2. Overview of Building Stock Management in Japan

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2.1 Introduction

For the last six decades, construction activities in Japan have mainly focused on new building activities rather than work on existing buildings and facilities. For several reasons, there has been a serious shortage of buildings and facilities with sufficient quality and performance: destruction during World War II coupled with the huge demand for new construction by the concentration of population in mega cities since the 1950s.

However, Japan is now faced with the situation of managing existing building stocks and facilities which have been accumulating for the last six decades. It requires a fundamental paradigm shift from new-building-based thinking to a model of thinking about working on existing buildings. Asian countries that are experiencing enormous new building activities will inevitably face the similar situation that Japan now faces. Therefore, the Japanese situation could provide lessons for future construction activities in Asia.

As an introduction to this book, this chapter describes why Japan needs to establish methods of stock management from the aspect of macro-scale building stock formation. The chapter also presents the potential of information provisions using information technology (IT) as an enabler for a holistic approach in stock management.

Y. Fujino, T. Noguchi (eds.) *Stock Management for Sustainable Urban Regeneration*,

2.2 Why Stock Management?

2.2.1 Age Distribution of Building Stock

Fig. 2-1 shows how much building stock has been accumulated in the last six decades in Japan. Japan has now over 8 billion square meters of building stock. Fig. 2-1 seems to show a very healthy, gradual increase in the national building stock.

Fig. 2-2 shows that the Japanese building stock is quite relatively new, with most of the building stock has been constructed after the 1970s; as a matter of fact, 80 percent of the buildings now in use have been constructed after that decade. The buildings constructed before that time represent less than 20 percent of the whole stock. Some work that has been done to these buildings, such as retrofitting, refurbishment, redesign or remodeling, has happened 20–30 years after their construction. Thus, it is presumed that a huge potential number of buildings will be targeted for building refurbishment in the near future.

Fig. 2-3 shows a comparative age distribution of existing buildings in the European and the North American countries. In Germany, France and England the postwar buildings occupy 50–60 percent of the building stock, while in Japan most of the building stock has been constructed after the Second World War. It is clear that the Japanese building stock is relatively new while it is

