooling to 28°C in Japan. In old days, the standard temperature setting was 26°C. The reason it increased by two points was because of Cool Biz, one of the campaigns in Japan to lower greenhouse gas emissions mandated under the Kyoto Protocol. In addition, although it was an emergency, the impact of energy saving from the Great East Japan Earthquake is also large. However, many people have now grown weary of such energy saving. The Cool Biz is not a problem. The 28°C is a problem because it is not suitable for office work. It is an uncomfortable temperature and it also results in lost productivity. There has never been any academic support for such a masochistic approach to energy saving. The recommended temperature is around 26°C in Japan: 28°C is the tolerance threshold.

So how can we save energy without having to suffer discomfort? One thing we can do is to cut wasteful use. We could, for example, turn off air conditioners in vacant rooms. This is an obvious action, and one that many people already practice. However, there is another way that might be less obvious: optimize operation of the building's air-conditioning system, lighting system, and so on. How to set room temperature is also one of optimization, but there is a plethora of other set points for control in the systems. With the right combination of set points, the same room temperature can be realized with less energy.

You may think, "Are these set points not optimized at the building design stage?" but they cannot be considered fully during the design process. Moreover, an air-conditioning system is built to order as well as a building. It is constructed by combining various devices, so there are generally some faults in the system. A troubleshooting process will always be necessary to iron out these faults. Therefore, optimizing of system operation should be conducted after building completion. However, that is not carried out in most buildings in practice. On the contrary, they do not even know what kind of operation of air-conditioning system they have currently. It might not be a completely fair comparison but, for example, in the automobile industry, there is a system to retain cars' performances continuously by periodic inspection and maintenance. However, there is no equivalent servicing for buildings once they have been completed and handed over to the owner (see Fig. 5.6). The potential energy savings from optimizing system operation are greater than we may imagine.

The "energy saving in operation" that engineers talk about refers to the depiction above, but when owners hear such a phrase, what occurs to them is a masochistic form of energy saving—i.e., enduring 28°C environments. Engineers try to plug this gap in understanding, but it is unreasonable as the concept is difficult to grasp without in-depth knowledge of how systems operate. This is not a recent issue but a big

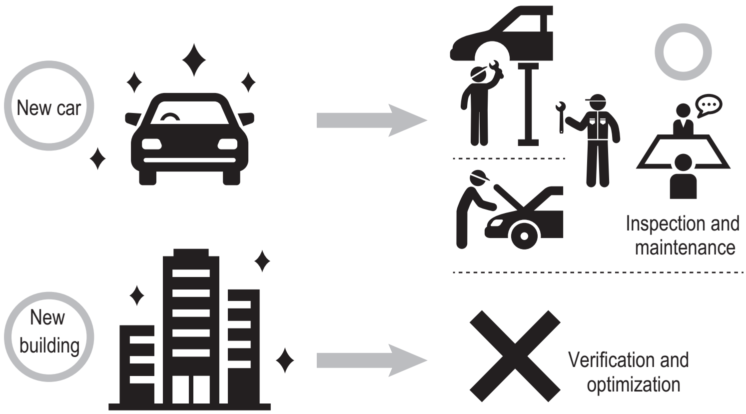

Fig. 5.6 There are scarcely any established business models for servicing completed buildings

barrier that has been around for a long time. Engineers probably lacked the motivation to break through this barrier because there were few business prospects. However, it is no longer acceptable to leave the barrier as it is.

Decarbonizing Existing Building Stock

Why can we no longer accept leaving the barrier as it is? The main reason is climate change. The Paris Protocol, effective since November 2016, indicated a change in mind-set: the signatories agreed to shift their sights from lower emissions to going carbon free, or "decarbonizing." Having signed the Paris Protocol, Japan is committed to a 26% reduction of greenhouse gas emissions compared to the 2013 level by 2030, and commercial and residential sectors are supposed to cut around 40%, respectively. This goal requires actions on the supply side, such as rolling out renewable energy, making thermal power stations more efficient, restarting nuclear power stations, and actions on the demand side, such as thorough energy saving in buildings. It is not only Japan that is focusing its efforts on commercial and residential sectors; this is the main focus among all developed countries.

