Considerations on Infrastructure Aging and Renewal Investment Financing*

NEMOTO Yuji

Professor/Course Chief, Course of Public-Private Partnership, Graduate School of Economics, Toyo University.

Abstract

In Japan today, the infrastructure that was intensively developed during the high-growth period of the 1960s and 1970s is simultaneously deteriorating. If left unchecked, this will lead to serious accidents such as bridge and tunnel collapses, road cave-ins, and water main bursts, endangering the lives and property of the people. Signs are already beginning to appear.

In order to solve this problem, the aging infrastructure should be promptly renewed, but the estimated investment amount to renew the entire current infrastructure would be an enormous 12.9 trillion yen per year.

Instead of financing this by issuing more bonds or raising taxes, various wisdom measures should be implemented to reduce the scale of renewal investment, such as public facility restructuring (wide-area expansion, softening, consolidation, shared use, and multifunctionalization), preventive maintenance, and risk-based management (RBM). The overall reduction rate was estimated to be 40%. Applying these measures to all of Japan, the amount of investment required for renewal would be reduced to 7.7 trillion yen per year.

Two issues are considered here. The first is the consensus-building issue of how to obtain the agreement with current users to the reduction. The second is how to finance the large burden that will remain after the reduction.

With regard to the first, consensus building, we introduced social experiments that are currently underway in the Toyo University Priority Research Project. In particular, the Toyo University-style Deliberative Polling (TDP), in which explanations are provided between multiple anonymous votes, is expected to be effective.

Regarding the second type of financing, I pointed out that particularly necessary investments include (a) base facilities that integrate the functions of other public facilities in schools after consolidation, (b) beneficiary-pay infrastructure such as water and sewage systems, and (c) infrastructure that does not generate cash flow such as roads and bridges, and that financing for these investments should be based on public-private partnerships (PPP) rather than conventional financing. Specifically, I envisioned (a) service purchase PFI, (b) public facility management rights, and (c) availability payments (including the use of public REITs).

All of these projects involve risk. The FILP is expected to provide risk money, including the provision of funds to specialized financial institutions capable of risk-taking or the

* This article is based on a study first published in the Financial Review 147, pp. 87-109, Nemoto Yuji, 2022, Considerations on Infrastructure Aging and Renewal Investment Financing, written in Japanese.

establishment of specialized funds, to ensure that financing proceeds smoothly.

Keywords: infrastructure, PPP, PFI, consensus building
JEL Classification: G32, H76

I. Introduction

Currently in Japan, the infrastructure that was intensively developed during the high-growth period of the 1960~70's is aging and becoming a problem.[1] This paper first summarizes the issues and causes of the aging infrastructure problem, and then identifies the amount of investment required to renew all of the currently existing infrastructure, which will need to be significantly reduced in the future. Next, based on the characteristics of individual infrastructure, "methods to reduce the burden as much as possible while ensuring that the infrastructure that should remain is maintained" will be organized, and the effects of implementing these methods will be quantified. Finally, the objective is to consider financing for the necessary investments.[2]

In this paper, infrastructure is mainly used as a generic term for public facilities (schools, public housing, government buildings, social education facilities, etc.) and civil engineering infrastructure (roads, bridges, tunnels, water supply, sewage systems, etc.) owned by the national or local government.[3]

II. Aging Infrastructure Issues

II-1. Obstacles posed by aging infrastructure

Infrastructure is constructed of concrete, metal, plastic, and other materials that can be damaged and deteriorate in function over time.

Chart 1 summarizes the typical deterioration phenomena that occur for each material used in infrastructure and the resulting infrastructure failures. First, buildings are at risk of collapse. Many readers may remember the Kudan Kaikan ceiling collapse (2011 Great East Japan Earthquake) and the Udo City Hall collapse (2016 Kumamoto Earthquake). While many buildings escaped damage during the earthquake, the fact that extensive damage occurred should be considered to be due to aging.

Roads routinely experience delamination of the pavement surface, but in addition, aging

[1] Nemoto (2011).
[2] This paper is one of the research results of Toyo University's Priority Research Promotion Program "Research Contributing to the Reconstruction of Global Cooperation by Proposing Sustainable Infrastructure."
[3] This definition is synonymous with "infrastructure" in the national "Basic Plan for Infrastructure Longevity" and "public facilities, etc." in the "Comprehensive Management Plan for Public Facilities, etc." of local governments.

underground water and sewer pipes create cavities that rise toward the road surface and ultimately risk causing the road surface to cave in, resulting in an accident. According to the Ministry of Land, Infrastructure, Transport and Tourism, there are many cases of road cave-ins, especially those caused by broken sewer pipes, with approximately 3,000 reported annually.

Collapse is the greatest risk for bridges. Examples include the Shikagyo Ohashi Bridge at the time of the Great East Japan Earthquake, the Furyo Daiichi Bridge at the time of the Kumamoto Earthquake, and the Daiichi Benten Bridge in Hamamatsu City, unrelated to the earthquake. In the case of the Shikagyo Ohashi Bridge collapse, one person died when a passing vehicle was caught in the collapsed bridge.

Collapse is the greatest risk for tunnels, which are appurtenant to roads. There have been no cases of tunnels collapsing, but there have been cases where the ceiling plate that divides the tunnel's exhaust passageway has collapsed. This is the case of the Sasago Tunnel accident on the Chuo Expressway. The ceiling panel was made of concrete, and nine people died as a result of the fall.

Because water pipes are pressurized by pumps to deliver water, minute damage to the pipes can cause them to burst, flooding the surrounding area and cutting off water supply over a wide area and for a considerable period of time. Water supply is one of the lifelines that is shut down for the longest period of time after each earthquake. Due in part to the relatively short service life of water pipes (40 years), 20,000 accidents involving water supply and distribution pipes occur annually.

The above shows that failures caused by aging infrastructure not only cause public service outages, but also have a significant impact on the lives and property of the public.

II-2. Infrastructure Investment Patterns and Renewal Investment

The simplest prescription for aging is investment in renewal. New and updated facilities reduce physical hazards. In fact, the private sector is coping with the problem by investing in renewal.

For example, factory machinery does not age all at once. This is to maintain competitiveness by steadily updating equipment even during recessions. This is called a level investment pattern. If investments are made under this pattern, even if the equipment becomes obsolete, there will be no problem because the budget for renewal is secured and the equipment will be renewed using that budget.

Independent department stores and hotels, on the other hand, instead of a level investment pattern, are invested in in a debt reduction pattern, in which debt is steadily reduced until the initial investment is recovered, and then financed with new debt when renewal investments are made. This is also not a problem, as financing is available.

In other words, private assets maintain safety and functionality through renewal investments. Essentially, the same should be true for infrastructure.

However, this is not the case, at least not in Japan. Most of the infrastructure was inten-

Table 1. Obstacles posed by aging infrastructure

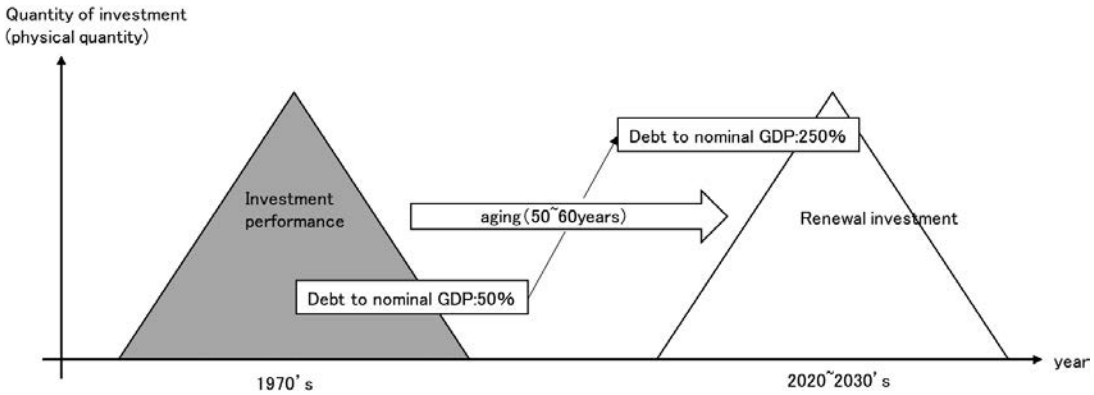
Phenomena due to aging by material		Building	Road	Bridges and Tunnels	Water Supply and Sewerage
Wood	Decay fungi, termites	○		△	
Asphalt, concrete	Fatigue, salt damage, freeze damage, neutralization, alkali aggregate reaction, chemical degradation	◎	◎	◎	○
Metals (steel frame, steel, cast steel, etc.)	Fatigue, corrosion, crushing	◎	○	◎	◎
Plastic	Damage and fracture (stress concentration and fatigue) caused by organic solvents	○			○
Disability		collapsed, collapsed ceiling, peeled exterior wall	sinking, surface	collapse	rupture, damage, underground void (=> road cave-in)
Case		Kudan Kaikan ceiling collapse accident Uto City Hall Collapse Accident	Road cave-ins due to deteriorating sewer pipes (about 3,000 accidents per year)	Rokko Ohhashi Bridge collapse accident Furyo Daiichi Bridge Collapse Accident Hamamatsu City Daiichi Benten Bridge collapse accident Sasago Tunnel Overhead Plate Collapse Accident	Accidents involving burst water pipes (about 20,000 per year)

(Source: Prepared by the author from Toyo University PPP Research Center (2019))

sively invested in during the high-growth period of the 1960s and 1970s, and then rapidly declined in a pyramid shape.[4] This is not a pattern of leveling off of investment. Moreover, as investment declines, debt does not decline, but on the contrary, the level of dependence on debt increases, which is not a pattern of declining debt. The ratio of total national and local government debt to nominal GDP at the time of past public investment peaks was about 50%, but at present, when the need for renewed investment has intensified, the ratio is about 250%.[5] The capacity to take on new debt is certainly becoming scarce.