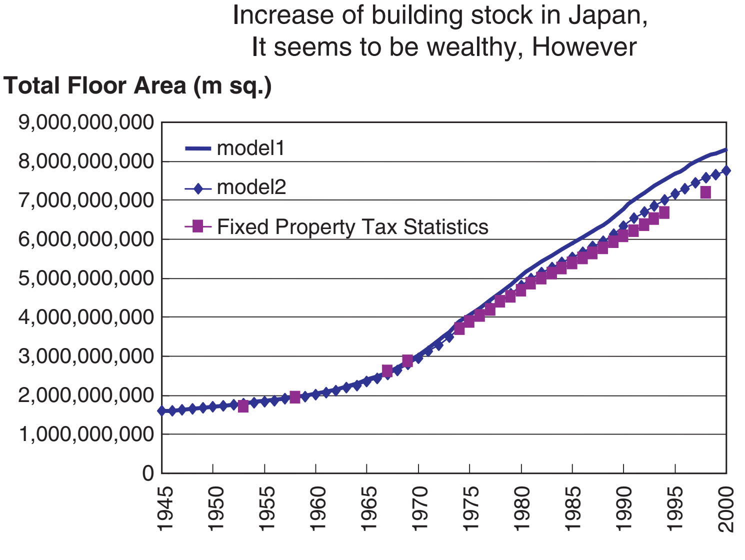

Fig. 2-1. Increase of building stock in Japan

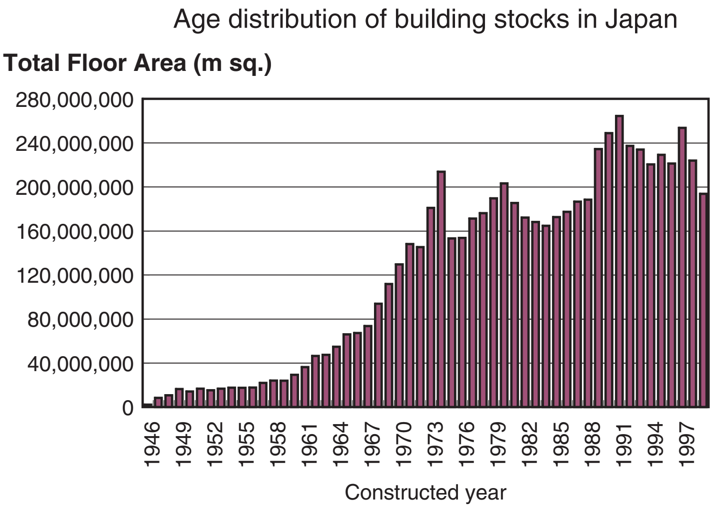

Fig. 2-2. Age distribution of housing stock in Japan

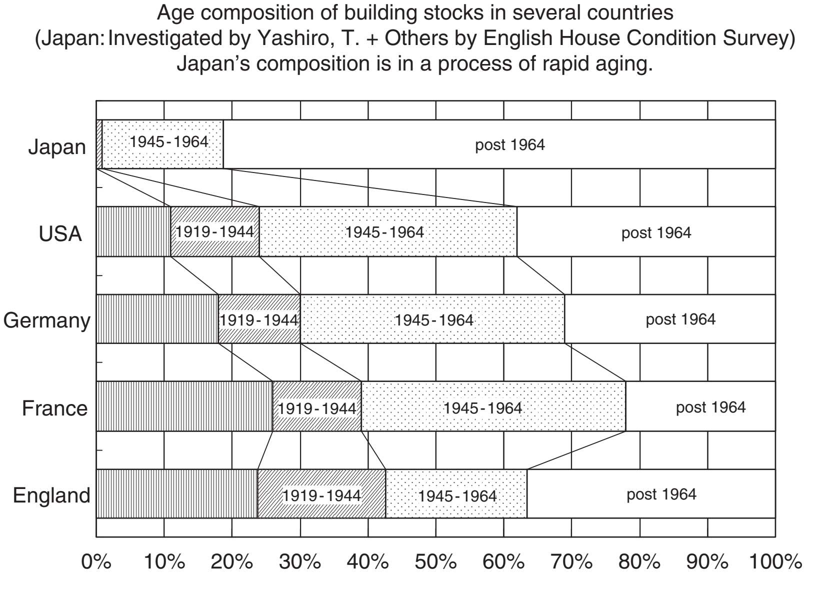

Fig. 2-3. Comparison of age distribution of housing stock (Source: English House Condition Survey, for Japan as calculated by the author)

older especially in the European countries. In England for instance, almost 40 percent of the building stock constructed before 1945 is still in use.

2.2.2 Short Building-Life Syndrome

Fig. 2-4 describes that in several cases, buildings in Japan are very new and thus exhibit the problem of the "short buildings-life syndrome." In the charts, the X axis shows the years since construction and the Y axis shows the percentage of buildings that have survived. The number of steel structural office buildings is decreasing because of demolition; within less than 30 years over 50 percent of these buildings will have been demolished.

Thus, the average life span for steel-structured buildings is less than about 30 years while it is almost 40 years for reinforced concrete buildings. This is a rather short span because statistics show that the life span of small timber houses in Japan is about 40 years (Fig. 2-5). After some surveys by colleagues, the middle sample indicates that the life span for small timber houses is now about 50 years.

In the United States, taking Indianapolis as an example (Fig. 2-5), statistics show that the average life span of a house is over 100 years. By comparison,

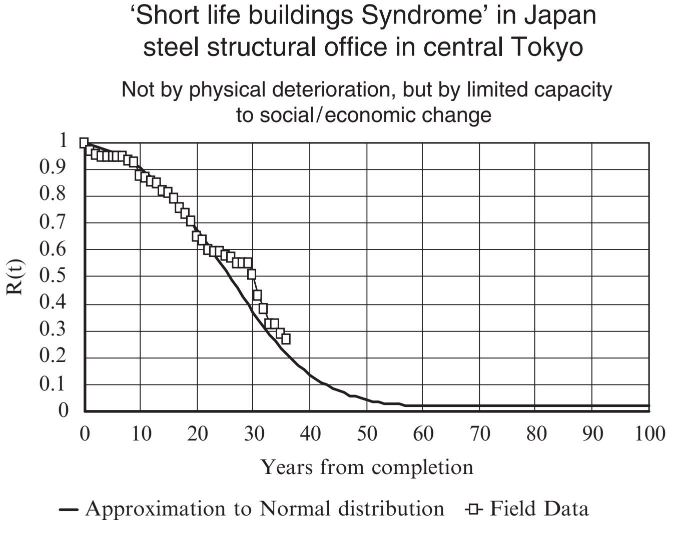

Fig. 2-4. Short-building-life syndrome in Japan for steel structure buildings and reinforced concrete buildings

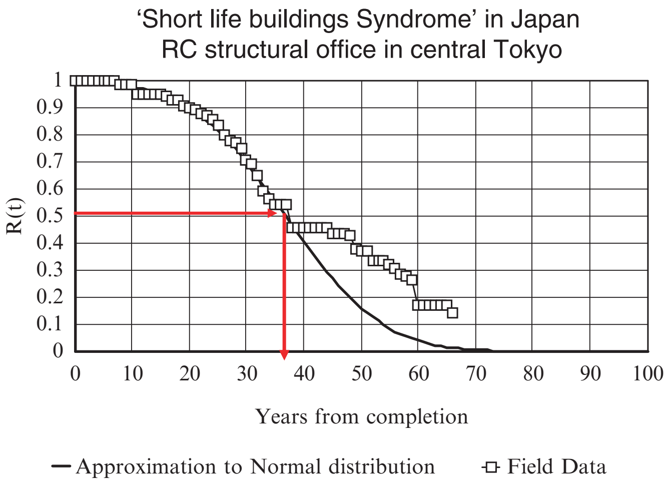

Fig. 2-5. Statistical analysis on house life in Japan and USA

Japanese houses have a much shorter life span. This is not due to physical deterioration though about 11 million houses do not meet with the current seismic building code, so it is probable that millions of houses will be destroyed by earthquakes. However, even if a building itself meets structural safety codes, it can still be in use only for 50 years simply because it does not meet with ever-changing social and economic requirements. The life of many Japanese buildings is short mainly due to socioeconomic issues rather than to reasons of physical integrity. So when one talks about the longer life of buildings, a system needs to be developed that integrates technological as well as socioeconomic issues.