According to building stock statistics and a building construction survey report of the Ministry of Land, Infrastructure, Transport and Tourism's Policy Bureau, as of 2015, there was a total of 1836 million square meters floor area of existing nonresidential buildings, and a total of 51 million square meters of floor area in new buildings. In the same year, there was a total of 5530 million square meters floor area of existing residential buildings, and a total of 79 million square meters floor area of new buildings. In other words, the floor areas of new buildings are only 2.8% of existing nonresidential buildings and 1.4% of existing residential buildings. There is little prospect that these percentages will rise in the future. These facts starkly illustrate the importance of decarbonizing existing building stock.

Of course, it is necessary to improve energy performance of new buildings. Japan is making advances in introducing zero-energy building (ZEB); these buildings are important from the viewpoint of not only decarbonization but also real estate value and technological innovation. However, the following issues remain: Are ZEBs being used as designed, and are their performances being maintained or improved? Without addressing these issues, the real estate value of ZEBs will overestimate the actual value, and the technological progress for ZEBs will be left behind because of no proper feedback. If ZEBs are also constructed, they become existing buildings.

So, the real challenge is how to decarbonize existing building stock. Hereunder, we will discuss this issue with a focus on management.

Energy Management

Figure 5.7 shows the 10-year trend in an office building's energy consumption from its completion (starting in 2004). A 40% cut in energy consumption was achieved over this 10-year period. Even if one discounts the decrease that was attributable to the Great East Japan Earthquake 2011, there was still a decrease of about 20%.

This was accomplished by improving energy performance through regularly monitoring the state of heat sources, air-conditioning, and lighting systems using hourly or minute-by-minute data, and identifying the optimal operations. Similar decreases in energy consumption have been achieved in buildings where there was such regular verification and optimization. This process is a part of "Commissioning (Cx)." Cx is a broad concept and is adapted through a building's life cycle. Cx is increasingly being applied to buildings, but it is still not common to do so in Japan. Here, we refer to the process mentioned above as Cx.

There are three major problems in the Cx. These problems represent three impediments to energy saving at the operation stage. The first problem is that human resources with specialized knowledge and technology to carry out the Cx are limited. This problem is related to building to order, and the complexity and the technical sophistication of the systems. There is little prospect of having a Cx professional for each building. Yet buildings have control/operation rooms, do they not? Yes, but most of these do nothing more than monitor the building systems. The second problem concerns the data processing. Cx deals with complex data sets with several thousand to several tens of thousands of data at increments of several minutes. Currently, these data are largely processed manually, meaning that the process is very inefficient and lacks a real-time element. As in the case of Fig. 5.7, a significant cut in energy use might be accomplished, but if it takes 10 years to do so, much energy and money during the period would be wasted. Air-conditioning systems operate differently depending on whether they are being used to heat or to cool, the way a building is used, as well as the meteorological conditions that change year by year to which the building is exposed. As such, it is probably to be expected that energy-saving efforts will take time. Still, 10 years is a long time to wait.

How can these two problems be solved? One solution is to have the limited number of Cx professionals conduct remote commissioning of multiple buildings. Another solution is to streamline and automate the Cx process using information technologies,