Figure 1 is an illustration of these relationships. Despite the concentration of investment in renewal due to aging, the debt capacity for renewal investment is becoming scarce. The contradiction exists in that "the growing demand for renewal must be covered by the declining public investment budget and debt-bearing capacity."

Figure 1. Japan's Infrastructure Investment and Debt Patterns



(Source: Prepared by the author based on GDP statistics, IMF data, etc.)

III. Calculation of renewal investment requirement

III-1. Calculation Method for Required Amount of Renewal Investment by Municipality (Micro Method)

So what scale of renewal investment is needed? In this chapter, we will try to figure it out quantitatively. It can be calculated if the data by infrastructure type shown in Figure 1 exists. In issuing the "Guidelines for the Formulation of Comprehensive Management Plans for Public Facilities" (April 22, 2014), the Ministry of Internal Affairs and Communications (MIC) released free of charge the "Public Facility Renewal Cost Estimation Software" ("MIC Software") to allow local governments to calculate budget excesses and deficiencies

[4] Ministry of Land, Infrastructure, Transport and Tourism (2018).
[5] IMF World Economic Outlook Database.

and consider specific methodologies such as consolidation and elimination.[6] The MIC software enables the estimation of the required amount of renewal investment using the following individual accumulation method (micro method).

(a) First, for each infrastructure type, the smallest unit that can be physically separated and understood (e.g., a building for utilities, a pipe for water and sewage systems, etc.) should be established.
(b) The municipality will determine the acquisition date (year) and physical quantity of the infrastructure it owns. The physical quantity is a unit that varies by type, for example, total floor area for public facilities and distance by pipe diameter for water and sewer systems.
(c) The number of years for renewal is set by type. The number of years is set based on the statutory useful life while taking into account the actual conditions. For example, public facilities are uniformly renewed for 60 years, while water pipes are renewed for 40 years.
(d) Each infrastructure is assumed to be renewed with the same physical quantity at the arrival of the renewal year, starting from the year of acquisition. For example, we assume that an elementary school with a total floor area of 5,000 m^2 constructed in 1970 will be renewed in 2030 with a total floor area of 5,000 m^2.
(e) Renewal unit prices by type shall be set uniformly throughout the country with reference to market prices.
(f) With respect to buildings, major renovations shall be undertaken after 30 years. Table 2 summarizes the above.

The micro method is widely used in the field because it can be calculated for each municipality as long as data is available (it can also be used at a more micro level, such as school districts and neighborhood associations, as long as data is available), it can be handled even by those who are not proficient in data analysis methods, and it is a rule approved by the government (Ministry of Internal Affairs and Communications), so there is no need to discuss the merits of the rule itself. The rules are widely accepted in the field.

The effects that can be calculated at the level of community development are particularly significant. They can learn how much they need to spend to sustain their own neighborhoods and how effective they can be if they make efforts such as consolidation and closure. Because they are able to position the issue of aging infrastructure as their own business, they will inevitably develop a responsible attitude. This effect is very significant.

III-2. Estimation of renewal investment requirements for all of Japan

III-2-1. Differences from MIC Software

In this paper, we use the micro method to estimate the national amounts. The major dif-

[6] The MIC software was then managed by the Foundation for Regional Development, but support for the software finished in March 2020.

Table 2. Assumptions of the MIC software

Type	Physical quantity unit	Renewal years	Unit price per renewal	Calculation Assumptions
Public facilities	Total floor area (㎡)	60 years	Unit: thousand yen/㎡ Citizen culture, social education, and administrative facilities: 400, sports and recreation facilities: 360, school education and childcare support facilities: 330, public housing: 280	Renewal at the time of expiration of the renewal period Major renovation 30 years after construction Unit cost of refurbishment is approximately 60% of the unit cost of renewal. Underemployment at the start of the program is eliminated within a certain period of time. ↓arrow (mark or symbol) Calculate total renewal investment required X
Road	Pavement area (㎡)	15 years	Unit: Yen/㎡ 4,700 for public roads, 2,700 for bicycle and pedestrian paths	
Bridge	Area (㎡)	60 years	Unit: thousand yen/㎡ Steel bridge 500, PC bridge 425	
Water supply	Distance by pipe diameter (km)	40 years	Unit: thousand yen/㎡ Water pipelines and water supply pipes: less than ~300mm 100, 300~500mm 114, Distribution pipes: less than ~150mm 97, less than ~200mm 100	
Drainage system	Distance by pipe diameter (km)	50 years	Unit: thousand yen/㎡ Concrete pipes, PVC pipes, etc. 124, Correction pipes 134~250mm 61, 251~500mm 116	
Potential budget amount available (millions of yen)			Investment in the relevant infrastructure in the last 5 years Y	
Budget availability (%)			Calculated by Y/X	

(Source: Prepared by the author from the Public Facility Renewal Cost Estimation Software ver. 2.10 specifications.)

ference from the MIC software is that the municipalities have data on when (year) the infrastructure was acquired, whereas the national data do not exist. For this reason, only annual averages are calculated. The calculation method is based on the following formula for each infrastructure type: annual average renewal investment requirement = physical quantity x renewal unit cost / renewal years, which is then summed. The author estimated once in Nemoto (2017) and obtained the result of 9 trillion yen per year.

In addition to updating to the latest data, the following two major improvements have been made.

III-2-2. Differences from Previous Estimates

① Addition of major building renovations

The cost of major renovation of buildings, which was excluded in Nemoto (2017), is included in this study. Buildings require not only the building frame but also equipment and interior work. Even if the building frame can be used for 60 years, the equipment and interior need to be renewed every 20~30 years. The MIC software sets the unit cost at about 60%

of the unit cost of renewal, with a major renovation to renew the equipment and interior to be done once every 30 years. Nemoto (2017) assumed "renewal after 50 years without major renovation" because in reality there are many cases where individual defects are treated as repair expenses when they occur, but in this case, "major renovation after 30 years and renewal after 60 years" was assumed, partly to promote an understanding that it is desirable to make major renovations. While 60% of the large-scale renovation cost will be required, the average annual renewal investment requirement will increase because the number of renewal years after the renovation will not be extended by that amount.

② Review of civil infrastructure

A shortcoming of the MIC software is that the coverage of infrastructure types is not high. Public facilities (buildings) are fully covered, but for civil infrastructure, road appurtenances other than bridges (tunnels, roadside trees, road signs, guardrails, etc.), water and sewage facilities other than culverts (water purification facilities, sewage treatment facilities, etc.) are excluded, as are rivers (including dams, erosion control, beaches), parks and green areas, ports, and airports. These types of facilities are not included because it is often impossible to ascertain the physical quantity, and because there is no market price for renewal unit costs, making it impossible to calculate the amount. In this paper, based on the Ministry of Land, Infrastructure, Transport and Tourism (2018), we decided to estimate and add as much as possible the percentage of civil infrastructure not covered by the MIC software. This allowed us to add rivers and ports.

III-2-3. Specific Calculation Method

The specific calculation method is as follows.

① building

For national property, the National Property Statistics, and for local property, the Survey on the Status of Public Facilities, etc. of the Ministry of Internal Affairs and Communications were used as basic data. Since the renewal unit prices in the MIC software are set by type, the basic data were also ascertained by type as much as possible. As with the MIC software, it was assumed that large-scale renovations would be made after 30 years and renewals would be made after 60 years.

