Chapter 2
Habitat Innovation

Hideyuki Matsuoka and Chiaki Hirai

Abstract Society 5.0 balances the best interests of the society as a whole, which involves the resolution of social issues, with the best interests of individuals, which is the indication of a human-centered society. In this chapter, we discuss the key performance indicators (KPI) formula as an approach to balancing these two factors. Under the context of "Habitat Innovation," the following approach is proposed to address social issues. In Habitat Innovation, the KPIs are factorized into three components that are "structural transformation," "technological innovation," and "quality of life (QoL)." Government leadership is required for "structural transformation." This component suggests ways in which the cyber-physical convergence framework can be deployed in the policymaking process. The "technological innovation" component tells us how the cyber-physical convergence framework can help to create a resource-efficient society. The "QoL" component can prompt us to deploy data in a way that generates new services for supporting people's QoL. In Habitat Innovation, the insights of engineering, social sciences, humanities, and many other disciplines are used to analyze what QoL means at an individual level and to identify the role that policy and technology should play in enhancing it. Examples using the Habitat Innovation framework to solve key social issues are shown.

Keywords Key performance indicator (KPI) · Quality of life (QoL) · Social issue · CO_2 emission · Technological innovation

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2.1 The Social Issues Japan Faces

The Social Issue Drivers

The problems Japan faces are legion. The country's birthrate will continue to fall, and its population will continue to age. Rural communities are dwindling, and many will decline and become abandoned and desolate. Meanwhile, the population is increasingly concentrated in cities, leading to traffic congestion and a heightened risk of mass-scale damage in a natural disaster. Though cities are supposed to be large population centers, the service-sector jobs therein are increasingly understaffed. Despite the labor shortage, wages are by no means high, and increasing numbers of young people are in non-regular employment, driving down the birthrate even further. As the workforce shrinks, so does tax revenue. Nonetheless, government spending will continue to rise because of the need to maintain crumbling infrastructure. These factors, coupled with the swelling welfare budget necessary for coping with the graying population, are placing an ever-heavier burden upon the working-age population.

How is Japan to deal with these problems? Rather than addressing the symptoms, it is better in many cases to identify and treat the root causes. Hence, we will distinguish the social issues themselves from their causal factors. These causal factors can relate to the social issues in very complex, interwoven ways, but if we trace the root causes, we should uncover phenomena that our society, like it or not, will have to acknowledge. It is these underlying phenomena from which social issues derive.

Let us clarify what we mean by "social issue." We define a social issue as a problem in a society that deprives many of that society's members of their lives, property, freedom, or dignity. We shall call these "social issue drivers" to describe the underlying phenomena that cause these social issues, and which our society must acknowledge, however inconvenient. Social issue drivers are not in themselves problematic. To take the graying population as an example, we could call this trend a social issue driver rather than a social issue, because it can cause the welfare budget to swell, which in turn can lead to significant losses in young people's disposal income (their property). In this case, the outcome (young people have less disposal income) is the social issue. What are some of Japan's social issue drivers (the factors that cause social issues)? What issues do these social issue drivers cause?

A Shrinking Labor Pool

Japan's birthrate looks set to continue falling for the time being. This trend has three main effects. First, it leads to an overall population decline and, more importantly, to a decline in the young population—and thus the working population. As Fig. 2.1 shows, the working-age population currently (as of 2015) stands at 76 million, but forecasts indicate that it will dip as low as 52 million by 2050 (Cabinet Office 2017).

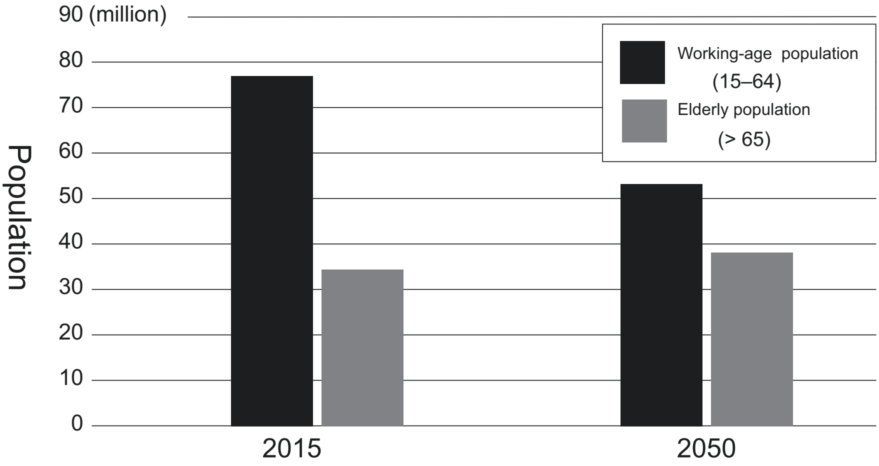

Fig. 2.1 Working population decline (Cabinet Office 2017). Source: Cabinet Office, *Annual report on the aging society*, 2017

A graying population also means that many people of working age will leave the workforce to care for their elderly parents.