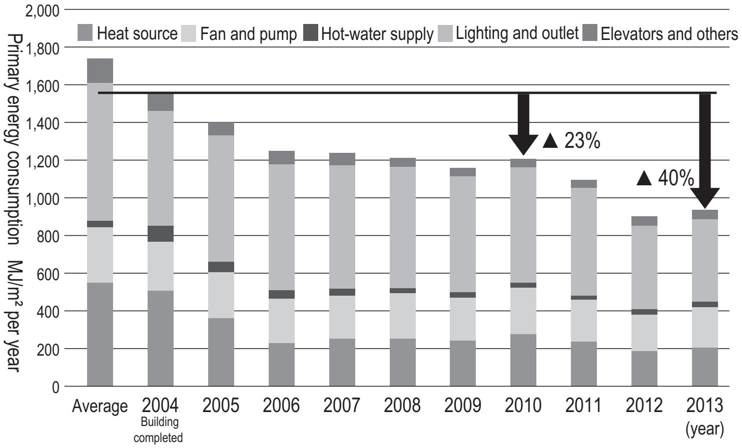

Fig. 5.7 Ten-year trend in an office building's energy consumption

such as AI, so as to accomplish energy savings within a short period after the building completion. As with our medical checks, continuous energy management is crucial for Cx where building system operations should be diagnosed and any problems should be rectified so as to restore the system to healthy operation. Thus, an energy management method for reducing system energy consumption with the Cx streamlined, automated, and conducted remotely is necessary. In 2016, Google reported that it had used DeepMind's AI system to cut energy consumption in its data centers by 40%. This is encouraging news, but coordinated and remote energy management is all the more challenging when it comes to large commercial buildings (especially multi-tenant buildings), which compared to data centers have many more variables to consider.

The third problem concerns something mentioned earlier: there is no established business model for managing the operation of building systems. This problem is related not just to technology but also to social institutions, business customs, and ethical concerns. In fact, building owners see little to be gained from energy-saving efforts in terms of cost-effectiveness. Although it does depend on the contract, owners of multi-tenant commercial buildings tend to be indifferent to energy efficiency, because the tenants typically pay lighting and heating costs at higher-than-usual energy unit prices, which include miscellaneous expenses. People used to speak of energy efficiency simply in terms of cost-effectiveness, saying that more efficient energy use will lead to lower heating and lighting expenses, but building owners do not seek to increase their profits through energy savings. To incentivize owners to take action in energy management, it is necessary to link energy management with other approaches. Accordingly, instead of evaluating energy-saving efforts based on short-term cost-effectiveness, we should use a longer term metric—namely, social return on investment (SROI), the social return in this case being the contribution to the prevention of global warming. SROI is closely related to the nonfinancial factors of environment, social, and governance (ESG), which have swiftly gained traction since the Paris Protocol. Thus, the future of energy management depends on whether Japan's building owners will identify the value in pursuing SROI.

Linking Energy Management with Life Management ("Energy" × "Life")

If your strategy for energy savings involves using the air-conditioning system sparingly during the summer, comfort and productivity may be sacrificed. On the other hand, even if the air-conditioning system is cranked up (to create a cooler room temperature), everyone in the room may still not be pleased. It is a problem that women may feel uncomfortable with cooler room temperatures and need to keep a blanket over the legs all the time. Even if the room temperature is controlled according to the set points, spatial and temporal distributions cannot be avoided, and there are individual differences in comfort and productivity. Therefore, if information on individuals' physical characteristics, preferences, and behavior is used to increase the adaptability of the environmental condition to the individual, these individual's quality of life (QoL) will improve. This is what we call life management.

This life management allows the comfort and productivity of individuals to be increased much more. This may have a positive effect on the real estate value for building owners. Greater productivity will lead to higher profit from limited work hours—something that will prove very attractive to tenants. An office's personnel expenses are said to be a hundred times its energy costs; comfortable and productive office environments will increase cost-effectiveness, which should be an attractive proposition to building owners.

Ostensibly, energy management and life management are independent of each other. However, insofar as life management is supposed to improve QoL, individuals' adaptability needs to be enhanced by unevenly distributing spatial and temporal environment conditions. It is necessary to measure QoL in a certain spatial location and time, and environmental control has to be changed from conventional common space to individuals to make the environmental condition uneven. Once the environmental condition has been distributed in this way, the environmental loads (in the case of cooling, the amount of heat removed from the room) will change accordingly, so energy savings may be achieved by cutting the loads. For both energy management and life management to function optimally, they must work in sync with each other.