② road

Since the national geophysical quantity (pavement area) is not disclosed, it was estimated using the roadway area x pavement ratio. The renewal years and renewal unit cost were assumed to be the same as those in the Ministry of Internal Affairs and Communications software.

③ bridge

All were assumed to be paved, but since the national geophysical quantity (area) was not disclosed, it was estimated by distance x average width. Renewal years and renewal unit costs were assumed to be the same as those in the Ministry of Internal Affairs and Communications software.

④ water supply

Calculated using the distance by pipe diameter x unit price by pipe diameter obtained from the water supply statistics. The number of renewal years and renewal unit prices are the same as those in the Ministry of Internal Affairs and Communications software.

⑤ drainage system

Calculated using the distance by pipe diameter x unit cost by pipe diameter obtained from sewer statistics. The number of renewal years and renewal unit prices are the same as those in the Ministry of Internal Affairs and Communications software.

⑥ Rivers and harbors

The Ministry of Land, Infrastructure, Transport and Tourism (2018) describes a 30-year total range (upper and lower limits) for rivers, etc. (rivers and dams, erosion control, and coasts) and ports. Since the estimation method is not published, this paper adopts this figure as is and uses "the simple average of the upper and lower limits of the range divided by 30 years" as the annual average renewal investment requirement.

III-2-4. Results

(1) Evaluation of total amount

As a result, the total is estimated to average about 12.9 trillion yen per year. The 12.9 trillion yen is equivalent to 46% of the annual public capital formation of nominal GDP of approximately 27.9 trillion yen (the average of the last five years). Indeed, it could be said that this could be covered by a significant reduction in new investment. However, as policy needs diversify, new needs for various infrastructure will surely emerge, and new investment will be required in places where compact urban development is needed to meet the needs of a declining population. For example, the paved area of a road will certainly increase even if a congested route is widened or a new right-turn lane is added. The improvement of convenience and disaster prevention through the completion of urban planning roads, which has not been realized for a long time, cannot be ignored.

With these new investment needs in all types of infrastructure, 46% of the annual budget is devoted to simple renewal. It must be said that it is impossible to renew all infrastructure with the current physical volume.

(2) Evaluation of breakdown

The breakdown is 6.3 trillion yen for public facilities and 6.6 trillion yen for civil engineering infrastructure, with civil engineering infrastructure being slightly larger. It is highly likely that the weight of civil infrastructure will further increase in the future as infrastructure such as road appurtenances (guardrails, traffic signs, street trees, etc.) and parks and green spaces become calculable.

Municipalities' interest regarding public facilities and civil infrastructure is rather high for public facilities. This is linked to the awareness of the residents who are the users. While they are not interested in civil engineering infrastructure, believing that it is like air and will naturally be sustained, they are talking about the construction of new, magnificent public fa-

Table 3. Estimated average annual renewal investment requirements

Type	Renewal investment required (trillion yen/year)	Calculation Method
Public facilities	6.3	○physical quantity National: Sum of official property and public property out of administrative property in the total of national property statistics general account and special account Municipalities: Public Facility Condition Chart (by prefecture and municipality, by school, public housing, administrative facilities, and others) ○Renewal years, renewal unit price: Same as the Ministry of Internal Affairs and Communications software ○Major renovation: 30 years later
Road	1.7	Road statistics National general roadway area 5,408,300㎢ × pavement ratio 82.5% × unit renewal cost (4.7 thousand yen/㎡)
Bridge girder	0.9	Road statistics National general road (bridge) distance 9,697,861m x width (average of about 117,000 bridges inspected nationwide in the August 2020 Annual Report on Road Maintenance: 7.45m) x renewal unit cost 425,000 yen/㎡
Water supply	1.8	Calculated by distance by pipe diameter x unit price by pipe diameter (unit price by pipe diameter is the same as the Ministry of Internal Affairs and Communications software)
Drainage system	1.2	Calculated by Sewerage Statistics Pipe Diameter Distance x Pipe Diameter Unit Price (Pipe Diameter Unit Price is the same as the Ministry of Internal Affairs and Communications software)
Rivers and harbors	1.0	Estimated based on the ″Estimated Maintenance and Renewal Costs in the Fields under the Jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism (FY2008)″.
Total	12.9	

(Source: Prepared by the author)

cilities, and when there is a talk of their consolidation or elimination, opposition movements may arise. As a result, both local government officials and local councilors often lose interest in public facilities, and as a result, infrastructure aging countermeasures often give priority to or follow public facilities. As discussed in IV, public facilities can maintain their public functions even if their quantity is reduced, but reducing the quantity of civil engineering infrastructure affects not only their functions but also their safety. The results of the present calculations may be said to reveal that greater attention should be paid to civil infrastructure, rather than to public facilities.

IV. Measures to address the problem of aging infrastructure

IV-1. Direction of measures by type of infrastructure

In the previous chapter, we made clear that it is impossible to renew all infrastructure in its current quantity. That said, as can be seen from the aforementioned ratio of total national and local debt to nominal GDP, it is out of the question to rely primarily on increased government debt to cover future investment needs for renewal, and there is a limit to how much can be covered by tax increases.[7] We need all kinds of wisdom and ingenuity other than these. Based on this understanding, the author has organized a list of measures in Table 4.

We begin by dividing the public nature of the functions provided by infrastructure into public facilities and civil infrastructure.

Public facilities are not public in themselves, but in the functions performed at the facilities (education, welfare, etc.). For example, even if residents' discussions and social education activities themselves are public, it does not mean that activities cannot take place without a community center or meeting place. It is possible to do so in a private café or family

Table 4. Organization of Infrastructure Aging Measures

<table>
<tr><th colspan="2">Type</th><th>Public facilities (buildings)</th><th>Civil engineering infrastructure</th></tr>
<tr><td colspan="2">Public functionality provided by the infrastructure</td><td>Since public facilities themselves are not public, they can be reduced in quantity and still maintain their public function.</td><td>Because of its public nature in that anyone can freely use it for any purpose, the amount cannot simply be reduced.</td></tr>
<tr><td rowspan="2">How to assume current infrastructure</td><td>How to reduce volume and maintain functionality</td><td>Reorganization (Cooperation between local governments, softening, centralization, shared use, multifunctionalization)</td><td>thinning out</td></tr>
<tr><td>How to maintain volume and reduce costs</td><td colspan="2">LCC reduction (inspection/diagnosis/monitoring, risk-based management (RBM), longer/shorter service life, etc.), PPP/PFI</td></tr>
<tr><td rowspan="2">How to change to a new infrastructure</td><td>Methods that do not use facilities or networks</td><td colspan="2">Distributed processing
Delivery
Virtualization</td></tr>
<tr><td>How the recipient of the service moves</td><td colspan="2">Relocation
Clustering (compact city, relocation to higher ground, etc.)</td></tr>
</table>

(Source: Prepared by the author)

[7] In the 1980s, when the problem of aging infrastructure became apparent in the U.S., as it is in Japan today, the gasoline tax rate was raised. Increasing the tax rate is a possible option in Japan as well, but given that it is a consumption tax (consumption tax revenue of approximately 19.3 trillion yen in FY2020), it would have to be raised even more significantly, which is not realistic.

restaurant in a vacant classroom at a school. Similarly, the function of cultural activities is public, but it does not mean that cultural activities cannot be conducted without a splendid cultural hall. In this way, public functions can be maintained even if the amount of public facilities is reduced. We need to devise ways to do so.

On the other hand, civil infrastructure is public by its very existence, and the act of using it is not required to be public. For example, roads are public, but they are not restricted to public transportation or emergency vehicles. They can be used for shopping, recreational purposes, or, in the extreme, for criminal purposes. In other words, the very existence of the road itself, which can be freely used by anyone for any purpose, is public. As a result, reductions in the amount of civil infrastructure directly lead to a decline in its public nature. It is necessary to devise ways to reduce renewal costs without reducing the quantity as much as possible.

IV-2. How to reduce volume and maintain functionality

Public facilities can be effectively restructured in order to reduce their volume and maintain their functions. There are five methods of reorganization: wide-area, soft, intensive, shared, and multifunctional.

IV-2-1. Cooperation between local governments

Regionalization refers to the joint establishment of large-scale facilities (cultural halls, sports facilities, hospitals, waste disposal facilities, etc.) whose users are spread across multiple municipalities. The standard population size of each facility (e.g., 200,000) is set, and a partial administrative association or wide-area federation is established to reach that size, and the burden can be estimated by assuming that the burden is paid in proportion to the population. Although the burden will remain, it will be reduced compared to the case where a single entity is established.