Although the labor pool as a whole is shrinking, regional disparities in the labor market have emerged, creating unstable supply and demand. Japan once pursued an economic growth model based on manufacturing. Under this model, both urban and rural areas benefited from economic growth. Manufacturers would establish factories and secure workforces in rural areas, and a transportation infrastructure linking these rural areas of production with urban areas of consumption enabled a reduction in the cost of distributing people and goods. However, the industrial structure has now shifted from manufacturing to services, and many businesses have relocated their factories overseas. This development has deprived rural areas of job opportunities, forcing many young people to move to large population centers. Despite the influx of young workers into cities, insufficient number of workers to prop up the service sector still remains. Convenience stores and transport businesses, for example, are increasingly facing the effects of staff shortages. These understaffed businesses are then criticized for making their staff work long hours and for their failure to maintain service standards.

One possible solution to this problem is to introduce AI and robotic technology. However, unstaffed convenience stores, automated driving, and other forms of radical automatization would result in many jobs being lost. With fewer job opportunities, the young people who came from rural areas would be forced to take low-paying jobs, which offer no prospects for getting married and raising a family. Consequently, the birthrate would plunge even further. Thus, cities absorb rural populations, but they fail to facilitate population increase; consequently, the overall Japanese population continues to decline while also becoming overly concentrated in cities.

Consumer Sparsity

The second effect of the falling birthrate is a sparser rural population. Over the years, Japanese population growth has been accompanied by an expansion of cities. However, it is difficult to accomplish the reverse—to downscale neighborhoods in tandem with the shrinking population. Because they receive an influx of workers, large population centers remain densely populated despite the general population decline. On the other hand, provincial cities and their suburbs become more sparsely populated. This trend means that core public services, including energy, water, education, and healthcare, must be supplied to a consumer population that is distributed sparsely over a large area. When it comes to infrastructure, the problem is not just the absolute population decline; another problem is what we call "consumer sparsity"—a consumer population that is distributed sparsely across a large area (there is a decline in population density). The greater the rate of consumer sparsity is, the higher the infrastructure-related costs per consumer are. When these costs cannot be borne, the quality of the services declines. If there is no adequate water infrastructure, for example, residents might have to head out every day to water supply facilities and haul back water to their homes.

Aging Population

The third effect of the falling birthrate is an aging population. This effect is also related to another causal factor: people are living longer. An aging population means that older people account for an ever-greater share of the overall population, a phenomenon caused by both the falling birthrate and longer lifetimes. With fewer of the population in work, economic growth stalls and national and local governments receive less tax revenue. Nonetheless, an older population entails higher social welfare spending (see Fig. 2.2) (Ministry of Health 2012). With national and local governments in poor fiscal health, citizens must either accept lower quality social welfare or shoulder a heavier burden to maintain social welfare at its current level. Less tax revenue also deprives government of the financial resources necessary to address social inequality or assist vulnerable members of society, resulting in entrenched intergenerational inequality. This situation increases social insecurity, and it robs marginalized people of opportunities by which they could otherwise use their talents. Consequently, Japan will lose its competitiveness, and its productivity will decline further.

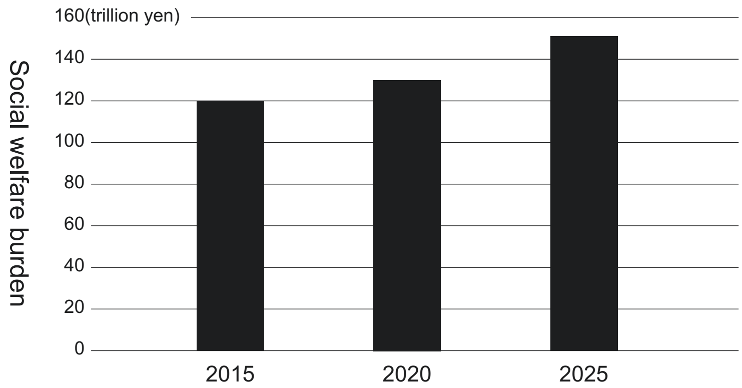

Fig. 2.2 Rising social welfare burden. Source: Ministry of Health, Labour and Welfare, *Shakaihoshō ni kakaru hiyō no shōraisuikei no kaitei ni tsuite (heisei 24 nen 3 gatsu) [Revision to future projection of costs required for social security <March 2012>]*

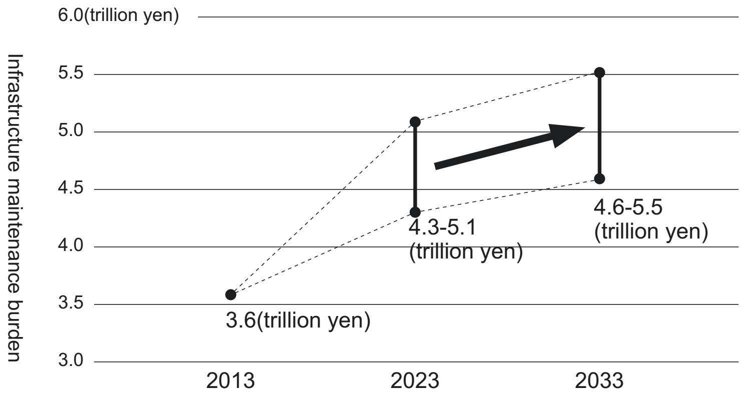

Fig. 2.3 Rising infrastructure maintenance burden. Source: Ministry of Land, Infrastructure and Transport, *ShoraiSuikei [Future projections]*