2.2.3 Decline of New Building Demand

Fig. 2-6 shows the ratio between newly built construction and the real increase of the building stock. Some buildings are demolished and replaced by new ones. In that case the building stock both decreases and increases, therefore any new construction is not equal to the new increase of the building stock itself. Until the end of the 1990s, almost 80 percent of new construction contributed to the increase of the building stock, but after the 1990s that ratio went down to less than 40 percent. This means that in Japan some 150 million square meters are constructed per year but only 60–70 million of these square meters result in an increase of the building stock. This fact suggests that the demand for new building space is declining in Japan.

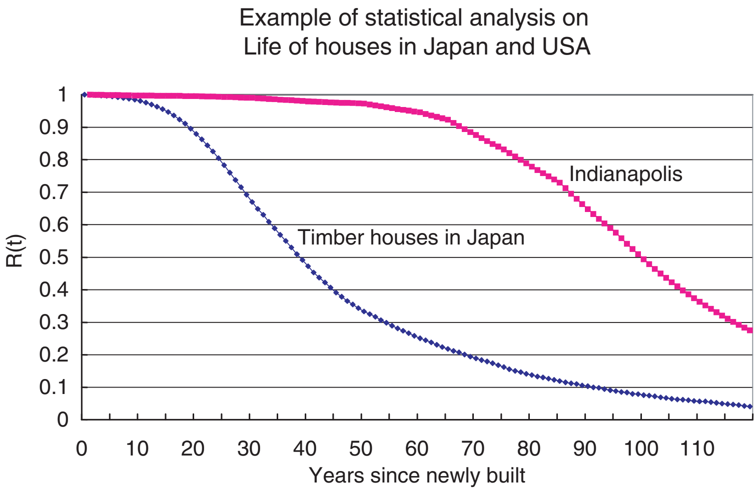

Fig. 2-6. Decline in demand of floor space

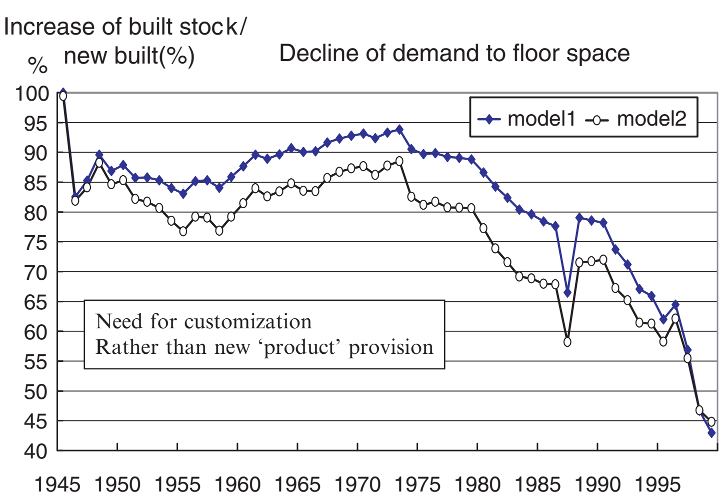

Fig. 2-7. Number of households in England, by year of house construction (Source: English House Condition Survey)

2.2.4 Comparative Content of Housing Stock in UK and Japan

A very comparative situation exists in the United Kingdom as shown in Fig. 2-7, which presents national housing statistics indicating the number of households living in structures built in given years. For example, the lowest graph

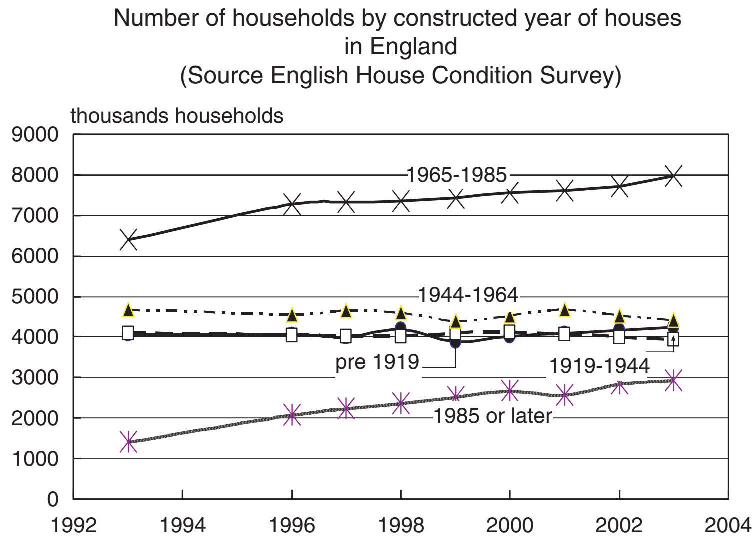

Fig. 2-8. Potential risk of households in Japan

shows households living in houses constructed after 1985 and the middle one shows the number of households living in houses constructed before 1919. This graph is almost horizontal, which means that, in England, the houses in every age cohort have not vanished so much. I heard from a British scholar that the life of a building in England is about 1,000 years because only 2,000 houses are demolished while about 160–200 thousand are newly constructed to accommodate the increase in households (Meikle and Connaughton (1994)).

