

Small House Projects in Japan: Housing Experiments for Sustainability and Open Building Concept

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Abstract

Focusing on minimum or small houses has become one of the recent trends in housing design in Japan, as has been observed in many house design works. Periodical coverage can tell that the number of such works has clearly been increasing since the 90s, as compared with the 70s and 80s. The trend of small houses was also observed in the 50s. In those postwar years of economic growth, it was driven by the conditions of the time, such as supply and housing shortages and urban centralization. Today's social conditions are significantly different from those in the 50s, and naturally, the whole concept of small houses has greatly changed from the past.

In this research, we evaluate the experiments of small houses, from the view of the idea of sustainability and open building concept. Specifically, the study compares the small houses of the 50s and those after 1990 to examine their differences or similarities in terms of size, structure and building systems. And thus clarify how industrialization and standardization reflect on these experiments.

The former period, most were constructed on wood, with traditional construction method. As Japanese traditional structural system contains sustainability and flexibility originally, the purpose of design was rather how to adapt the industrialization to the traditional construction and how to realize the modern way of living in the smallest space, than fulfillment of flexibility. Moreover, low cost was also included in the design purpose.

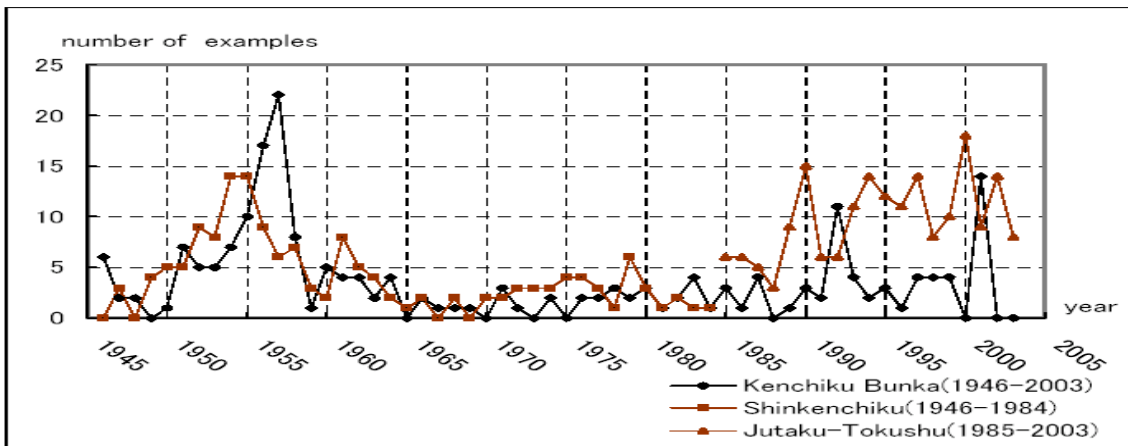
In latest examples, not only wooden but various structural systems are seen, such as steel, reinforced concrete or mixed structure. Also multi-storey houses are major. It cannot be said that those houses are cheaper than “non-small” houses. The total floor areas are larger than those of the 50s, and also the floor area ratios are. The “small” means “small building area” rather than “small space for life and minimal cost for construction”. The experimental projects were conducted by the intention exploring new possibilities and diversities of space design, with various highly industrialized materials. The small houses after 1990 can be regarded as experimental efforts to explore new approaches to skeletons within the context of urban tissue.

Key words: small house, experimental house, floor area, building area, Japan

1. Purpose

Focusing on minimum or small houses has become one of the recent trends in housing design in Japan, as has been observed in many house design works. Periodical coverage can tell that the number of such works has clearly been increasing since the 90s, as compared with the 70s and 80s. The trend of small houses was also observed in the 50s. In those postwar years of economic growth, it was driven by the conditions of the time, such as supply and housing shortages and urban centralization. Today's social conditions are significantly different from those in the 50s, and naturally, the whole concept of small houses has greatly changed from the past.

Given this background, this study looks into what approaches are adopted for small houses, evaluating the design efforts made for this housing type, particularly in terms of building systems such as prefabrication and open building concepts. Specifically, the study compares the small houses of the 50s and those after 1990 to examine their differences or similarities in terms of size, structure and building systems. In so doing, it attempts to shed light on the changes in the notion of architects towards the relationship between small house design efforts and prefabrication or open building systems.



Shinkenchiku (Japan Architect, hereinafter “JA”), *Shinkenchiku Jutaku-Tokushu* (hereinafter, “JT”) and *Kenchiku Bunka* (hereinafter, “KB”)¹.