Aging Infrastructure

As we just learned, consumer sparsity leads to inefficient usage of infrastructure, but crumbling infrastructure is an independent social issue driver besides the demographic problem. Japan's basic infrastructure was developed at a massive scale during the country's high economic growth period, during the 1950s, 1960s, and 1970s. With more than half a century having elapsed since then, Japan's roads, bridges, waterworks, and other infrastructure are decaying, placing upward pressure on social costs (see Fig. 2.3) (Ministry of Land 2013). According to estimates, around 190 trillion yen will need to be provided for infrastructure renewals over a 50-year period from 2011 to 2060.

Shift to Renewables

In some cases, infrastructure needs to be innovated due to global pressure. As one of the countries that signed the Paris Agreement at COP21, Japan has pledged to the world that it will work toward a low-carbon society. Accordingly, the country is committed to a shift toward renewable energy sources (see Fig. 2.4) (Ministry of the Environment 2015). The levels of energy yielded from renewables such as wind and solar power fluctuate and cannot be controlled. As such, when society shifts to renewables, it will struggle to balance the energy supply and demand. The society will also face problems related to frequency trimming, controlling reverse power flows, and dealing with voltage fluctuations. In addressing these problems, the society will need to invest more in power system facilities and raise energy prices to reflect energy yield and storage unit prices. It must also contend with a destabilized power system resulting from the diminished ability to adjust energy demand and supply. Such responses generate new social issues.

Stated differently, to achieve a carbon-free society, Japan must lower renewable energy prices, promote energy saving and more controlled supply and demand in large population centers (where energy consumers are clustered), and provide energy at lower prices to a sparsely distributed consumer population in provincial cities and their suburbs. If Japan fails to deal with these tasks appropriately, energy prices will rise and the power system will become destabilized. These outcomes will then have negative repercussions; as well as causing inconvenience for consumers, they will make businesses less competitive, thus hindering Japan's economic growth and undermining the country's productive capacity.

Figure 2.5 illustrates the above dynamics. There are three relational elements. The first is social issue drivers, which describe unavoidable social trends. These social issue drivers give rise to the second element, which is social issues. Social issues then affect the third element, which is quality of life (QoL).

The next section outlines our view on how we should deal with the social issues.

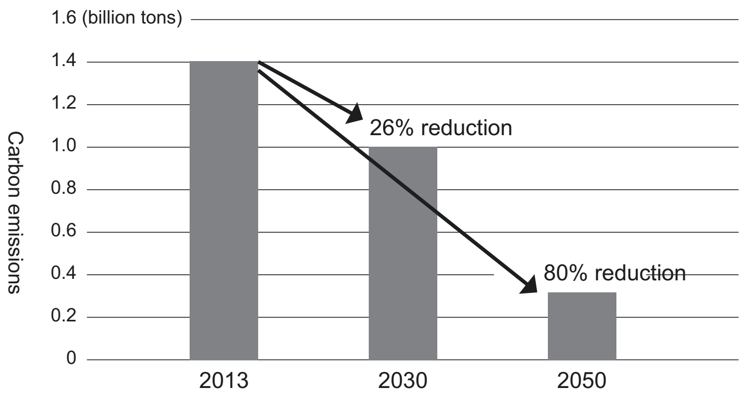

Fig. 2.4 Carbon reduction targets. Source: Ministry of the Environment, *Nihon no yakusokusōan (2020 nenikō no aratanaonshitsukōkagasuhaishutsusakugenmokuhyō [Japan's draft pledge: new targets for reducing greenhouse gases from 2020 onward]*