Comparatively, the situation in Japan is explained in Fig. 2-8, in which the graph shows the amount of debt remaining in terms of the number of months. The "price" of houses (i.e. their value) starts to elapse right after the loan is obtained and construction begins. Anyone who has incurred a housing loan pays back this loan on a monthly basis, and due to the interest rates the graph has an upper hill shape. The significant thing in Japan is that the economic value in the market of timber houses is dropping down, and within 15 years the value will drop down between 10 to 20 percent of the initial cost.

In other words, if someone does not have any income then there is no way he or she can pay the house loan, so naturally the house will be sold, but at a lower value than when it was initially bought. Still, even if the house is sold there is still the remainder of the housing loan to be dealt with. This is one invisible risk. Earlier in time, very few Japanese would have recognized this invisible risk because there was a capital gain from land.

The comparative situation in England and in Japan in terms of the design life of the building versus its physical life is as follows: in Japan the design life is longer than the actual building's life. In the UK, and probably in other European countries, the design life is shorter than actual life; therefore, Europeans make some investments to rehabilitate the structure and so on. Japanese homeowners suffer from the invisible risk of losing the value of the housing investment while in England the house value can be maintained if the residents make investments in that house. For the last 10 years England enjoyed a good economic situation; therefore, the housing prices increased nearly fourfold during the last 20 years. So the people who bought houses 20 years ago are now enjoying this fourfold increase while the Japanese who invested in buying a house have almost lost their wealth. These are quite serious differences.

2.2.5 "Poverty Trap"

Fig. 2-9 illustrates a situation in which Japan now finds itself. It can be called the "poverty trap." When buying a newly built house, one typically takes on a 20- to 30-year mortgage; in Japan, once this loan is paid off, a male purchaser will enjoy 10 or 15 years left of his life (knowing that the average life of a Japanese man is about 70–80 years). His house would then be inherited by one of his children, Since the inheritance taxes are quite high, it is very probable that this son or daughter would sell the house, which eventually would be demolished. This leads the son or daughter absurdly back to square one, from where his/her parent had started. It

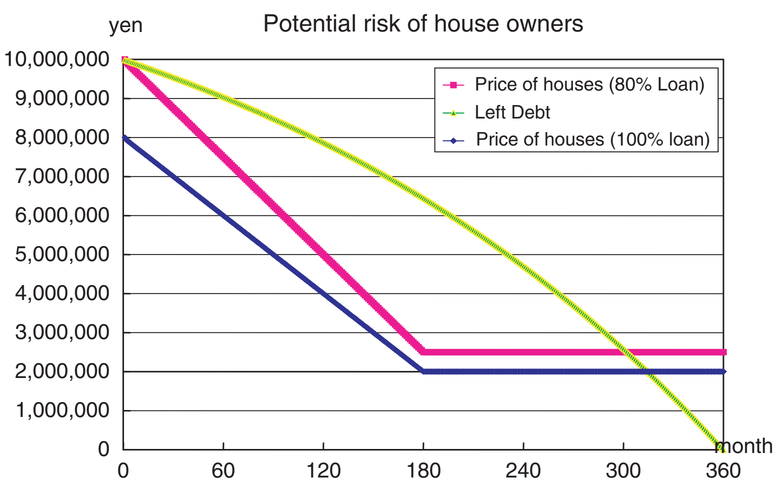

Fig. 2-9. Need of escape from "poverty trap" caused by rapid drop of house value by age associated with short-building-life syndrome

should be emphasized that there is a need to escape from this "poverty trap" situation by a restructuring of the technological and socioeconomic system that could enhance the value of existing buildings through continual investment. Stock management should take a major role in this restructuring.

2.2.6 Expected Paradigm Shift

Fig. 2-10 introduces the concept of life cycle value. It is the integration of the value over time on the buildings. The vertically hatched area of the graph represents the life cycle value. When new building activities are dominant in construction activities, most building engineers in Japan tend to only think about initial price or cost; consequently the life cycle value drops down through time. The building engineers and all the stakeholders who are involved in the building process need to completely change their way of thinking and jointly create a new paradigm that will maximize the value of a building over time. If the value of houses can be maintained in Japan or in Asia, the people here can enjoy the lifestyle that will allow them, once they buy a house in young age, to obtain economic stability throughout their entire lives.

Fig. 2-11 presents a comparison of resource productivity in a new-building-oriented society to an existing-buildings-oriented society. In a new-building-oriented society various resources are consumed and huge amounts of waste are generated while only very little value is created.