Among the works covered by these periodicals, this study dealt with those that were described in such expressions as “a small house” or “a small lot house” (hereinafter collectively called “small houses”). The “small houses” studied here were those that had been designed to represent the architects’ specific notion of “smallness”. The criteria to define small houses are not based on square measure or cost. Thus, the issue here is how the concept of architects of the time towards small houses has been represented in their works. Likewise, the criteria to determine “low-cost houses” or “small lot houses” are based on whether the architects use expressions that convey these characters when describing their works.

First, the number of houses described as “small houses” (those actually constructed) between 1946 and 2003 was counted. Figure 1 shows the number of small houses covered in each periodical between 1946 and 2003, organized by the year of construction². After peaking in the mid 50s, the number of small houses covered in

the periodicals was rather small throughout the 70s and 80s, which has been on an increase in recent years. In other words, the graph indicates that small houses have experienced a boom twice, namely during the 50s and the recent 10 years. Addressing these two phases, a comparative study is carried out here. The small houses studied here are those covered by JA between 1950 and 1959, JT since 1990, and KB between 1950 and 1959 as well as after 1990. The number of small houses studied was 163 for the 50s and 197 after 1990.

3. Square measure of small houses

In the 50s, which is sometimes termed as the “age of small house architects”, small houses were one of the key issues for the architects of the time. During the postwar reconstruction period, though there was a surging demand for housing construction, there was also a serious shortage in building materials. Given this, the government issued a temporary building restriction ordinance in 1946, which restricted the size of houses to 12 *tsubo* (1 *tsubo* = 3.954 sq.yds or 3.31 sq.m) for families of five. This restriction was relaxed to 15 *tsubo* (49.5m²) in the following 1948 and then was lifted all together in 1950.

In the same year, the Government Housing Loan Corporation Law was issued to support the nation to own houses. However, according to the lending contract term, the square measure had to be between 9 and 30 *tsubo* to be entitled for loan, of which up to 18 *tsubo* only was covered. It is easy to imagine that such detailed loan conditions served as a guideline for postwar housing design.

Under such circumstances, it can be said that houses of approximately 15 *tsubo* were generally regarded as “small houses” in those days. This is also implied in Figure 2, which shows the building/total floor areas of small houses in the 50s. Also, as characterized by the fact that the houses having the total floor area of 60m² or smaller account for 62 % of all small houses, most small houses had the floor area of between 40 and 60 m² (Figure 3). Single stories account for 78% of all small houses.

The periodicals were full of small house discussions, not only about floor area but about planning methods for materializing modern life within such a small space. The common theme was to what extent a living space could be made small, which was in other words the question of how to put into practice houses with small total areas.

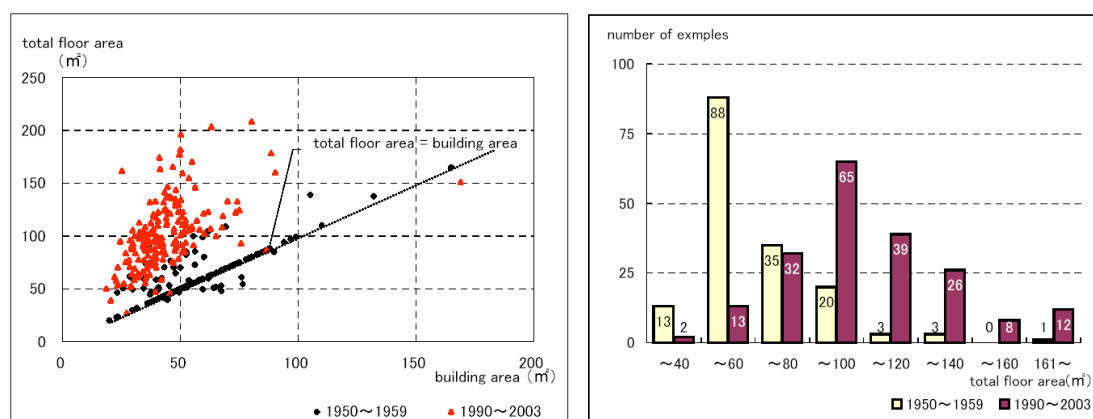
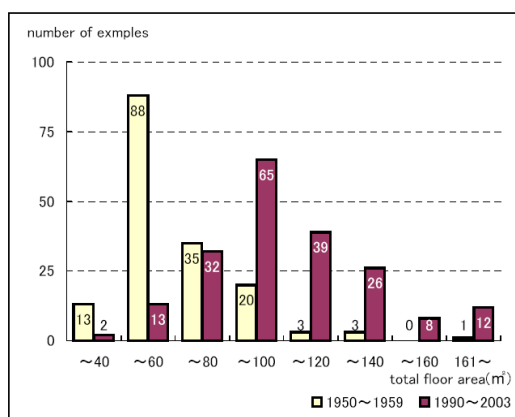