Thus, the coupling of energy and life management work will produce a synergy that optimizes both energy efficiency and workers' QoL and, in turn, create economic benefits. The conventional (and poor) approaches to energy saving have undermined QoL and impeded economic activity. However, by pursuing energy management alongside life management, one can create an ongoing decarbonization cycle in the existing building stock. In other words, it is possible to innovate energy saving together with QoL (see Fig. 5.8).

To ensure that this vision of coupled management becomes a viable business model at the operational stage, it will be essential to make building owners realize that energy management will attract ESG investment and that life management will attract both ESG investment and tenants.

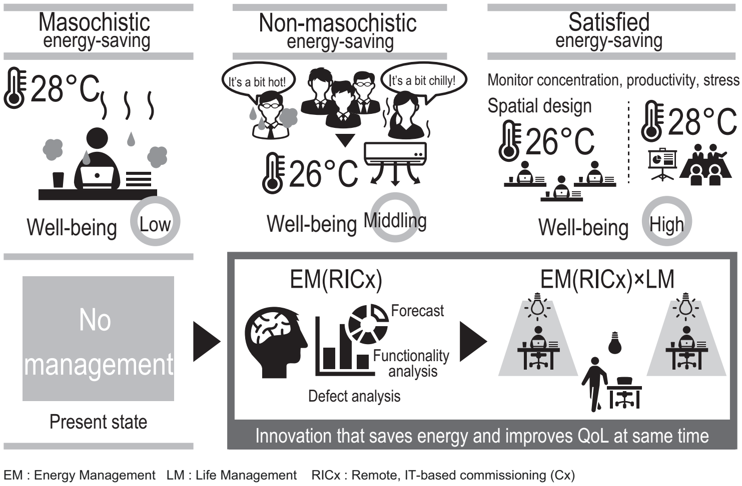

Fig. 5.8 Masochistic energy saving, non-masochistic energy saving, and satisfied energy saving

The next section aims to give readers a better overall idea of "energy" × "life" management by outlining the concept through the lens of life management.

How Business Customs Affect Energy Use

If you look around the lecture rooms of a university campus, you will usually find a room with a single occupant who is busy studying, taking advantage of the room's bright lighting. The atmosphere of the room is conducive to concentrated study, so the student can get plenty of work done there. If it is the middle of summer or winter, the student will surely feel more comfortable if the room is air-conditioned. Regardless of how that student feels, it is obvious that air-conditioning this room, which is vacant but for that one student, is not an efficient way to use energy. However, the student is probably not concerned with this fact. Such lack of awareness is problematic. Is there no way that we could inform this student of how much energy his/her activity is consuming? Can we not convince him/her to continue his/her studies in a different location? As things stand, if a member of the teaching staff or the porter admonished the student, he/she would probably walk out in a huff.

Surely, many students have found that they get much more work done if they study in a café with a laptop, compared to when they study at home. Likewise, a growing number of white-collar workers are becoming "digital nomads" and carrying out their work in cafés. One must pay for the price of a coffee to "rent" a coffee space, but this poses no problem for the digital nomads. The return this investment promises—the comfortable space and productivity boost—far offsets the price of a coffee. It is also an energy-efficient way of working, because the air-conditioning is being shared with others. What is more, the café makes money, so there is an economic benefit too. This option is even more appealing if the café is a short walk from home; you will not need to consume energy in traveling to the café, and will get some exercise into the bargain. The students and digital nomads using these cafés are contributing to society to a surprising extent, albeit unwittingly. Can we not find a way to let them know how much they are contributing to energy efficiency?

Studying alone in a classroom and studying in a café are both habitual behaviors. Both environments are conducive to comfort and productivity. In these environments it is not necessary to make a conscious effort to study; in other words, there is minimal mental burden—one instinctively performs the habitual behavior. The former habit (studying alone in a classroom) uses plenty of energy, while the latter (studying in a café) is energy efficient. Hence, it would be preferable to replace the former habit with the latter.