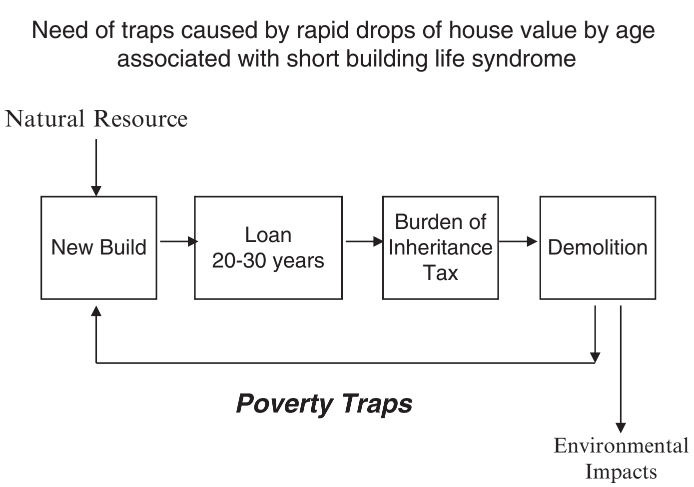

Fig. 2-10. Expected paradigm shift from initial value to life cycle value

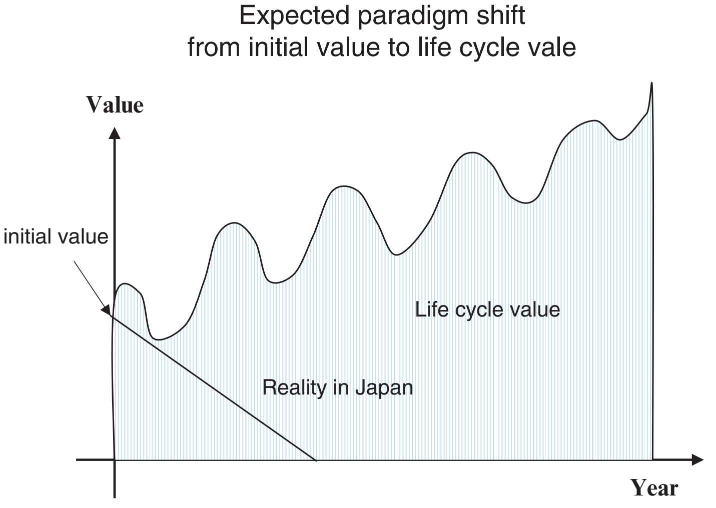

Fig. 2-11. New-building- oriented society vs Stock-based society

Contrarily, works to existing buildings involving repetitive use of the stock there will result in a consumption of fewer resources and less waste while adding more value to the existing stock.

2.2.7 Adaptability to Ever-Changing Requirements

Fig. 2-12 introduces the idea of open building, where the building is separated into two parts: the skeleton and the infill. The skeleton is the infrastructure of building and includes the structure, stairs and vertical pipes and wires that are commonly shared by all users of building. The infill is the private part of building that includes interior finishing and appliances. Thus, infill is expected to be exchangeable, corresponding to the ever-changing requirements of occupants and users while the skeleton lasts for 100 or 200 years with a well-planned long-term maintenance program.

The cycle of change is completely different for each of these two elements. Sadly, in most buildings, the two are entangled: both the element that is expected to last for 100 years and the element that needs to be replaced within 5–10 years are mixed together. It is difficult to sort them out. Consequently when the building is refurbished, the healthy part also inevitably needs to be destroyed.

The concept of "open building" is the principle and method of construction to assure full autonomy to both the skeleton and infill so that decisions can be made about each of them separately, as part of an independent package.

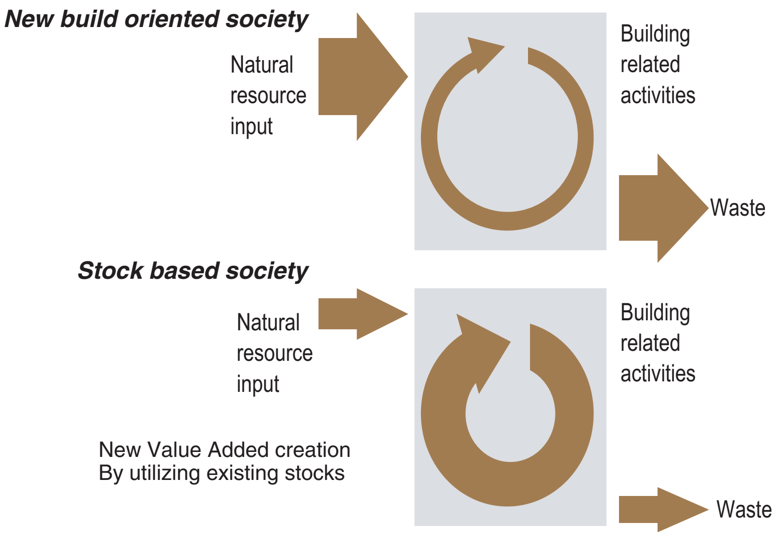

Fig. 2-12. Idea of open building

Inspired by the idea of open building, the financial/tenure system of the houses is proposed by Mr. Nakazato as shown in Fig. 2-13. Here skeleton is owned by a single responsible body and the financial arrangements are on a long-term basis so long-term-based investors such as pension funds could provide the financing. In this case, the skeleton is maintained by the single responsible body and an engineering report is issued to the investors and shareholders. In the diagram shown in Fig. 2-13, the infill is considered as personal, property, so the short-term house loan, for 10 or 15 years, becomes just a small amount.