Figure 2 Relation between total floor area and building area

Figure 3 Number of examples, classified by sizes of total floor area



On the other hand, the small house boom in the 90s could be characterized by the consideration for the relationship between houses and the urban tissue. While site conditions were not a big issue in the 50s, the size of the site and its conditions have become a major issue among the small houses in the 90s cited in this study. Of all small houses built after 1990, 73 % have been designed with the focus on the smallness of sites (Figure 5). According to the graph of site/total areas (Figure 4), many of the 50s small houses were characterized by a total floor area of approximately 50m² built on relatively large sites, while after 1990, the majority has been those with a total area of approximately 100m² built on approximately 70m² sites. Also, as shown in the graph of building/total floor areas (Figure 2), while many of the 50s small houses were single stories, recently there have been many high-floor-ratio houses constructed high up on the small sites. In the periodicals, architects often describe their works in relation to the urban tissue, elaborating on the problem of how to dwell on small sites under severe urban conditions.

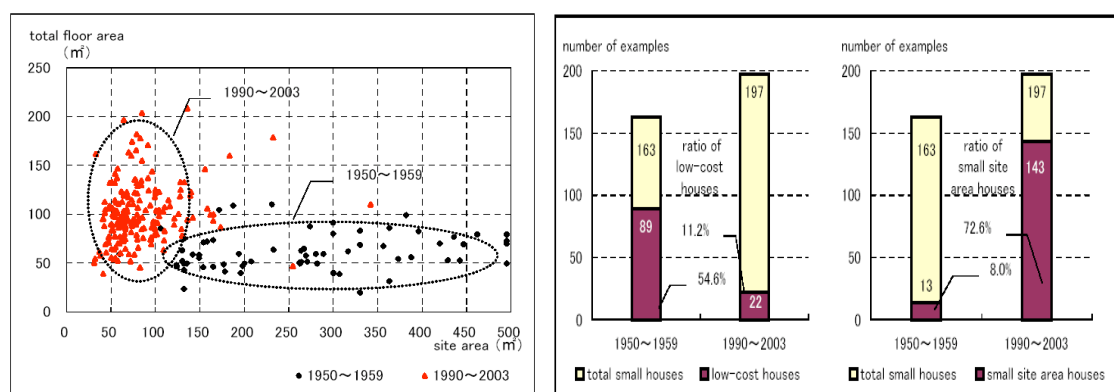


Figure 4 Relation between total floor area and site area

Figure 5 Ratio of low-cost houses / Ratio of small site area houses

4. Structural materials used for small houses

Figure 6 shows the percentage of each structural system. Approximately 83% of small houses were made of wood in the 50s. At the same time, 55 % of all small houses were low-cost houses (Figure 5). Cheaper traditional wooden houses were preferred in the 50s due to the situations concerning material supply and industrialization. Since 1990 on the other hand, purely wooden houses has accounted for as small as 32%, while various structural systems have been adopted, such as reinforced concrete, steel and mixed structures, which account for 21%, 19% and 27%, respectively. It is natural that more diverse materials and structural systems are available today than the 50s. What should be noted about the 50s is the fact that two notable works namely “Steel House Op.1” by Kenji Hirose (1953) and “Seike House” by Kiyoshi Seike (1954), which are regarded as having great impacts on posterity, were steel and reinforced concrete structures, respectively. Though rare, experiments on small houses through application of new structural materials in the 50s indeed proved fruitful.

On the other hand, what is notable in recent years is the fact that cost reduction efforts are not that prioritized as compared in the 50s when they were the major objective for the rationalization and standardization of construction work (Figure 5). With regard to the structural type, wooden structures have been decreased due to the trend towards

high-rises and increased fireproof performance. Instead, reinforced concrete and steel structures have been increasing, though they are more costly than wooden structures. It seems that utilization of small sites has replaced the construction cost reduction efforts in trying to reduce the overall cost because of the steep rise in land prices.