IV-2-2. Softening

Softening involves switching public facilities to private facilities. Facilities that can be supplied by the private sector, such as welfare,[8] sports facilities,[9] and housing[10] fall under this category. Existing facilities may be privatized, or existing facilities may be abolished and private facilities used. Privatization is an example of privatization of daycare centers. The use of private facilities is an example of abolishing school swimming pools and out-

[8] In Japan, the long-term care insurance system and subsidy system are well-developed, enabling the establishment and operation of facilities by social welfare corporations, etc. Examples of private facilities as a percentage of the number of facilities: Healthcare facilities for the elderly (94.4%), welfare facilities for the elderly (95.1%), fee-based nursing homes for the elderly (99.9%), children's homes (94.6%), nursery schools (65.2%), and certified nursery schools (85.0%).

[9] Private sports clubs.

[10] The private sector accounts for 95.6% of the housing stock. The Housing Safety Net System, which registers private rental housing for those in need of housing security and provides tenancy assistance, is in effect an example of the softening of the public housing sector.

sourcing swimming lessons to private sports clubs. There are also examples of subsidizing the use of private lifelong learning institutions (vouchers). In many cases, subsidies to the private sector are still necessary after the system is softened. In such cases, the local government still has to bear the burden according to the subsidy rate (e.g., 25%), but the burden is reduced compared to maintaining the facility as a public facility.

IV-2-3. Consolidation

Consolidation is the process of combining multiple similar facilities into one, and is generally referred to as consolidation. A typical example is the consolidation of schools whose student population has declined and is below the appropriate size.[11] However, facilities other than schools can also be subject to consolidation if there are multiple similar facilities. If the number of facilities is maintained in an era of declining population, the per capita burden will increase. Reducing the number of facilities to match the decline in population (in the case of schools, the decline in the number of students) is something that should be promoted even if it is separated from the issue of aging.

IV-2-4. Shared use

Shared use is the consolidation of similar facilities with different users into a single facility for common use. In many cases, schools and communities have their own libraries, gymnasiums, music rooms, kitchens, and so on. These facilities are jointly installed and used jointly or at different times. Libraries can be completely shared since many can be used at the same time. For other types of facilities, since only a limited number of people (groups) can use them at the same time, it would be reasonable to use them at different times (time-sharing). One example is that school children use the library in the morning and afternoon, and local residents use it in the evening and night.

IV-2-5. Multifunctionalization

While the above four methods are the main ones, an alternative when they are not possible is multifunctionalization. This is where only the respective necessary functions are relocated to other large facilities, rather than to stand-alone facilities. One example is to make vacant classrooms in a school available to residents as a meeting place. Common areas such as entrances, lobbies, hallways, stairways, restrooms, and common meeting rooms that would be necessary in a stand-alone facility are no longer needed.[12] Even if the need for the facility is recognized and no other method is available, there is no need to maintain it as a freestanding facility.

If the above five methods are reorganized as those that are employed without exception,

---

[11] Appropriate size of public elementary schools (Compulsory Standard Law, School Education Law Enforcement Regulations) 35 students/class x 12~18 classes = 420~630 students
Basic School Survey Number of elementary school children ÷ Number of schools = 322

[12] Generally, 20~40% of the total floor area of a public facility is considered to be a common area. If the facility is multi-functional, this amount can be shared by multiple functions, thus reducing the area.

the volume will be dramatically reduced. However, all necessary functions are secured. I believe that public facility reorganization is the mainstay of measures against aging infrastructure.

IV-3. How to maintain quantity and reduce costs

The costs of civil infrastructure, on the other hand, need to be reduced while maintaining as much quantity as possible.

IV-3-1. Inspection, Diagnosis and Monitoring

First, in the inspection, diagnosis, and monitoring fields, preventive maintenance technologies that prevent failures before they occur have become more sophisticated and diversified. What used to be an after-the-fact response after a failure occurs has now been switched to preventive maintenance. Although preventive maintenance costs are required, the life cycle cost (LCC) can also be reduced because repairs and replacement of parts can be made earlier, saving costs in the event of an accident or major failure (post-failure maintenance costs). In the first place, the reduction of major hazards to the lives and property of residents is itself desirable.

IV-3-2. Risk-Based Management (RBM)

RBM is not to manage all infrastructure at the same level, but to change the level according to the level of importance. For example, road pavements are supposed to be renewed every 15 years according to the Ministry of Internal Affairs and Communications software, but on residential roads, even if the pavement surface deteriorates slightly, it is not considered to be a major obstacle, so it is not renewed for 30 to 50 years. Since roads for daily use account for more than 80% of the total area, the introduction of RBM can significantly reduce the overall cost.

Being risk-based is an attitude of accepting some risk. Rather than seeking zero risk, which may or may not be feasible even after expending enormous costs, the idea of controlling within a certain risk range makes sense. In fact, in the current situation, the level of control on roads is being lowered by reducing the frequency of renewal in cases where it is considered to be safe. In other words, it can be said that the response is risk-based. RBM is a concept of making rules for municipal organizations, instead of placing the responsibility on individuals.

IV-3-3. Longer and shorter service life

Longevity improvement has the effect of reducing the cost per year by extending the number of years of use as a result of long-life rehabilitation and preventive maintenance. Large-scale renovation of public facilities is sometimes referred to as long-life renovation because of the expected longevity effect. As indicated by the fact that the name of the national policy is the Basic Plan for Infrastructure Longevity Extension, longevity extension is

the most typical measure to address aging infrastructure. However, the cost-effectiveness of longevity extension is not always positive. This is because it is necessary to spend money to extend the service life of infrastructure, and it is not always possible to expect that the service life extension benefits will be commensurate with the cost.

On the other hand, short-life construction is a method of constructing a building so that it can be easily torn down, or even easily converted to another use, based on the assumption that it will be used only for a short period of time and that it should be maintained for that period. This is a reversal of the conventional construction industry's technological development approach. In an era of declining population, it is essential to develop technologies for shortening the service life of buildings to reduce future risks.

IV-3-4. PPP/PFI

PPP (public-private partnership)/PFI (private finance initiative) transfers the risk of infrastructure construction, maintenance, and operation to the private sector and encourages ingenuity to lower LCC. In addition to PFI based on the law,[13] there are various other methods such as Design Build Operation (DBO), Public Real Estate (PRE), designated managers, and comprehensive private outsourcing. Infrastructure cannot be reduced to zero, and necessary infrastructure must be sustained in the future. In such cases, PPP/PFI should be introduced to increase cost-effectiveness as much as possible.

IV-3-5. Application to public facilities

The method of maintaining volume and reducing costs is applicable not only to civil infrastructure but also to public facilities. Bold restructuring of public facilities, including consolidation and elimination, is also essential, but it does not mean that facilities will be reduced to zero. There are already many examples of preventive maintenance and PPP/PFI to reduce the LCC of facilities that should be retained, and these should be greatly expanded in the future.

IV-4. How to change to a new infrastructure

Service delivery formats that differ from traditional infrastructure include distributed processing, delivery, and virtualization.

IV-4-1. Distributed Processing

Decentralized processing enables services that have been provided in a network to be provided in a decentralized manner. A typical example is the combined septic tank in the sewage system. Network infrastructure requires the network to be maintained even as the population decreases, resulting in high costs per capita. In contrast, decentralized treatment systems have a lower cost per capita because there are no network costs. Renewable energy

[13] Act on Promotion of Improvement, etc. of Public Facilities, etc. through Utilization of Private Finance, etc.

in the electric power sector and groundwater-only water systems in the water supply sector are similar examples of decentralized treatment.

IV-4-2. Delivery

Delivery is literally the delivery of a service. The water truck in the water supply system is an example. Delivery can also be applied to public facilities. In fact, it is more applicable to public facilities. For example, for libraries and hospitals as facilities, there are delivery-type mobile libraries and home-visit medical services. The same can be said for the private sector, where door-to-door sales are conducted by small trucks rather than by setting up supermarkets. The delivery-type service is an old-fashioned service, but its value is being reevaluated in this era of declining population.

IV-4-3. Virtualization

Virtualization is a method that uses the IoT. Electronic libraries and telemedicine are the equivalent. The COVID-19 pandemic led to the rapid introduction of remote adoption in society. Remote education will also advance in school education. For example, hybrid education in which students can take distance education courses using IT equipment in the district community center and are regularly transported to the school by bus for group education would eliminate the need to leave small schools in mountainous areas behind. If all government procedures can be done online, the amount of in-person contact can be reduced. There is a lot of room for innovation in social education and welfare facilities, which have many types of facilities.

IV-4-4. Relocation and clustering

The ultimate method is relocation and clustering, where the recipients of services move. Current infrastructure is built on the premise of delivering services to where residents reside. It is not the services themselves, but the high cost of delivering them, that is the bottom line. If people are moved by compact cities and collective relocation, costs can be greatly reduced.