Thus, by following such a scheme, the value of the skeleton and the value of the infrastructure of the building can be maintained on a long-time basis, while the value of the infill itself can drop down and jump up repetitively on a short-term basis. In this way, 70 percent of the value of the building can be maintained in the long run.

2.3 How Could We Improve the Situation?

2.3.1 Stock Management in an Information-Driven Society

In order to mitigate the serious problems of the "poverty trap," we need to establish and practice a method of stock management in the Japanese con-

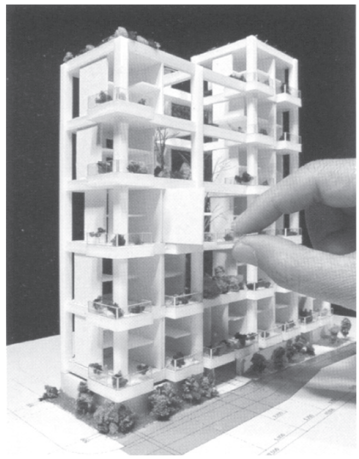

Fig. 2-13. A. 11. Housing loan system corresponding to open building idea

text as fast as possible to enhance the value of the existing building stock. It should be noted that a fundamental change in the global socioeconomic and technology systems are underway, especially in the well-developed world; information itself is becoming one of key driving forces in society. It can be said that the society is getting to be information-driven where information itself generates added value.

Various stakeholders are committed to the decision-making process of stock management, and there is a serious need to provide understandable and traceable information with engineering integrity in order to promote continuous investment in existing building stock and facilities.

2.3.2 Information-Embedded Building

Performance and quality are the key factors in identifying the value of existing buildings. However, these factors are invisible and difficult to assess for nonprofessional stakeholders. Therefore, assessment of performance and quality of buildings, and provisions of assessment report to stakeholders is getting to be quite significant. To make the assessment report traceable and reliable, it is mandatory that the assessment is done by evidence basis.

In reality, not all buildings have sufficient evidence usable for assessment. Information relating to a building is generated by many agents such as the architect, engineer, main contractor, subcontractors, suppliers, operators, maintenance teams, owners, occupants and users, etc. Generally, information generated by some agent is saved and used by that agent only.

Therefore, from a bird's-eye point of view, a set of information needed for a comprehensive assessment of the performance and quality of a building is fragmentally maintained and used by various agents. Thus, it is difficult for a stakeholder to collect necessary information at any specific occasion because of fragmented information management. In a sense, a building is a black box for stakeholders. No one can put value into or make an investment on an object whose performance and quality are unknown. This is one of the reasons why the value of Japanese buildings follows a conventional evaluation curve over time. In other words, if we intend to enhance the value by jumping up from the conventional curve, we need to assure that full accessibility to a set of comprehensive information is available anytime for any stakeholder who has socially agreed permission to access the information. When reliable, traceable, transparent information is provided, the value could be increased as seen in Fig. 2-14. And if the content of provided information is of high quality, proving that this is a very high-performing building, its value could be additionally enhanced as seen in Fig. 2-14. We can thus expect an enhancement in value by making the building traceable and by providing evidence or excellency when the building displays good performance and quality.

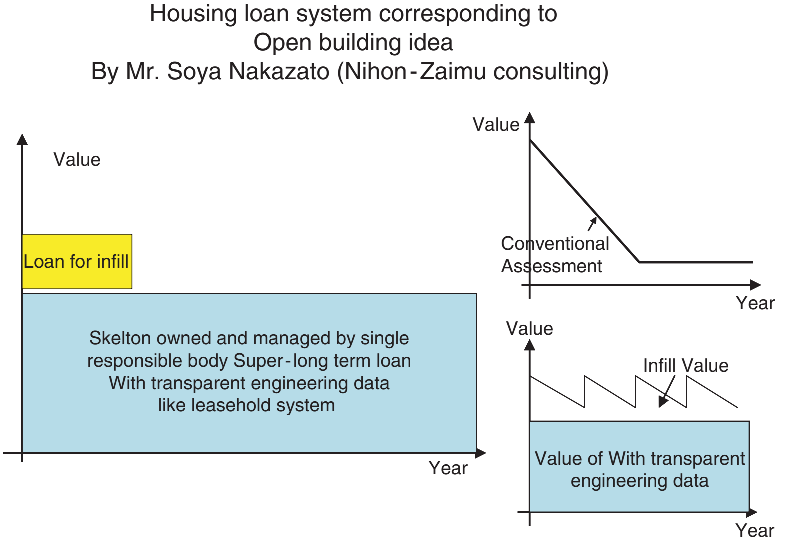

Fig. 2-14. Enhancement of value by information provision
Significance of provision of traceable and understandable information with engineering integrity

Here the idea of an information-embedded building is posited to assure full accessibility to a set of comprehensive information (Fig. 2-15). It is a building for which on-site accessibility to necessary information can be provided, as supported by ubiquitous computing and information networking technologies.