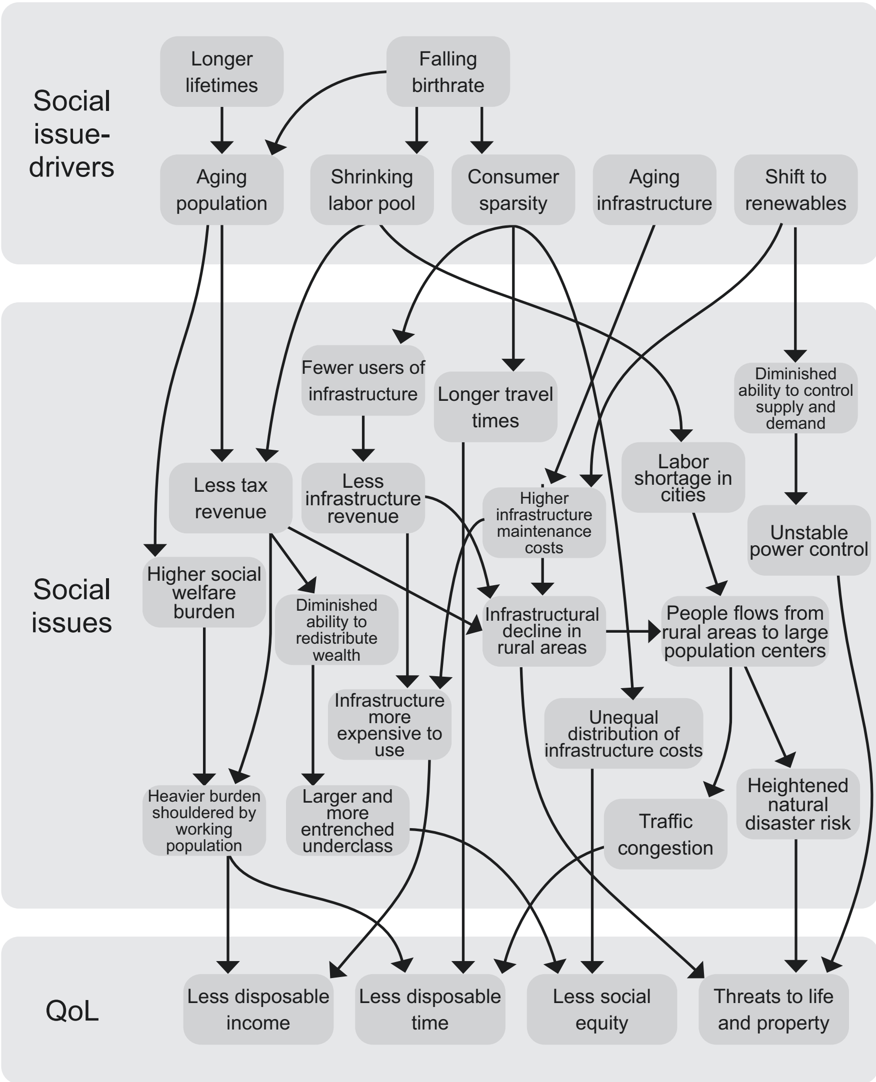

Fig. 2.5 Social issue drivers and social issues

2.2 Habitat Innovation Framework

Analyzing the Target KPIs

How should the social issues discussed in the previous section be dealt with? The quandary Japan faces concerns how it should accommodate growing social costs with a shrinking productive output. These social costs include monetary costs such as healthcare and infrastructural maintenance, but they also include environmental burdens such as carbon emissions. Japan's declining output is driven by its falling birthrate and aging population.

We should avoid falling into the trap of believing that the solution is to force people to live frugally. Policy outcomes can be measured with numerical key performance indicators (KPIs) describing costs and output, but too much focus on numerical targets might lure us into thinking that we should just strive to keep costs to a minimum and working hours as long as possible. One KPI is carbon emission per capita, which describes the amount of reduction in the carbon footprint per person. If we blindly focus on this KPI, we might end up believing that humans should be as inactive or frugal as possible.

However, Society 5.0 does not just aim to resolve social issues; it also advocates a people-centric society in which people live joyful and vibrant lives. Forcing people to live frugally runs counter to the core principles of Society 5.0. Habitat Innovation, which we outline in this book, focuses not only on the KPIs themselves but also on the components used to calculate these KPIs, and it emphasizes addressing these elements.

Figure 2.6 shows the formula for calculating the KPI "carbon emissions/capita." The formula shows two components of "carbon emissions/capita": the first is "carbon emissions/total energy consumption" and the second is "total energy consumption/capita." Total energy consumption represents the entirety of the energy used in Japan. Given that carbon emissions result from energy consumption, it makes sense to take the amount of total energy consumption into consideration when devising strategies for minimizing "carbon emissions/capita." These two components underscore the fact that if we manage to reduce "carbon emissions/total energy consumption" enough, we will not necessarily need to reduce "total energy consumption/capita"; in other words, we will not need to be frugal with our energy consumption.

$$\frac{\text{Carbon emissions}}{\text{Capita}} = \frac{\text{Carbon emissions}}{\text{Total energy consumption}} \times \frac{\text{Total energy consumption}}{\text{Capita}}$$

Fig. 2.6 Analysis of carbon emissions (1)

The only way to achieve the reduction in "carbon emissions/total energy consumption" is to switch to renewables. If we restructure our energy mix, raising the share of renewables (nonfossil fuels such as wind and solar power), then we can consume plenty of energy while still reducing carbon emissions.