Relocation and clustering include methods of changing the way public services are provided depending on where people live. For example, snow-covered roads are not plowed outside of certain areas in urban areas, and sewerage service plans are changed so that peripheral areas are switched to merged septic tanks. In fact, these methods have already been incorporated.

Whether we are aware of it or not, we have been thinking in terms of freedom of residence. Freedom of residence, or at least the right not to be forcibly displaced, must be respected. However, it is not self-evident that it always takes precedence over the cost-effectiveness of sustaining a society, and this is an issue that we must discuss as a people.

V. Estimation of effects after countermeasures

V-1. Effects of Public Facility Reorganization

In this chapter, we will estimate the effects of implementing the measures organized in IV.

The ultimate goal is to calculate macro figures for Japan as a whole. First, a model city with a population of 50,000 will be set up and specific measures for each infrastructure type will be applied. The method will then be used to apply the calculated reduction rates to the entire country. The specific procedure is as follows.

V-1-1. Facility Assumptions

Assuming facilities owned by the model city based on the examples of several similar cities surveyed by the author. 8 elementary schools, 4 junior high schools, 1 citizens' hall, 1 general citizens' gymnasium and 2 district sports facilities, 4 childcare support facilities, 8 assembly facilities, 1 central library, 1 District library, 2 Museums, 1 Recreation facility, 1 Welfare center for the elderly, 1 Day service center for the elderly, 2 Comprehensive welfare centers for the handicapped, 1 Day service center for the handicapped, 2 Main libraries, 1 main government building, 4 branch offices, and 3 public housing units. The area is assumed to be the standard size for each. The total floor area is 160,600 m^2 and the size per capita is 3.21 m^2.

V-1-2. Countermeasure Assumptions

The measures described in IV shall be implemented.

The civic hall and the general civic gymnasium will be expanded (jointly established by multiple municipalities) to a total of 200,000 people, and 25% will be borne in proportion to the population (50,000 people divided by 200,000).

Childcare support facilities, recreation facilities, day services for the elderly and disabled, and public housing shall be softened (privatized), and the equivalent of 25% shall remain as the municipal burden except for recreation facilities.

Four elementary schools and two middle schools shall be consolidated. The closed school buildings shall remain as district assembly halls, but shall be reduced in size to the size of assembly halls at the time of renewal. The surviving school shall serve as a base and shall relocate the functions of the school district's assembly facilities, district library, district sports facilities, and branch offices.

V-1-3. Conclusion

Based on the above, the total floor area would be 83,540 m^2 and the size per capita would be 1.67 m^2, a reduction of approximately 47.8% from the original.[14] As shown above, if the measures indicated in III are implemented as is, a significant reduction will be possi-

[14] The actual total floor area will be further reduced because the financial burden is expressed in terms of area in the case of widening and softening.

Table 5. Public Facility Ownership and Effectiveness of Measures in a Model Municipality with a Population of 50,000

(Data) Item	Status quo	Countermeasure	After countermeasures
Public elementary school	7,000㎡×8=56,000㎡	Reconstructed as centralized (consolidated into 4 schools, eliminated the remaining 4 schools, and reconstructed as assembly halls (200 ㎡ each) at the time of renewal)	7,000㎡×4=28,000㎡ 200㎡×4=800㎡
Public junior high school	10,000㎡×4 = 40,000㎡	Consolidation (consolidate into two schools, sell closed buildings)	10,000㎡×2 = 20,000㎡
Civic Hall	5,000㎡	Widespread (calculated as one facility per 200,000 population)	5,000㎡×1/4=1,250㎡
General Civic Gymnasium	5,000㎡		same as above
Childcare Support Facilities	500㎡×4 = 2,000㎡	Softening (privatization) However, municipalities bear 25% of the cost	2,000㎡×25%=500㎡
Community center	200㎡×8=1,600㎡	Four locations are multifunctionalized into schools (80% except for some common areas) Four locations are in former abandoned school buildings	200㎡×80%×4 = 640㎡
Central Library	3,000㎡×1=3,000㎡	Moved to the integrated junior high school and shared with the junior high school library.	Increased by 50% of the previous amount for the region 3,000㎡×50%=1,500㎡
District Library	1,000㎡×2=2,000㎡	Moved to the integrated elementary school and shared with the junior high school library.	Increased by 50% of the previous amount for the region 2,000㎡×50%=1,000㎡
Museum	1,000㎡×1=1,000㎡	Transferring functions to the elementary school after consolidation to make it multifunctional	Relocate 80% except for common areas 1,000㎡×80%=800㎡
District Sports Facilities	1,500㎡×2=3,000㎡	Shared with post-consolidation schools	Increased by 50% of the previous amount for the region 3,000㎡×50%=1,500㎡
Recreational facility	4,000㎡×1=4,000㎡	Soften (privatize)	
Welfare center for the elderly	2,000㎡×1=2,000㎡	Moved functions to the main government building to make it multifunctional.	Relocate 80% except for common areas 2,000㎡×80%=1,600㎡
Day Service Center for the Elderly	500㎡×2=1,000㎡	Soften (privatize) However, 25% municipal contribution is required	1,000㎡×25%=250㎡
Comprehensive Welfare Center for the Disabled	2,000㎡×1=2,000㎡	Moved functions to the main government building to make it multifunctional.	Relocate 80% except for common areas 2,000㎡×80%=1,600㎡
Day Service Center for the Disabled	500㎡×2=1,000㎡	Soften (privatize) However, 25% municipal contribution is required	1,000㎡×25%=250㎡
Main government office	12,000㎡×1=12,000㎡	Maintain as a base	Assumes that the area of the main government building portion will be maintained. 12,000㎡×1=12,000㎡
Branch government office	500㎡×4=2,000㎡	Functional relocation to a post-consolidation elementary school	Relocate 80% except for common areas 2,000㎡×80%=1,600㎡
Public housing	6,000㎡×3=18,000㎡	Soften (privatize) However, 25% municipal contribution is required	180,000㎡×25% = 4,500㎡
Total	160,600㎡		83,540㎡
Space per capita	3.21㎡		1.67㎡

(Source: Prepared by the author)

ble. Conversely, it can be said that only half of the reduction can be achieved even with such a bold restructuring.

V-2. Effectiveness of Civil Infrastructure Measures

Measures for civil infrastructure can be estimated using specific methods and quantifiable data if they are presented in the individual facility plans.[15] Estimates are made assuming that risk-based management (RBM) will be implemented as a common measure in cases where no methodology is presented.

Specifically, each infrastructure is divided into three categories, A, B, and C, according to its level of importance.

The percentages of volume are assumed to be A: 10%, B: 10%, and C: 80%. These percentages generally follow the classification of the roads (main arterial, other arterial, and residential roads). Importance A is the most important and is updated as per the rule. Importance level B is similar, and the renewal period is set to 1.2 to 1.5 times. Importance C is the least important, and the number of renewal years is set to 1.5 to 2 times. The upper and lower limits of the renewal period are determined by the type of infrastructure.

Roads should be set wide enough that if the surface pavement becomes more than a certain level of worn out, the comfort level will decrease, but it is unlikely to lead to an accident that directly affects the lives of the residents. Specifically, the rate of extension of the renewal period is set to be twice as large as that of the life roads in the importance level C. Since daily life roads account for about 80% of all roads, the total reduction rate for all roads will be 42.5%, which is as high as that for public facilities.

On the other hand, for bridges, which are likely to directly endanger lives, and water and sewage systems, which are indispensable for the maintenance of daily life, the range of years for renewal will be set smaller. Specifically, the extension of service life will be limited to 1.5 times, even in the case of criticality C. As a result, the total reduction rate is rather modest at 28.7%.

Among civil infrastructure, rivers and ports used in the estimation for all of Japan are limited to roads, bridges, waterworks, and sewage systems, as before, because at this point we have not obtained enough knowledge to be able to incorporate them into model municipalities. At present, it seems difficult to find a way to reduce civil engineering infrastructure to the same level as public facilities, with the exception of roads, due to its characteristic of being difficult to reduce in quantity, but this is an area with tremendous room for technological development, and we look forward to future developments.

[15] Plans by infrastructure type (roads, bridges, water supply, sewerage, schools, etc.) required to implement the Comprehensive Management Plan for Public Facilities, etc. Each municipality is required to formulate its own plan.