In an information-embedded building, for instance, structural performance and energy use are monitored using networking technology as well as innovative sensing devices. In addition, the history of the maintenance of components or equipment of the building can be traced using IT tools. The following technological developments by the author are examples of subsystems that support an information-embedded building

2.3.3 Life-Cycle Traceability System

The first example is a life-cycle traceability system of building components and equipment using RFID (Fig. 2-16). Regrettably, the repair and mainte-

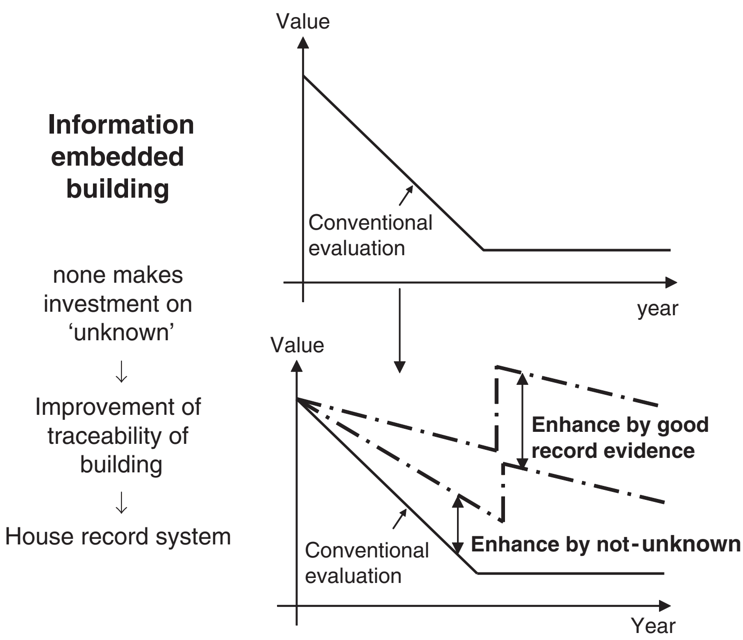

Fig. 2-15. The idea of an information-embedded building
In an information-embedded building, professional and nonprofessional stakeholders have access to information for well-informed decision making using IT devices (including RFID and barcode, sensors which are connected, systematized and integrated by Internet/Intranet)

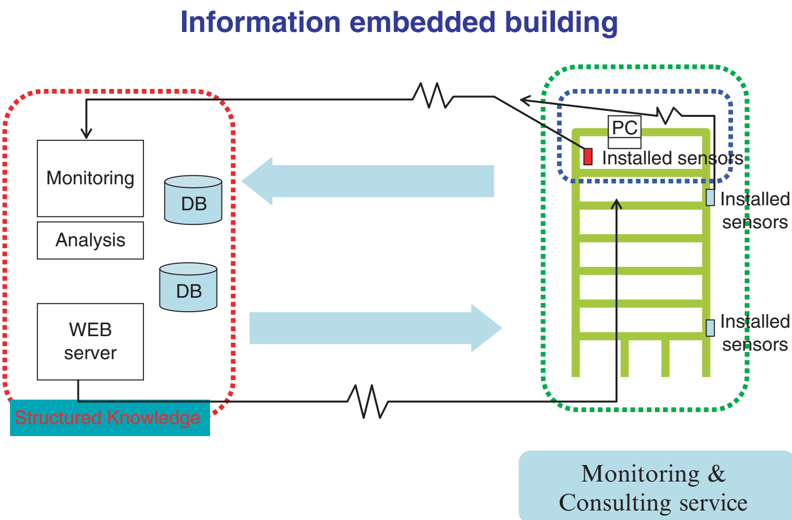

Fig. 2-16. Life-cycle traceability system using RFID

nance of components and equipment are generally inefficient because site operatives have difficulty in accessing the necessary information for repair maintenance. It is a time- consuming task. Site operatives often take longer time to access, seek, collect, send and return information than in the actual repair and maintenance work. Moreover, there is no assurance that maintenance record data are stocked and used consistently. In reality, the loss of maintenance record data degrades the efficiency more seriously.

As Fig. 2-16 shows, a life cycle traceability system using RFID improves the inefficiency of repair and maintenance and loss of maintenance record data: site operatives of repair and maintenance can easily access the information needed for execution of onsite tasks such as previous maintenance record, technical specification of components and equipment, and detailed technical information about the fabric of the building. The repair and maintenance record data are sent to a database almost automatically and a revised data base is updated consistently for future repair needs.

The traceability system reduces the risk of the cost increase of maintenance, repair or refurbishment and provides benefits such as:

- Faster response to technical failures
- Proactive user support by suppliers
- Links with electronic manifesto certificate for waste treatment

2.3.4 Energy-Use Monitoring System

Fig. 2-17 shows an example of the output of a real-time-based energy-use-monitoring system developed by the author and his colleagues. Energy-use data can be collected through the intranet network installed in the building, and the results of structural analysis are displayed according to the needs of the users. Through the monitoring system, all stakeholders of the building can see how much energy is used in each part of the building (of course there is a need for access control to protect privacy). This system could be a mechanism for promoting voluntary actions by various stakeholders of the building to improve the energy use, because anyone can see and learn how his/her actions contributed to the end result.

2.3.5 House Record System

The author and his colleagues also developed a house record system where a set of drawing specifications, maintenance records, and energy use data is maintained. Fig. 2-18 is the example of the display of this house record system. In a sense, the system is the view window of a set of comprehensive information used for evidence of assessment of performance and building quality.