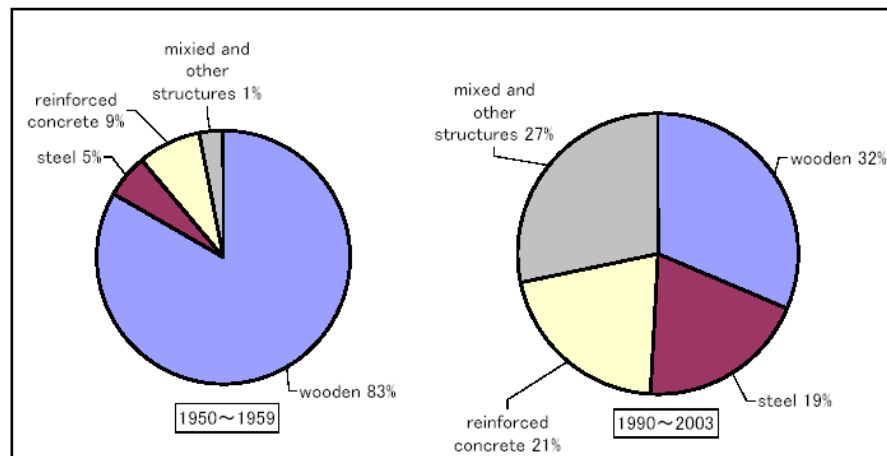


Figure 6. Ratio of structural materials

5. Building system experiments on small houses

5.1. Building system experiments in the 50s

As studied above, architects of the 50s attempted to create houses that materialize modern living out of the minimum budgets, materials and space. In specific terms, most of the discussions about such attempts focused on layout and cost. At the same time, there seem to have been various experimental efforts on building systems. Case studies on building system experiments in the 50s yielded certain insights, which are categorized into the following 4 subjects:

(1) Planning by the core system

The core system is the method of materializing a small house by integrating specific-purpose services in one place and leaving other space open. Combining this concept with structural ideas gave rise to the notion of categorizing not only the living style but also the structural system itself into fixed and flexible parts³. This concept was clearly put forward by Kiyoshi Seike and Makoto Abe in their works in 1951. An integrated flexible space can adapt to short- and long-term changes through use of subsystems such as furniture and partitions. A house called “Residence No. 20 (1954)” by Yoh Ikebe (Figure 7) is a good example of materializing such a concept in an extremely small space. In those days, not only Ikebe but also Bunzo Yamaguchi of the Research Institute of Architecture made the same experiments. The small houses designed through this approach⁴ that aimed to modernize services and rationalize domestic work contained the seeds of open building concepts.

(2) Proposal of dimensional systems and modules as part of prefabrication efforts

Most houses of this period were based on the Japanese traditional module, namely the *Ken* module. As long as this module was followed, it was possible to deal with any changes in doors/windows or furniture easily, share craftsmanship and take flexible measures in terms of both materials and construction. That is to say the traditional construction method used to ensure open-system like flexibility without having to go through prefabrication. In the 50s however, revision of the standard dimensional system gradually attracted attention, driven by the influence of modern architecture and the demand for prefabrication.

Studies on the dimensional proposals often made by architects when describing their works reveal that there were two attitudes towards this issue: to propose a new dimensional system suitable for modern living and prefabrication; and to propose new ways of applying dimensional system for the purpose of making the most of available materials in the marketplace. The houses that represented the former attitude were minority, while most of the houses were based on the latter position.

A house called “Minimum-Volume House (1950)” by Yoh Ikebe was one of the examples of the former, which proposed the 0.75-m, 1.5-m and 3-m modules. Although various proposals were made, no unified dimensional system was established. There was another aspect that was supposed to be as important as dimensional systems in contributing to prefabrication and the open-building concept, namely the specifications of joints. In his series of steel houses typified by “Steel House Op.1 (1954)”, Kenji Hirose made various experimental efforts to explore the possibility of prefabricated houses, combined with joint detail studies. However, as in the case of dimensional systems, the majority of experimental works did not go beyond the traditional building systems.

The most pressing issue for the architects of the time was how to prefabricate the materials used in conventional building systems. There were very few works that tried to go beyond the traditional construction regime, aiming to develop new dimensional systems or propose prefabrication of new materials.