Table 6. Civil Infrastructure Ownership and Effectiveness of Measures in a Model Municipality with a Population of 50,000

Type	Classification	Example	Amount	Renewal years	Per year	Reduction rate (individual)	Reduction rate (total)
Road	Importance A	main thoroughfare	10	15	0.0667	0	0.0
	Importance B	Other arterial roads	10	20	0.0500	25%.	2.5
	Importance C	everyday road	80	30	0.0333	50% of	40.0
	total						42.5
Bridge girder	Importance A	Bridge length 200m or more	10	60	0.0167	0	0.0
	Importance B	Bridge length 15m or more	10	75	0.0133	20%.	2.0
	Importance C	Bridge length 2m or more	80	90	0.0111	33%.	26.7
	total						28.7
Water supply	Importance A	Water pipelines and water transmission pipes (water source - water purification plant - water distribution reservoir)	10	40	0.0250	0	0.0
	Importance B	conduit (pipe)	10	50	0.0200	20%.	2.0
	Importance C	Water supply pipes (distribution pipe network - business and residential)	80	60	0.0167	33%.	26.7
	total						28.7
Drainage system	Importance A	Main pipe (branch pipe - treatment plant)	10	60	0.0167	0	0.0
	Importance B	branch pipe	10	75	0.0133	20%.	2.0
	Importance C	Drainage pipes (business and residential - branch pipes)	80	90	0.0111	33%.	26.7
	total						28.7

Source: Prepared by the author

V-3. Combined effects of measures

Table 7 shows the combined results for public facilities and civil infrastructure. Overall costs for the model municipality are reduced by 40%.

Table 7. Summary Table of Reduction Rates in Model Municipalities

	Before (a)	Reduction rate (b)	After measure (c)=(a)*(b)	Overall reduction rate
Public facilities	50.4	47.8% (in %)	26.3	
Road	14.4	42.5% (in %)	8.3	
Bridge	4.6	28.7	3.3	
Water supply	18.7	28.7	13.3	
Drainage system	11.9	28.7	8.5	
Total	100		59.7	40%.

(Source: Prepared by the author)

Multiplying this by the required amount of renewal investment estimated in III, it is equivalent to 5.2 trillion yen. In IV, we indicated that the amount of infrastructure renewal investment necessary to maintain the minimum functioning of Japan's economy and society is 12.9 trillion yen. This means that even if we combine bold methodologies for both public facilities and civil infrastructure, we still need 12.9 - 5.2 = 7.7 trillion yen.

VI. Consensus Building Devices

In the previous section, we assumed that all of the measures organized in IV could be implemented. However, opposition by residents, who are the users of the infrastructure, is anticipated in reducing not only all, but even some of the measures. Resident consensus is essential for implementing countermeasures. This chapter discusses consensus building.

VI-1. Consensus Building in the Infrastructure Sector

In general terms, there are two cases in which consensus building is needed in the infrastructure sector.

The first is the location of facilities with negative externalities. There have long been opposition movements against the location of so-called "nuisance" facilities such as waste incineration plants and crematoriums, which are socially necessary but have negative externalities for people's lives. In the U.S., the NIMBY (Not In My Back Yard) movement, which arose in the 1980s in response to opposition to the siting of nuclear power plants, is well known. Negative externalities include not only pollution-level problems that affect the human body, but also odors, noise, scenery, and crime risks, which are evaluated differently by different people, and other reasons for nuisance facilities. In some cases, private residences are considered a nuisance because they spoil the aesthetics of the area and are opposed. The criteria for negative externalities vary greatly depending on the time period, the region, and even the individual's perception.

The second is when a facility[16] with positive externalities is discontinued. Opposition

[16] It can be said to be an economically valuable good.

occurs when so-called welcoming facilities such as libraries, community centers, and sports facilities are discontinued. This can also occur in private supermarkets and gas stations. In the context of this paper, which is about reducing the amount of infrastructure, consensus building on this issue is more serious. In the United States, the campaign to attract such facilities is called YIMBY (Yes In My Back Yard) in contrast to NIMBY. Opposition to the abolition of welcoming facilities is often based on the motive of wanting to make an exception for the facilities they use, even if the abolition of welcoming facilities itself is unavoidable. The next section describes our experience in the U.S. in dealing with NIMBYs and YIMBYs.

VI-2. History and Methodology of U.S. Consensus Building Methodology

According to the U.S.-based International Association of Public Participation (IAP2), after the spread of NIMBY-like activities since the 1980s, consensus-building methods were sought and systematized through conflicts and compromises in individual cases. The methodologies have been systematized.

Table 8 shows the main consensus building methods used in the U.S. IAP2 states that the most important element of consensus building is "provision of balanced and objective information." At the same time, however, it is not enough to simply provide information; the recipients of information need to be able to understand it more actively and act on it as needed. The methods in Table 8 have been actively devised and utilized as methods to promote changes in perception and behavior. The author believes that the common denominator of these methods is narrative. Narrative means that it is not enough to simply disclose information, but to tell a story about the relationship between the past and the present, and between the assumed future and the present, using the past, present, and future of the community as the stage. The methods in Table 8 have the effect of enabling residents to imagine the community's future in concrete terms as a party to the project.

VI-3. Toyo University's Social Experiment

Toyo University considers consensus building to be the biggest obstacle to the problem of aging infrastructure and has conducted several social experiments applying the U.S. method discussed in the previous section to Japan.[17] This paper introduces Deliberative Polling (Discussion Polling, DP).

VI-3-1. Positioning Effect

The main reason for the lack of consensus building is that when residents have a face-to-face relationship with each other, they are unable to voice their opinions out of concern for those who are more vocal, even if they agree with them inwardly. Since this risk cannot be

[17] Yuji Nemoto (2019)①, (2019)②, (2021)①, (2021)②

Table 8. Consensus Building Methods in the U.S.

Technique name	Meaning
Open House	A place to provide information on the project and how to proceed by exhibiting panels and distributing leaflets and other materials.
Focus Group	A method of ascertaining trends in opinion through discussion among a small group of subjects in order to infer public opinion on a specific topic.
Serious Game	Games whose main purpose is to solve social problems, such as educational and medical applications (learning elements, experiences, fostering and arousing interest, etc.), rather than for entertainment purposes only.
Asset Mapping	Map local resources and shortcomings point by point and overlap them to identify problems and consider solutions.
Charrette	Experts collaborate on a design in a short period of time. In a short period of time, usually about one week, experts from various fields meet with the government and residents to present a concrete plan through repeated discussions, and finalize a consensus plan.
Participatory Budgeting	The process by which the general public determines how to allocate a portion of a local or public budget.
Deliberative Polling	Discussion-based polling. After receiving sufficient information from discussion materials and experts, and after a lengthy discussion in small groups and plenary sessions, the survey is conducted again to see how opinions and attitudes have changed.

Source: Prepared by the author from materials provided by the International Association for Public Participation (IAP2)

removed in an ordinary DP, the University's DP uses an anonymous questionnaire to include explanations instead of discussions. Specifically, the process is as follows: first round of voting ⇒ explanation by facilitator ⇒ second round of voting ⇒ free response.

Table 9 shows an example of a DP conducted during a training session for municipal officials within a prefecture. Participants were asked anonymously whether they were for or against group homes for people with disabilities being located in their neighborhoods. The response options were "agree," "secretly disagree but allow," and "actively disagree." At the time of the training, there had been a high-profile incident of death and injury involving a mentally disabled person as the perpetrator, and the safety of the facility was being severely questioned. Therefore, to persuade them to support the location, we explained the changes in the government's disability welfare policy (promotion of normalization to be accepted in the community) and measures to reduce risk (diagnosis by a doctor and implementation of tests).

As a result, "agree" increased significantly between the first and second rounds, while "actively disagree" decreased significantly. We believe that the significant transformation in the voting results is the result of the fact that the first round of voting made the respondents clearly aware of their own opinions on their own, which increased the seriousness with

Table 9. Examples of Deliverable Policing Implementation (Municipal Staff Training Q1 within a Prefecture)

	Questions	Agree	Disagree inwardly, but allow it.	Actively oppose
First question	In a residential area, a social welfare corporation has announced plans to build a group home for the handicapped. This facility will also house people with mild mental disabilities. Assuming you live in the neighborhood, do you support (including tolerance) or oppose this location?	10(19.6%)	32(62.7%)	9(17.6%)
Second question	Japan's current disability welfare policy has shifted to the concept of normalization, which means that all people with disabilities should be accepted in the community, rather than being cut off from society. In addition, the actual move-in process is determined after standardized national tests are administered and a doctor's diagnosis is made.	23(45.1%)	23(45.1%)	5(9.8%)
Free answers (excerpts)	Agree: It is an indispensable facility, the idea of normalization is important, there should be no discrimination, all people should be allowed to be diverse, it is not good to lead to discrimination and division, I feel comfortable with certain screening, there are firm standards, we need to help each other in the community, it does not directly affect me in any way and I want to help with acceptance in the community, I happen to be able-bodied Against: Because they could be dangerous people, it is too late after an incident, there must be other appropriate places, the diagnostic criteria are not credible, I am worried because I have children, there is a risk of sudden change from the time the doctor decides, there is no guarantee of absolute safety, it is unclear whether the national standards are appropriate, it is still dangerous and concerns remain, I don't want dangerous people in my neighborhood.			