However, switching over to renewables for all our energy needs is not feasible in the short term. So does that mean that, for the time being, we limit our energy consumption as much as possible, so as to minimize "total energy consumption/capita?" Let us change the angle slightly and ask this: Is quality of life proportionate to energy consumption in the first place? In asking this question, we are not trying to suggest that we should look to more nonmaterial forms of comfort. Rather, we are suggesting that total activity and energy consumption are, to some extent, independent of each other. For example, if your air conditioner automatically deactivates airflow when the room is vacated, you could save energy without sacrificing any comfort. Similarly, if you replace your light bulbs with LED bulbs, you could cut your energy consumption while enjoying the same light levels as before. Technological progress enables us to maintain the same level of total activity (for example, engaging in work or leisure activities after dark) and still reduce energy consumption (such as by installing LED lighting). With this in mind, we have taken "total energy consumption/capita" in Fig. 2.6 and broken it down into two further components (Fig. 2.7).

Deriving an Approach from the Formula

Figure 2.7 shows three components of "carbon emissions/capita": "carbon emissions/total energy consumption," "total energy consumption/total activity," and "total activity/capita." These are the three factors we analyze in Habitat Innovation as part of our effort to usher in Society 5.0.

The social issue in question concerns the need to minimize "carbon emissions/capita." However, individual members of society wish to increase the third compo-

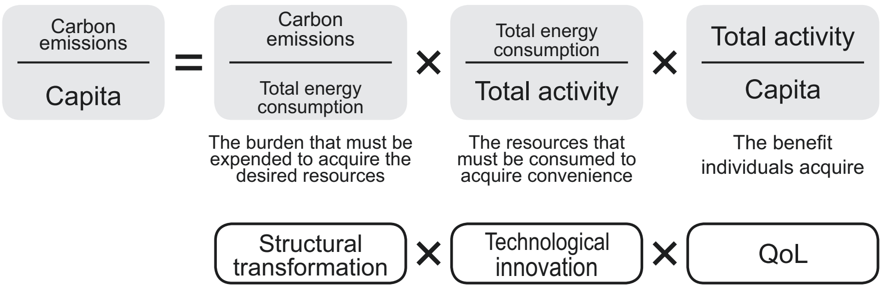

Fig. 2.7 Analysis of carbon emissions (2)

nent—"total activity/capita." To balance these two interests, we must sufficiently reduce the first two of these components ("carbon emissions/total energy consumption" and "total energy consumption/total activity"). To reduce the first component, "carbon emissions/total energy consumption," we must transform the very structure that generates social costs, as in the case of carbon emissions. Let us call this task the "structural transformation." Structural transformation requires government leadership. On the other hand, to reduce the second component, "total energy consumption/total activity," we must find new ways to enjoy a full life—ways that do not require us to use too many resources. To this end, we must look to technology, including automation, optimization, and energy efficiency. Let us call this task "technological innovation." As for the third component, "total activity/capita," this KPI represents our quality of life (QoL). Total activity is in large part conceptual; we do not define it as a numerical metric. In fact, the main point of this formula is to prompt a discussion of how we should define QoL.

Habitat Innovation is not only concerned with environmental issues. Rather, it uses the threefold analytical paradigm (structural transformation, technological innovation, and QoL) to explore how to minimize a whole range of social costs and how to boost productivity.

In Chap. 1, we described Society 5.0 as a data-driven society based on cyber-physical convergence. How does this ICT-infused vision relate to Habitat Innovation's formula? Cyber-physical convergence is ultimately a framework. Habitat Innovation, on the other hand, provides some direction by exploring how we should deploy this framework.

The "structural transformation" component suggests ways in which the cyber-physical convergence framework can be deployed in the policymaking process. To effectuate a massive structural transformation in society, policymakers must analyze quantitative data about the status quo, forecast future trends, and compare potential policy options with existing precedents. In the case of carbon emissions, they must analyze energy demand, forecast long-term energy trends, and evaluate the technological and economic feasibility of renewables. An effective approach for analyzing energy demand would be to visually model societal trends using data gathered from the physical space (real world). An effective approach for the forecasting and evaluation processes would be to run simulations in cyberspace.

How does the "technological innovation" component help us? It tells us how the cyber-physical convergence framework can help bring about a resource-efficient society. Cyber models that minutely recreate the real world can help us understand how best to use resources so as to minimize waste. For example, if we can predict the overall pattern of people flows in a city, we can customize transport, lighting, and air-conditioning patterns to these movements so as to avoid waste.

As for QoL, this component can prompt us to deploy data in a way that generates new services for supporting people's QoL. It also emphasizes that residents should take the initiative in using data to make a change in society. When data are used to gain quantitative insights into social issues, they allow all the stakeholders, including government, businesses, and residents, to share their views and discuss the issue on a level playing field. In this sense, data are a crucial tool for encouraging residents to come forward and communicate their interests and concerns with government, businesses, and each other.

Residents as the Actors of Innovation

There are existing cases of structural transformation and technological innovation in practice, and these have been led by government and businesses. Government has been the instigator of structural transformation, while businesses have been the actors of technological innovation. However, the critical impact of the data-driven society is the potential for residents to use data and become the chief actors of innovation. It was with this in mind that we named our approach Habitat Innovation.