Nudges

One often hears the term behavior change theory, which refers to theories and strategies concerning positive behaviors such as abstaining from smoking or alcohol or improving diet. The term became widely known, thanks to the application of behavioral therapy, a form of psychotherapy that sets out clinical interventions based on learning/behavior strategies. James Prochaska developed the transtheoretical model of behavior change (TTM). The TTM consists of five stages of behavior change and ten processes of change, of which five are empirical and five are behavioral. Prochaska argued that the key to successfully changing behavior is to strike the right balance between the positive and negative effects of the behavior change and to gain self-esteem. The physical and mental burdens associated with changing behavior must be offset. Stated differently, the change in behavior should lead to physical and emotional well-being and entail only minimal discomfort. The sense of satisfaction the person gains at changing their behavior motivates them to sustain the positive behavior.

A related term, one that often comes up in economics and marketing, is "nudges." A famous example of a nudge is the image of a housefly painted onto the urinals in men's public toilets. Notices imploring men not to make a mess during their micturition have met with only limited success. The image of a housefly, however, presents a "target" at which men will feel naturally inclined to aim. This ingenious leveraging of behavioral psychology has resulted in much cleaner toilets. Economist Richard Thaler made nudge theory widely known. Drawing on behavioral economics, Thaler outlined his ideas of nudges—ploys and strategies that "nudge" people into performing the desired behavior by their own volition rather than coercing them. People can be nudged by descriptive as well as injunctive norms. Descriptive norms concern perceptions of how people do in reality behave (whether rightly or wrongly). An example of a descriptive norm is the idea that if a crowd of people are crossing the street even though the light is red for them, you too can cross without fear. On the other hand, injunctive norms concern perceptions of how people should behave. You might be inclined to follow everyone else in crossing the street on a red, but you *should not* really do so. When it comes to energy saving, however, the reverse is true: if you notice that everyone else is saving energy, you might be inclined to follow suit, and indeed you *should* do so.

Life Management in Society 5.0

Society 5.0 remains somewhat ephemeral in terms of its key ideas, including the resolution of social issues with development, the supersmart society where all can live comfortable lives, and real-time exchanges between cyberspace and physical space (real world). However, efforts are being made to flesh out these ideas. Ever since the arrival of the Internet of Things, vast quantities of data from the physical space (real world) are sent to cyberspace, and from the data, new information is produced, which is then fed back instantaneously into the physical space (real world). Emotions such as discomfort and stress can be detected by sensors. Sensory perceptions and atmosphere can be extrapolated and communicated to others or relayed to remote locations. It will then be possible to forecast energy consumption and behavior. Society 5.0 will offer great value in terms of how information, sensory perceptions, and forecasts can be employed in real time. The ability to forecast and broadcast subjective human experience will help people adopt more pleasant behaviors; moreover, it will make it possible for the small choices that people make to generate sizable social value.

Let us consider free time as an example. Many workers in Japan skimp on break times to get more work done. This practice is problematic because it causes a buildup of fatigue. When you take breaks, your net working hours are less. Many Japanese workers avoid breaks for this reason—because they dread being thought of as lazy. Society 5.0 advocates well-timed, effective breaks. Fatigue and productivity can be continuously monitored. You could view real-time data that tells you how much employees could restore their productivity by taking a rest at a given time and how soon they might be able to complete their tasks. Stimuli, such as aromas, vibrations, sounds, or illumination, could be used to induce workers to take breaks. Then, objective data could be shown illustrating the uptake in performance following the rest compared to before. This data would help convince workers to rest—as they would see that taking a break is not synonymous with being lazy. More rest times will also help save energy because computers and lighting will be shut down during rest times. Workers will be able to see data informing them of how much they are contributing to energy efficiency.

That student in that classroom could avoid being scolded by doing his/her studies in a café instead.

5.4 Local Co-creation and Data-Driven Urban Planning

Why Data-Driven Urban Planning?