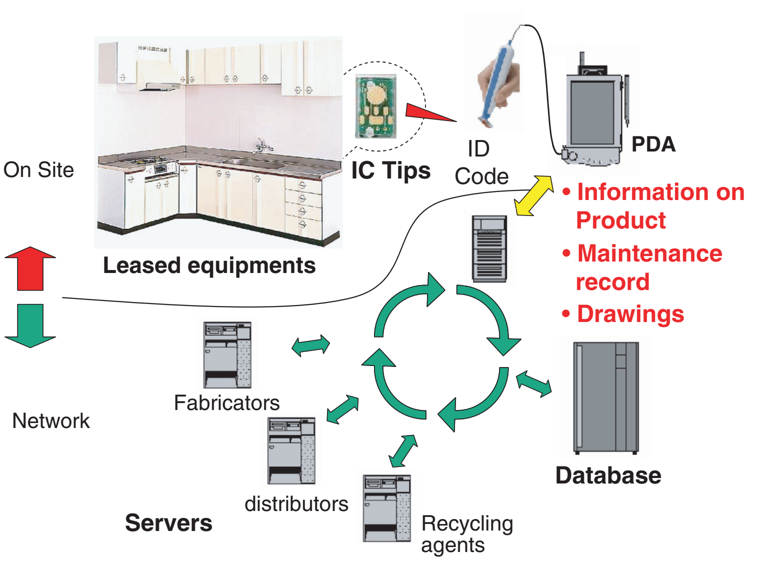

Fig. 2-17. Real-time energy monitoring system

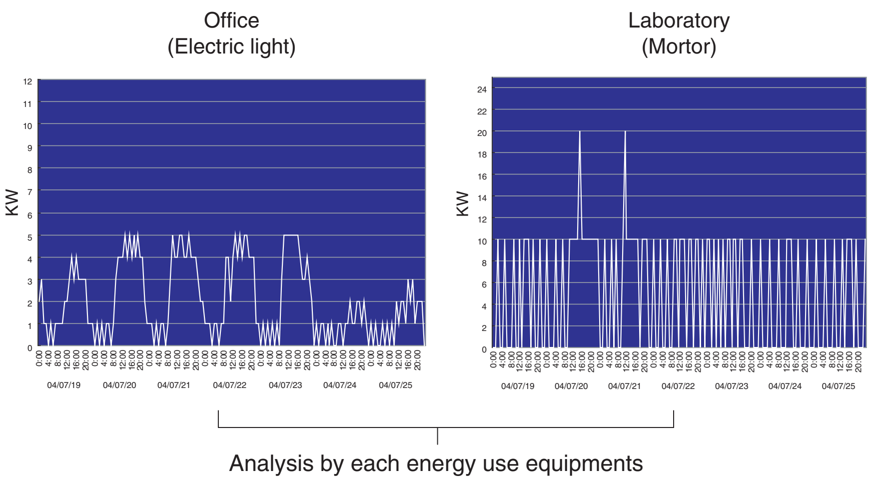

Fig. 2-18. House history system

2.3.6 Implication of an Information-Embedded Building for Stock Management

Then, what are the implications of an information-embedded building for stock management?

In a time of structural change in a construction market dealing with modifications to existing buildings, as well as in a time when an information-driven society is emerging—one where many stakeholders can participate in and commit to the process of decision making about stock management—the building industry itself needs to be fundamentally changed.

It should be noted that, when compared with new building activity, actual stock management contains uncertainty because of the lack of information. Also, currently it is difficult to introduce the benefits of economies of scale because most stock management requires highly individual, very specific components and materials. The manager of the stock management project is required to have patient dialogues with various stakeholders; linkage to the financial sector is required as well. Information-embedded buildings provide traceable information usable for this multi-stakeholder dialogue.

Thus a completely different knowledge is required for new building projects, one that is quite challenging. There is a need to create a body of empirical knowledge first of all through experiments; this empirical knowledge then has to be systematized. The information-embedded building is the device that will enable professionals to build up empirical knowledge of stock management with certain engineering data. This is a challenging area for younger professional and students, who are expected to do make their contributions toward resolving these difficulties and challenges.

2.4 Concluding Comments

For stock management of urban facilities, a holistic approach is needed. "Holistic" means that one can collaborate or team with people having different expertise—not only building engineers, but also financial people, local stakeholders, and so on. In the existing academic domain, that could either be a constraint or an obstruction, because the issues at stake today are completely different from those derived from academic traditions as described here. Probably most readers have dealt with these issues where problems are simply defined, where the number of decision makers is limited, and where there is no discussions about norms. In this scenario, a simple principle can often be applicable to describe the whole system. But in terms of stock management, none of those traditional typical attitudes are valid any longer; in other words, some really complicated matters now arise: the number of decision makers can be unlimited sometimes, or the discussion can sometimes extend to the field of norms and ethics. Also there are new issues around the parameters of what is being created: various principles can describe a part of the problem, but no single principle can describes the whole system. This is the area of challenge, practically or academically.

Thus, the author charges the student: "Be ambitious, everybody, in defining the next generation of practices and to work on them beyond the existing academic domains."

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