However, individual residents will only respond to this opportunity once the practice of resident-led data gains traction. Additionally, the public must use the data effectively. Otherwise, the stability of society might be threatened. For example, data might be leveraged by some residents for their own personal ends, or the government might become wary of letting the public take the lead if public opinion is too easily swayed by a short-term outlook. We must therefore ask the question: How can we ensure that the public, government, and businesses are sufficiently literate for the digital age?

Government and businesses must use reliable data and become more open. The public, for their part, must engage with government and businesses continually and proactively while generating data themselves, and government and businesses must duly respond to them. To ensure that this cycle leads to a more data-literate society, it is essential to progressively develop best practices and foster a conducive culture. Once there is a critical mass of stakeholder consultations over services, technologies, and laws, the public will increasingly become the chief actor of society, and innovation will be increasingly instigated by and for the public. This is what Habitat Innovation is all about. According to Habitat Innovation, once the public take the initiative in using data, it will be possible to balance the resolution of social issues with economic growth and create the conditions necessary for sustainably transforming cities; this is how Habitat Innovation can help usher in Society 5.0.

In Habitat Innovation, the insights of engineering, social sciences, humanities, and many other disciplines are used to analyze what QoL means at an individual level and to identify the role that policy and technology should play in enhancing it. Habitat Innovation further proposes that alongside this, we should develop platforms that enable interdisciplinary data sharing, technologies that can simulate the benefits for society and individuals, and a system architecture that precisely tracks and responds to long-term demand fluctuations and latent needs. These developments must be practically applied in a manner that puts the public first, so as to achieve a sustainable Society 5.0.

The next section analyzes several social issue drivers through the lens of Habitat Innovation. In each case, the more one contributes to structural transformation and technological innovation components, the more the QoL component is improved.

The question of how to improve QoL, which includes the matter of how to define it, is discussed throughout this book; for now, we will discuss strategies for improving the other two factors: structural transformation and technological innovation.

2.3 Using the Habitat Innovation Framework to Solve Key Social Issues

Shift to Renewables

As a means of achieving a carbon-free Japan, the task of shifting to renewable energy entails many social issues. In shifting to renewables, Japan must develop the necessary transmission and distribution infrastructure. This infrastructural requirement will force up energy prices. Energy prices will be further increased by another factor: energy still costs more to generate from renewable sources than it does from conventional sources. Another issue concerns the difficulty of adjusting energy demand and supply; as energy yields vary depending on the weather, it is not always possible to generate energy on demand. Imbalance in supply and demand incurs the risk of major power outages.

Habitat Innovation aims to reduce carbon emissions while maintaining happy and comfortable lives. The formula in Fig. 2.7 provides a working framework for balancing comfort and happiness with carbon emission reduction. The component on the far left, “carbon emissions/capita,” represents the amount of carbon dioxide emitted per person. To minimize this metric would be in society’s best interest. “Carbon emissions/capita” is the result of multiplying the three components on the right with each other (“carbon emissions/total energy consumption,” “total energy consumption/total activity,” and “total activity/capita”). Because the principle of Society 5.0 is to maintain or maximize QoL (the third component in our analytical paradigm), we can only reduce the other two components.

Structural Transformation

In this case, structural transformation underscores the importance of reducing the amount of carbon dioxide we produce when consuming a given amount of energy. In other words, it implies that we must increase renewable energy as a share of the total energy we use. In doing so, we must fulfill three requirements: our energy must be ecologically sustainable, stable, and economically viable. Accordingly, when considering the basic power system, for instance, we must ensure that local power distribution networks are able to deliver power to consumption zones within the region, and that the broader power transmission networks can deliver power across each region. To ensure the stability of the power system, it will be necessary to deploy IT-based and finely tuned control technologies. To forecast demand more effectively, it will be necessary to gather data from stakeholders, including businesses and social actors. Policy recommendations will be essential in encouraging investment in facilities and innovation, as well as in facilitating the gathering and deployment of data.

Technological Innovation

In this case, technological innovation is a means to eliminate wasteful energy consumption at a society-wide level. The aim is to encourage society to use energy less wastefully, so as to bring down the total energy consumption without having to effectively curb people's activity. In public transport, for instance, if timetables were regulated dynamically to reflect ridership levels, it would help curb wasteful energy use. Another example is courier services, where much energy is spent on redeliveries (due to the absence of the recipient). Technology could help couriers cut out wasteful energy use by monitoring whether recipients are at home and by plotting the most efficient routes. Of course, these technologies must be accompanied by technologies that ensure personal privacy. Industrial actors and large building operators could combine data gathered from IoT devices and sensors to derive precise estimates, from which they could run simulations so as to minimize peaks in energy use or share energy with other regions. Such action will optimize the overall supply of energy; moreover, when we do switch over to renewable energy, this action will have enabled us to prevent a wasteful swelling of the energy supply facilities. It will be good news for consumers too: electricity rates will be lower. Technological innovation also has a crucial role to play when it becomes necessary for consumers to change their habits. That is, technology can help consumers pursue their desired activities in more flexible ways and ultimately guide them into more energy-efficient behavior. To enable such technological innovation, we first need to develop a data networking infrastructure spanning social actors and industries.