(Source: Prepared by the author)

which they listened to the subsequent explanations and considered them in depth.

This transformation was manifested because of the state of guaranteed anonymity. Upon receiving the results of the vote, a strong dissenter will know not only that an opinion differing from his or her own exists, but also that his or her opinion is now in the minority. The author calls this effect the positioning effect. Knowing that one's opinion is not an absolute majority, but rather that there are different opinions or that one is in the minority, may in many cases transform one's own perception as well.

VI-3-2. Effect of understanding core reasons

At the end of the same question, the respondents were asked to give their reasons for approval or disapproval in an open-ended question. The significance of this question is to find out the core reasons of those who remain opposed to the project until the end. The results of

the second question show that active opposition is less than 10%, and the number of respondents in favor of the project is significantly higher. In the past, the administration would consider consensus building to be complete in this situation. However, the fact that nearly half of the respondents remain of the opinion that they are inwardly opposed is very worrisome. Those who are inwardly opposed are not actually convinced, and a slight change in their opinion could change them into active opposition. We need to think of ways to persuade them more deeply. To this end, it is extremely important to understand the core reasons for opposition.

The free response portion of Table 9 provides a sampling of the reasons for and against. Looking at this, the reasons for disagreement can be summarized as "no zero risk." On the other hand, there is no "no risk" in the reasons in favor. The reasons in favor can be summarized as "there is a risk, but it should be done." From this survey, it is not correct for the government to "guarantee zero risk" in consensus building. There is no way it can be done. It's a lousy thing to say. The government must be repulsed by the idea of "zero risk." The right thing to do is to persuade them that "we will reduce the risk as much as possible, but we should accept the remaining risk, if any." In this way, by understanding the reasons for and against the core, we can consider our response in advance.

VI-3-3. Priority Effect

Table 10 is another question added to this training. The question was asked only once, in the form of asking respondents to select one of the most troubling of multiple options. As in the case of "location of a residential facility for the mentally handicapped," the following objections were added: "a waste incineration plant will be located nearby," "the nearby community center will be consolidated and become far away," and "the nearby mini supermarket will close and I will have to go to the suburbs for shopping."

Table 10. Examples of Deliverable Policing Implementation (Municipal Staff Training Q2 within a Prefecture)

Please select one of the following that you find most troubling.	Answer.
Residential facility for the mentally disabled located nearby	7 (14.0%)
Waste incineration facility located nearby	29 (58.0%)
Neighboring community centers will be consolidated and become distant from each other.	0 (0.0%)
Neighborhood mini-supermarkets close and you have to go to the suburbs for shopping.	14 (28.0%)

Of these options, the one that gives an idea of the reaction to the issue of aging infrastructure is "neighborhood community centers will be consolidated and become distant from each other." In fact, when the consolidation of community centers is proposed, there is a considerable probability of opposition. If anyone were to ask, "Would it be a good idea to consolidate nearby community centers?" users would definitely oppose the idea, and even those who have never used a community center would say, "It is better to have one than not

to have one." This would result in the majority of residents opposing the plan, and the plan would come to a halt.

This question was not designed to identify absolute pros and cons, but rather which of these are most troubling on a relative basis. The results showed that the elimination of the community center was at the bottom of the list, with zero responses. Even when asked "would you rather have it?" the "yes" response quickly dropped in support compared to the other "troubling" options. While the location of nuisance facilities and the elimination of supermarkets are certainly troubling, the results show that community center consolidation is not as troubling by comparison.

This awareness of priority in one's intentions has the effect of transforming one's perception of what one thought was "rather troubling" into "actually not so troubling." The author calls this the priority effect. In promoting consensus building, it is effective to present not only the issue but also various other issues and ask for relative evaluations.

Consensus building is a very important process, yet it is still an area in which solution methodologies are in their infancy. It is hoped that a variety of problem-solving approaches will be developed.

VII. Financing for Sustainable Infrastructure Development

VII-1. Typical projects requiring financing

In this chapter, we will consider how to finance the funds indicated in section V. We will examine what projects need financing in each of these areas and what is appropriate financing for them. Specifically, there are three types of projects that require financing.

Base facility

Beneficiary-pays infrastructure

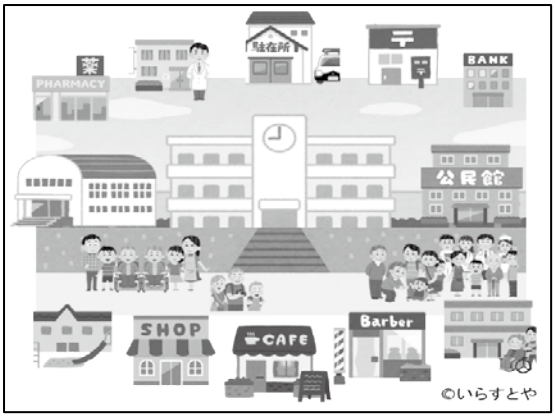
Infrastructure that does not generate cash flow

In the following chapter, these three types are discussed in the order above.

VII-2. Financing for base facilities

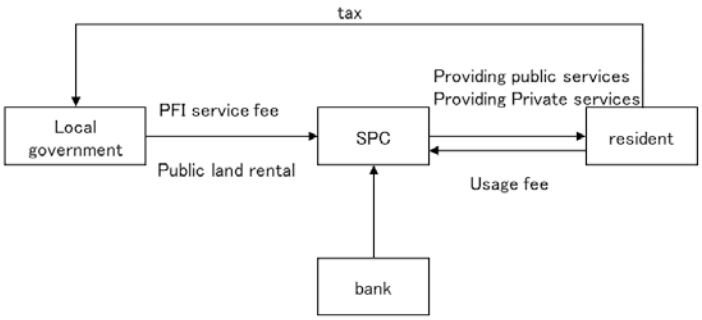
The first is the financing of the construction of bases, which are post-consolidation schools. The base will function not only as a school, but also as a social education facility in the school district, a meeting place, and a branch office of the town office. When schools and other facilities are concentrated in the base facility, not only children but also their parents' generation, the elderly, and the young will come to use the area around the base. Even though the population may decrease, if people concentrate their activities in a particular location, it is the same as an expanded market for the private sector, and the break-even point will be lowered. Not only stores and gas stations, which are currently considered unsustainable if the population decreases, but also post offices, bank branches, cafes, flower shops, bookstores, hospitals, pharmacies, cram schools, and private welfare facilities, which are in

Figure 2. Image of bases



(Source: Prepared by the author)

Figure 3. Financing for base facilities



(Source: Prepared by the author)

great need, may be able to expand. Financing for these locations would be a catalyst for private investment.

Even today, schools account for about 40% of all public facilities in municipalities. The author proposes that these centers be viewed not as school facilities but as centers that provide many public services, and that the risk of maintenance and management arising from ownership be separated from the school (the head) and entrusted to the private sector, which has a high level of expertise. PFI makes this possible. Since PFI is a public-private contract, it is necessary to appoint legal and financial experts as advisors, and the scale of the project must be large enough to cover the fixed costs of such advisors. The Cabinet Office estimates that a project cost of at least 1 billion yen is required, but the scale of investment for the base is well in excess of 1 billion yen for the school portion alone.[18] If the location and population size are large enough to induce private investment, the project can be a so-called Public Real Estate (PRE) project, in which the service purchase fee is reduced in expecta-

[18] Total floor area of base facility 7,800 m^2 (12 school classes 5,800 m^2 + other facilities 2,000 m^2) × renewal unit price 330,000 yen/m^2 = 2.6 billion yen.

tion of rental income from publicly owned land.

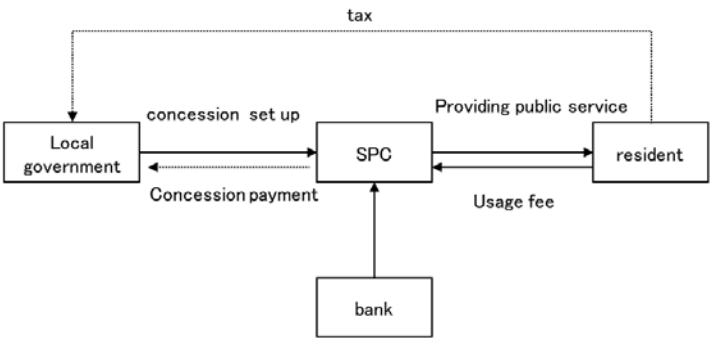
VII-3. Financing for beneficiary-paid infrastructure

Civil engineering infrastructure should be divided into two categories: beneficiary-paid infrastructure such as water supply and sewerage systems, and non-cash flow-generating infrastructure such as roads and bridges.