An important part of urban planning is transport. During the 1950s, Chicago became the first city in the world to introduce quantitative methods into its transport plan. As for Japan, the Hiroshima Major Metropolitan Area introduced the "person-trip" survey, leading to widespread use of the survey across the country in transport planning. Following Hiroshima's example, Japanese cities with populations of over 300,000 began to conduct the survey, sampling 3–5% of their populations. The survey data were used to guide and evaluate urban planning after the high economic growth period. The rise of this approach was underpinned by computer technology (see Fig. 5.9). Engineering workstations made it possible to run transport simulations that engineers could easily relate to. Economist Daniel McFadden used a behavior model to predict ridership demand on San Francisco's Bay Area Rapid Transit (BART) system. In 2000, McFadden won the Nobel Prize in Economics for his development of a model for analyzing discrete choice.

In actual urban traffic planning, you collect survey data on people's daily travel behavior, tally up volumes of the various travel paths, use the relevant statistical models to predict future travel behavior (such as generation/attraction, distribution, split, traffic assignment), and then formulate the transport plan accordingly. This process is based on mathematical models of transport that were developed 50 years ago. The data collection was paper based, but the data on people's daily transport behavior have grown increasingly sophisticated. Since the turn of the century,

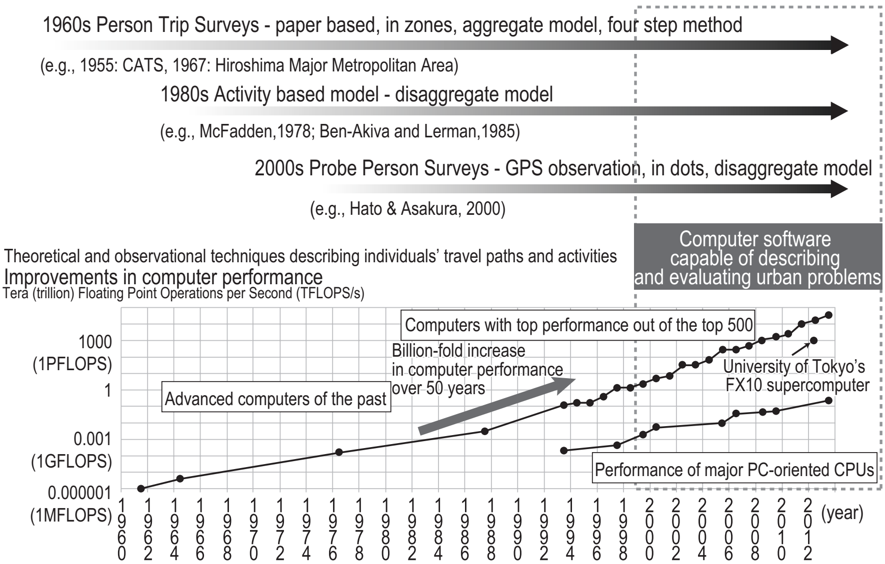

Fig. 5.9 Relationship between improvements in computer technology and urban planning

Japan has seen the emergence of the "probe person survey." Thanks to mobile communications, the probe person data are increasingly becoming directly available to urban planners. Indeed, we are close to the age of data-driven planning. Yet, so far these new methods have failed to gain traction in urban planning. Why?

Urban Planners Lose in a Lawsuit

In June 1989, an environmental organization called the Sierra Club Legal Defense Fund sued the Metropolitan Transportation Commission (MTC) of San Francisco. Why? The MTC had developed a model in 1977–1978, but it had failed to calculate the precise equilibrium values between the sub-models owing to the limitations of computer software at the time. The MTC argued that the construction of highways would ease congestion and improve the environment. This argument was premised upon the following causal chain: highway construction → highway capacity increases → highway speed improvements → lower emissions. The Sierra Club's retort was that the MTC's model failed to adequately account for the induced travel that resulted from congestion being eased.

What was the result of the trial? The MTC did not lose the case as such (the court accepted the plan to construct the highways), but the judge ordered the commission to make several revisions to the plan, effectively forcing it to develop new transport planning techniques. The defendant nominated individuals to serve as technical experts in the case. The plaintiff, being the world's largest environmental organization, did so too. The court appointed one of the nominees as a technical expert and, based on his insights, found that the MTC's transport-demand estimates were flawed.