The Shrinking Labor Pool

Japan's labor pool is shrinking because of its dwindling population, itself a result of the falling birthrate. Japan currently relies on foreign workers to plug the labor shortfall. In cities, many foreigners work in the service sector; in rural areas, many are propping up farming businesses. But this strategy might not be sustainable in the long term. As populations across Asia get older, Asian nations will increasingly compete over foreign workers, which may lead to lower numbers of foreign workers in Japan. Eventually, Japan's foreign workforce will start declining alongside the indigenous workforce. The labor problem is also related to productivity. Workers in Japan tend to be less productive than their counterparts in other developed nations, and they make up for this with the deep-seated practice of long working hours. Japan has some room for improvement in this regard.

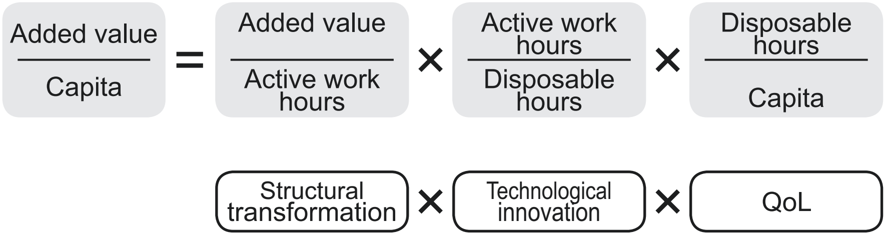

Fig. 2.8 Analysis of labor productivity

Habitat Innovation has broken down the issue into the formula shown in Fig. 2.8. On the left is "added value/capita," which represents how much added value each person produces. A society must try to maximize this metric. The KPI is the result of multiplying the three factors (structural transformation, technological innovation, and QoL) together, which are shown on the right-hand side of the figure. In this case, structural transformation represents the added value produced per working hour, technological innovation represents the number of hours that must be spent in work for each disposable hour, and QoL represents the number of disposable hours allotted to each person. In other words, structural transformation relates to productivity, technological relates to work time, and QoL relates to free time. Habitat Innovation aims to raise productivity sufficiently to allow a reduction in work time and an increase in free time. As important as work may be, a vibrant life also requires plenty of free (or "disposable") time.

To calculate labor productivity, it helps to divide work time into net "active work hours," meaning the time workers spend in value-generating work, and "waiting hours," when workers are commuting or traveling as part of their job or are waiting for the resources to be prepared. If you increase productivity per active work hour and decrease waiting hours, you will generate more disposable hours (free time). Readers ought to note that we have defined travel time and the like as "waiting hours" rather than "work hours" for the sake of convenience; whether such time is legally deemed to be work time is another matter.

Structural Transformation

In the context of this issue, structural transformation underscores the need to raise the amount of value produced per active work hour—in other words, the need to boost value productivity. Finding a place to work is an essential requirement for a vibrant life. The objective of data deployment and AI-driven automation is not to take away job opportunities but to create new industries. Historically, automation has transformed livelihoods and jobs, but it has always generated new industries too. With Habitat Innovation, industry-spanning data are combined in such a way as to yield analytical tools that can help identify new needs and business opportunities. To this end, businesses must be incentivized to move toward value-added services, and there must be a legislative infrastructure to encourage more open data, a wellspring of innovation. Another task is to offer proposals for education policies aimed at nurturing the ideal workforce—individuals with the creative ideas and practical know-how necessary to produce new value, and who can adopt work styles fit for the digital age.

Technological Innovation

Technology has a major role to play in reducing waiting hours and increasing disposable hours. For example, VR and communications technologies can cut travel time by recreating the office environment in workers' homes or satellite offices. Similarly, where once it was in the realm of science fiction, it is now becoming possible for people to port themselves into a robotic avatar and exist virtually in a remote worksite. Even when workers have to travel physically, greater travel efficiency can be realized by mobility-as-a-service (MaaS), which describes a trend to combine transportation services dynamically so as to provide the most efficient travel possible. Using data gathered from the real world, businesses can coordinate their schedules with each other to minimize lag time that would result from unsynchronized schedules.

Aging Infrastructure and Consumer Sparsity

Aging infrastructure and consumer sparsity are closely related, so we shall discuss them together. Much of Japan's infrastructure was erected during the country's period of high economic growth, and it is rapidly approaching its expiration date. To maintain this infrastructure, renewal is necessary. However, users are dwindling due to depopulation, and so there is no need to maintain the infrastructure at its present scale. Accordingly, infrastructure should be renewed, but in a manner that reflects the diminished population.