The financing for water supply and sewerage systems is assumed to be the concession for operation of public facilities (a method based on the PFI law, commonly known as concession). The right to operate, maintain, and manage water and sewage systems is established by the private sector while retaining ownership of the water and sewage systems in the municipality. Like ownership, operation rights are a type of property right, and a consideration (operation rights consideration) must be paid when acquiring the rights. The right holder acquires (purchases) the right to operate the facility and recovers the investment from future operating revenues. When the operating right consideration is incurred, the financing is also required.

Water and sewage systems, like electricity and gas, are huge network infrastructure to be maintained and operated, and transferring them to private companies with specialized skills for proper management is the right direction to take. At present, however, there does not appear to be any noticeable progress. There are two reasons for this, one on the part of the residents and the other on the part of the private sector. On the residents' side, especially in the case of water supply, there are concerns about the safety and sustainability of the private sector's management of the water supply. Some criticize that "water produced by the private sector is not safe." However, this is a misconception. We buy tea and beer produced by private companies and drink them without concern. Foods and medicines that we put into our bodies are basically all made by the private sector. The reason we are comfortable with the fact that they are not made by government employees is because we know that they have passed strict safety standards. Thus, the theory of private-sector danger is probably an emotional one, and we believe that a solid explanation would convince many citizens.

Figure 4. Financing for beneficiary-paid infrastructure



(Source: Prepared by the author)

On the other hand, the private sector's hesitation is more fundamental. That is, the current rates do not cover the costs necessary for adequate maintenance. Even if local government officials appeal the need to raise the fees by adding up maintenance and management costs as well as future renewal costs, they are restrained by political decisions, or the timing of the increase is postponed. As a result, the system becomes decrepit without adequate maintenance management and renewal at the appropriate time. In the conventional model, it is possible to have the repair budget disbursed from the general account even when failures occur, and this is done for implementation. However, this is difficult when the private sector takes the lead. Inevitably, the user fees must be set to cover the cost. Some people criticize that prices will be raised if the private sector operates, but this is also an emotional argument and logically wrong. Prices do not go up because the private sector runs the facility, but because they do not cover the costs required for maintenance and management, and therefore must be raised. Even for conventional types, price hikes are necessary.

VII-4. Financing infrastructure that does not generate cash flow

Roads and bridges are infrastructure that does not generate cash flow. Under conventional thinking, this category was basically managed directly by local governments. However, with the decrease in the number of technical staff in local governments and the improvement of know-how on the part of the private sector, there has been an increase in outsourcing to companies with specialized know-how, as well as comprehensive private-sector outsourcing where the wisdom of the private sector can be easily demonstrated through performance orders.

In addition, the Action Plan for PPP/PFI Promotion states that for infrastructure that does not generate cash flow, such as roads, a method in which compensation is linked to the results of management is to be considered. This method, also known as the availability payment (AP) method, has been introduced for roads in the United States. In contrast, AP is based on performance ordering, whereby the commission is reduced if the expected results are not achieved (or increased if the expected results are exceeded).

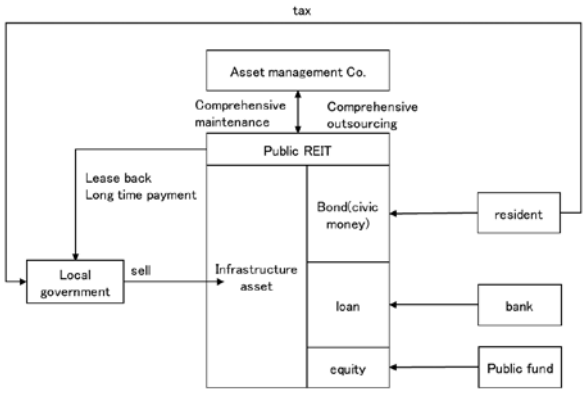
In both cases, the basic structure of covering the constant maintenance and management costs through consignment fees will remain the same, but because the private sector will have more freedom, capital investment in inspection vehicles, analysis equipment, and other facilities will be required. Furthermore, when concessions are set up as described for water and sewage systems, financing will be required to acquire the rights. Roads and bridges exist in every municipality, and this could be a business opportunity for local companies in the construction and landscaping industries that support them.

In addition, there could be a way to convert such infrastructure into cash. This would include the roads, bridges, and possibly water supply, sewage systems, schools, etc. that are currently in use, once sold to a private fund and then leased back (leaseback) for use.

Figure 5 illustrates the use of a real estate investment trust (REIT) structure.

In addition to generating cash income, municipalities will be able to transfer to the pri-

Figure 5. Example of financing for infrastructure that does not generate cash flow (REIT type)



(Source: Prepared by the author)

vate sector the risk of maintenance and management, which is difficult to pass on know-how due to a decrease in the number of specialized personnel, and concentrate solely on utilization.

The fund side can operate with confidence over the long term, since the leaseback recipient is a municipality and the infrastructure is the most stable property. Investors include local residents. Although the yield will not be high, there is no small amount of motivation to support the sustainability of local infrastructure. A certain amount of shift from savings accounts and chest deposits can be expected.

Table 11. The Role of Finance and Expectations of FILP on the Problem of Aging Infrastructure

Type	Subject (of taxation, etc.)	Role of Finance	Expectations for Fiscal Investment and Loan
Financing for base facilities	Base facility with school	Financing for construction of bases (service purchase PFI) Public Real Estate (PRE)	Supply of risk money (including the provision of capital to specialized risk-taking financial institutions or the establishment of specialized funds)
Financing for beneficiary-paid infrastructure	Water supply, sewerage	Financing for acquisition of public facility management right consideration	
Financing infrastructure that does not generate cash flow	Roads, bridges	Capital investment funds for inspection vehicles and analysis equipment in availability payments (AP) If a method similar to concession is used, financing for the acquisition of the right to operate consideration REIT and other fund-type financing	

(Source: Prepared by the author)

VII-5. Role of Fiscal Investment and Loan

Which of the above is appropriate in view of the nature of the FILP is a subject for further study, but it is difficult for the private sector alone to procure such financing because it is of a very large scale and the risks involved are not small. We would like to see the FILP provide risk money to facilitate each type of financing (i.e., establish specialized financial institutions or specialized funds that are capable of risk-taking).

References

Nemoto, Y. (2011), "Aging Infrastructure", Nippon Keizai Shinbun

Nemoto, Y. (2015), "Proposal of a Standard Model for the Comprehensive Management Planning of Public Facilities and Examples of Application", *Bulletin of the PPP Research Center*, Toyo University, No. 5

Nemoto, Y. (2017), "Estimation of the Scale of Renewal Investment for Aging Infrastructure (FY2016 version)", *Bulletin of the PPP Research Center*, Toyo University, No. 7

Nemoto, Y. (2018) ①, "Development of a public facility evaluation method to enhance the effectiveness of the comprehensive management plan for public facilities", *Bulletin of the PPP Research Center*, Toyo University, No. 8

Nemoto, Y. (2018) ②, "A Study on the Regional Base Setting and Infrastructure Development in the Era of Declining Population", *Bulletin of PPP Research Center*, Toyo University, No. 8

Toyo University PPP Research Center (2019), "Infrastructure Aging Countermeasures and Maintenance Technologies", Report of Research Project on Science and Technology, National Diet Library.

Nemoto, Y. (2019) ①, "Consideration on the Importance of 'Explanation' for Realization of Comprehensive Public Facility Management Plan", Gyosei, Local Finance Vol. 58 No. 8, pp. 4-12

Nemoto, Y. (2019) ②, "Answering Criticisms of PPP: A Social Experiment for Consensus Building Using a Smartphone App", PPP Research Center, Toyo University, W*hite Paper on Public-Private Partnerships 2019-2020*, pp. 22-29

Nemoto, Y (2021) ①, "A Study on the Possibility of Asset Mapping and Online Citizen Workshop: Through a Social Experiment in Wako City, Saitama Prefecture", Bulletin of PPP Research Center, Toyo University

Nemoto, Y. (2021) ②, "The Problem of Aging Infrastructure and the Role of Consensus Building", *Local Government Mie*

Nemoto, Y. (2022),"Considerations on Infrastructure Aging and Renewal Investment Financing", Financial Review, Vol. 147, pp. 87-109

Ministry of Land, Infrastructure, Transport and Tourism (2018), "Estimation of Future Maintenance and Renewal Costs of Social Capital in the Fields under the Jurisdiction

of the Ministry of Land, Infrastructure, Transport and Tourism", Ministry's "Infrastructure Maintenance Information" website
<https://www.mlit.go.jp/sogoseisaku/maintenance/index.html>