Transport and urban planning often become subject to litigation. The reason is that urban plans restrict people's constitutionally enshrined land-use rights and affect their lives over a long period in the name of the public interest. It is now clear that public will not be convinced of the merits of public projects based on the actors who implement them or the procedures under which they are implemented. Accordingly, advocates of public projects must find ways to justify the projects on more rational grounds—i.e., they must proffer rational reasons justifying the public interest nature of the project. Accordingly, advocates must use data to adequately justify the project. Insofar as urban planning is a public act, the planners must be accountable to the public. Of course, in the interest of data privacy, the planners must not use personal data recklessly. However, when the public does not see the data, they may end up accepting a cobbled-together plan without that plan undergoing any improvements and, as a result, the public's freedoms may end up being significantly curtailed. Hence, urban planning must be data driven so that the public can understand which groups might be inconvenienced, when they may be inconvenienced, and how.

Examples of Data-Driven Planning

At present, it is not easy to pin down the meaning of data-driven planning. Arguably, conventional urban planning could be defined as data driven in that it used data (namely the "person-trip" survey data). The issue does not concern the technique then. Rather, it concerns whether the plans are scrutinized and debated with reference to quantitative data. If you live in a city with a population of over 300,000, you could check to see how many years it has been since the last "person-trip" survey was conducted. If the survey was conducted more than 15 years ago, then you should see this as a red flag. It indicates that the city should revamp its traffic system urgently, reconfiguring the travel paths in districts with aging populations and redistributing road routes to foster communities within walking distance. Because there is now the demand that new initiatives accord with the circumstances of local communities, we should be wary of plans or policies that are not shaped by comprehensive and quantitative survey data.

Figure 5.10 shows an example of smart planning in Kobe's Koikawa-suji street. When Kobe City revamped a district in the city center, it took a data-driven approach: it used Wi-Fi data and data from a "probe person survey," in which subjects carry GPS mobile phones and make online travel diaries so that their travel paths are traceable online. As the figure shows, Kobe City presented simulated outcomes of its project to expand sidewalks and create pedestrian-only environments, including number of visitors, city center stay time, city center walking distances, distances from entrances, and stay time in given locations. The data illustrated that creating pedestrian-only environments would be very impactful and enliven the area. The stakeholders (e.g., a local retailer association, Kobe City, transport companies, the police) discussed the plan with reference to the numerical data.

	Present state produced	Sidewalk extension	Enhancement/ pedestrian-only environments
Number of visitors	2.21	2.10 (-5.0%)	2.11 (-4.5%)
Minutes spent in city center	267.8	279.4 (+4.3%)	271.6 (+1.4%)
Meters walked in city center	432.6	441.7 (+2.1%)	540.5 (+24.9%)
Maximum number of meters walked from entrance point	200.5	189.5 (-5.5%)	225.0 (+12.2%)
Minutes spent in each area	124.2	130.4 (+5.0%)	125.5 (+1.0%)

Fig. 5.10 KPIs for project to redistribute pedestrian space in the Motomachi area

The Future of Cities

The city is humankind's greatest invention. Cities house enormous economic potential as illustrated by the fact that many companies claim that business-to-business innovation is only possible in Tokyo. On the other hand, in *Urbanism as a Way of Life* (Wirth 1938), Louis Wirth defined cities as places that require urban planning to control the size, density, and heterogeneity of the population aggregate. These urban issues continue to pose challenges to urban planners in the twenty-first century. There is little sign of progress in solving issues such as energy, migration, and congestion; on the contrary, these issues have grown in severity. Many creative millennials will be living the 100-year life, but these individuals tend to opt for more fluid lifestyles. Increasingly, people select the city rather than the city selecting them. Cities are great for doing things on a large scale and doing things efficiently, but urban environments often lack a human touch—that sense of inspiration and sensuality. Humans are social animals, and we seek environments that enliven us sensually and provide emotionally stimulating interpersonal encounters. What then is the ideal urban environment to aim for?