It is important to realize that we cannot simply downsize infrastructure in proportion to the population. When Japan's population was growing, neighborhoods expanded in tandem with the growth. However, in this era of population decline, living space remains as expansive as before, while the population grows ever sparser (i.e., while the density decreases). Accordingly, if service provision is scaled down in proportion to the rate of population decline, many users would be inconvenienced. Suppose that the number of elementary schools in a given area is reduced to reflect the dwindling number of children. Because the residential spaces remain as expansive as before, many families will have to endure a longer school commute. The same goes for hospitals and retail stores; when these facilities are reduced to reflect the shrinking demand, many users will have to travel further to the few that remain. Likewise, the services that deliver goods, water, and energy will be supplying these services to fewer users but over an equally large area, which means a heavier cost of service delivery per user.

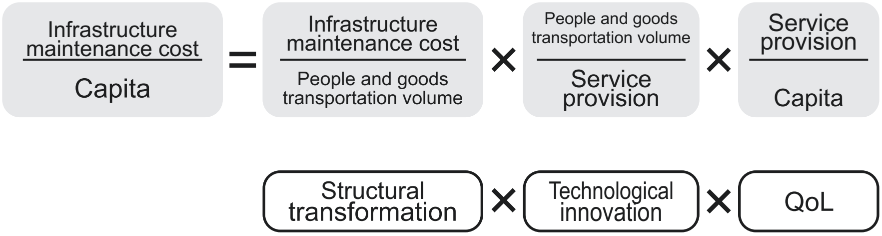

Fig. 2.9 Analysis of aging infrastructure

Consumer sparsity is associated with greater costs in terms of time and money. The problem could be solved by making communities more compact, but until then, we must find a way to ensure that sparsely distributed consumers are not inconvenienced.

Habitat Innovation has broken down the issue of aging infrastructure into the formula shown in Fig. 2.9. On the left is “infrastructure maintenance cost/capita.” Reducing this metric is in the best interest of society. On the right, the third component (QoL) is “service provision/capita.” To increase this metric (while decreasing “infrastructure maintenance cost/capita”) would align with the ethos of Society 5.0. Accordingly, we must minimize the other two components: “infrastructure maintenance cost/people and goods transportation volume” (which corresponds to structural transformation) and “people and goods transportation volume/service provision” (which corresponds to technological innovation).

To minimize the first of these two components is to reduce infrastructure maintenance costs while retaining the same level of people and goods transportation. An effective method for this is to make neighborhoods smaller. If communities are more compact, this would reduce transport distances, and we could then achieve a general decrease in infrastructure maintenance costs without needing to reduce the volume of goods delivered. However, this goal is not feasible in the short term. A more short-term measure is to reduce the second component, “people and goods transportation volume/service provision” (technological innovation). The aim here is to leverage technology to reduce physical transport volume while retaining the same level of service provision.

Structural Transformation

In this case, structural transformation means downsizing social infrastructure assets—in other words, making neighborhoods more compact. If expanses of suburban neighborhoods were reorganized into more compactly distributed neighborhoods, the infrastructure in these neighborhoods could be accessed by many more people than before. The problem, however, is that forcing people to move would run counter to the people-centric ethos of Society 5.0, as it would rob people of the ability to exercise choice in their pursuit of happiness. We must therefore make urban life attractive enough that residents naturally want to move into compact cities. Then, as the environs become more depopulated, the configuration of the social infrastructure there should be scaled back flexibly, in tandem with the depopulation rate. To take transport as an example, there should be a rail network within the city, but on the outskirts, people could use buses or car-sharing schemes. To this end, there needs to be the necessary regulatory easing and urban planning.

One effective strategy for downsizing infrastructure is to focus on minimizing peak demand. In the case of energy, for instance, storage batteries could help control peak demand, meaning that you could use smaller power generators. When the facilities are smaller, it is much simpler to phase them out. Another way to control peak demand is to enlist the cooperation of residents. For example, residents could be called on to avoid morning and evening rushes. There should be no coercion though; the infrastructure should be designed in such a way as to incentivize cooperation, and this cooperation should not compromise convenience and comfort.

Technological Innovation

In this case, technological innovation means developing technology that enables infrastructure to operate in sparsely populated expanses at minimal cost. Transport services, for instance, could optimally supply demand with a combination of bus services and car sharing, which can enable dynamically variable scheduling. The running costs could be controlled by limiting unnecessary services and maximizing ridership. On the other hand, IT applications can deliver services without necessitating travel. Examples include remote learning, remote healthcare, and remote elderly care monitoring, each of which can be operated at a cost lower than the cost of traveling for such services. Automated driving and drones can reduce the personnel expenses for goods deliveries. Technology that monitors whether recipients are at home can be used to plan delivery routes and cut down redeliveries. In this way, we must use data, IT, and robotics to lower the costs of public services.

Society 5.0 balances the best interests of society as a whole (resolution of social issues) with the best interests of individuals (people-centric society). In this chapter, we discussed the KPI formula as an approach for balancing these two concerns. Habitat Innovation proposes using this approach to address social issues. The measures under such an approach are discussed in detail in Chap. 4 onward. The next chapter, however, focuses on a precursor to Society 5.0, the smart city. The chapter discusses the smart city initiative and the challenges it has encountered.

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