Figure 5.11 shows a photo of an urban design school that forms part of the Urban Design Center Matsuyama (UDCM). It also shows a green space called Minna no Hiroba; both are undertakings by Matsuyama City, Ehime Prefecture. Matsuyama City was full of car parks, so we decided to construct a green space, Minna no Hiroba, in a car park a little away from the commercial district in the city center. We ripped up the asphalt and found an old well. After running tests on the water, we formed a knoll with a fountain in the center for the public to enjoy. The fountain is now a spot where children gather. We also set up the abovementioned design school in a boarded-up shop across from Minna no Hiroba. The design school serves as a forum for discussing community-building projects that use Matsuyama's resources, including camellias and "Iyo-Kasuri" fabrics.

Fig. 5.11 Minna no Hiroba (Matsuyama, left) high line (New York, right)

There is increasing interest in the benefits of creating open spaces in urban environments that would otherwise be saturated with drab, utilitarian features. There is also interest in how higher quality spatial designs can generate novel ideas regarding urban stock such as car parks, roads, and elevated walkways.

An example of the latter is New York's High Line (the photo on the right in Fig. 5.11). The High Line is a linear green space running along what was once an elevated railway line. The structure was about to be destroyed, but Joshua David and Robert Hammond led a campaign to save the High Line and renovate it as a relaxed parkland. Their organization keeps the site clean and cultivates gardens with many different kinds of vegetation. How can we shape our urban environments? As democracy withers, cities around the world need more than ever to have people-centric urban planning that is grounded in data and behavior.

Transcending City Boundaries

The use of data does not guarantee that the city will improve. Urban planners need to have data on their side. Cities face a mountain of problems. A major task in the twentieth century was how to introduce automobiles into cities. In the twenty-first century, urban planners must work to find ways to introduce automated driving into cities, which requires hitherto unseen urban designs. When it comes to Society 5.0, we must work out what such a society should look like. Local communities, public

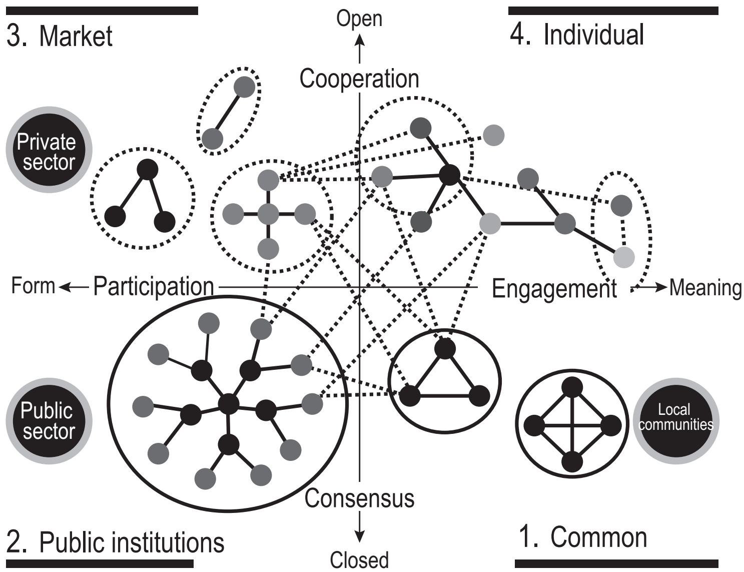

Fig. 5.12 Data-driven planning

institutions, markets, and individuals can each play a leading role in mapping out this society. However, each society has weaknesses. We must support and augment each society by engaging, cooperating, and sharing ideas (see Fig. 5.12). Cities will lose their spark if they are too homogenous. Likewise they will fail if they are too disorganized and incoherent. The boundaries of cities should be flexibly defined so as to ensure human and urban creativity as well as stability and security. Data-driven planning is nothing more than a means to prompt dialog on urban boundaries. Without this dialog, urban boundaries will become rigid. This is something that we must avoid.

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