(3) Prefabrication of materials

The dry construction method and panel wall systems were observed in “House of Prof. Dr. Otto Mori (1951)” and “House & Atelier of Mr. T (1952)”⁵. In “House of Mr. K (1953)” by Han Konishi, exterior curtain walls were applied to a reinforced concrete structure, while Kenji Hirose experimented with wall building systems in a series of his steel house works. Experimental use of panels and curtain walls, whose purposes were the prefabrication of materials and simplification of construction process by separating walls from the structural system, had already been observed in the early 50s.

As cited above, there were many works that rendered new ideas to promote the prefabrication of materials. “Residence for Mr. Kimoto (1958)” by Isao Shibaoka was designed with many prefabricated materials. According to the architect, it actually cost more than the traditional building system because of the lack of expertise by the

workers. In those days, the experimental use of new materials and prefabrication of materials were concurrently in progress, and even if a new material was found suitable for prefabrication, it did not mean to be low cost due to the immature prefabrication procedures.

(4) Notion of extension

Small houses gave rise to the notion of extension, i.e. to build a small house for a start and then deal with future changes by extension work. Some of the examples that entailed the notion of extension include “Minimum House in Musashino (1952)”, “Architect’s House (1953)” and “House in Kamakura (1955)”⁶. The notion of extending a house to deal with future lifestyle change was developed into an idea related to the core system and structural considerations, which was to divide a house into fixed and flexible parts and accommodate future changes with the flexible part. The notion of extension was born out of the intention of seeking the minimum space, which later develop the concept of small houses into sustainability and adaptability.

Throughout the 50s, there was a lack of urban-oriented viewpoint or forward-looking ideas about sites. The common concerns were the search for the minimum layout to live modern life and the reduction of construction cost. The aforementioned experiments on building systems were derived from these concerns too.

5.2 Building system experiments after 1990

For the past 10 years, the term “small houses” has been used to express “houses built on small sites” in many cases. Diverse building system experiments have been carried out, which can be summarized as attempts to propose housing design that represents the way it should be to live in the current urban environment.

In specific terms, building system experiments have shifted their focus from the prefabrication of materials in the 50s to the development of completely new ways of applying existing prefabricated materials in recent years. Below are some of the examples of diverse building system experiments.

(1) Prefabricated units for unusual houses

Houses on complicatedly shaped small urban sites under severe legislative restrictions often have site-specific forms. In addition, because it is impossible to expand the space area-wise, these houses are often built high up above the ground. Considering these, it seems natural that there are many small houses that display architects’ various spatial ingenuities.

Under these circumstances, there are very few houses that were intended to seek a prototype or mass production for universal applications. To stretch a point, there have been a few works that are considered as prefabrication efforts to some extent. A house called “Y Studio (1995)” by Yasutaka Yamasaki was one such example, in which the “framework unit method” was experimentally adopted (Figure 8). This house is quite similar to a steel rigid frame prefabricated house.

However, it should be noted that the method was developed as a solution to the question of how to deal with unusual urban conditions, such as the highly dense urban residential environment (the units can be stuck to make up to 4 stories) and the aftermath of the Hanshin-Awaji Earthquake (the units can be built as a temporary building to be transformed into a permanent home).

Another example is “Natural Shelter (1999)” by Masaki Endo and Masahiro Ikeda, which is covered with unitized curved panel shelters. These panel shelters are prefabricated units, though they were not intended for mass production. It was an attempt to create an unusual house using prefabrication-oriented units to meet the requirements imposed by the specific site conditions and client’s lifestyle.

(2) New applications of existing prefabricated materials and new structural ideas

In his “Mo House (2003)” and “Ni House (2003)”, Hiroaki Kimura experimentally adopted 9-mm thick steel sheets to cover exterior walls. Mitsuhiro Satoh used steel pipe piles for part of a spiral staircase and structural members in one of his works, “House in Oshima”. As cited here, there are cases where existing prefabricated materials, such as steel plates, corrugated pipes and steel pipe piles, are applied in unconventional manners.

Furthermore, in terms of structural systems, there are many cases where attempts have been made to depart from the usual wall or rigid systems, trying to seek new ways of applying prefabricated materials. “House in Koutou (2003)” by Mitsuhiro Satoh has a steel skeleton system combined with ribbed steel plates (a steel version of 2 x 4 system, so to speak).

Because finished panels that serve as the structural units were installed from within, it was possible to build the structure to the absolute edge of the site boundary. “House of Shelves (2000)” by Koichi Maeda and “Wood Box” by Kiyoshi Kasai are wooden frame structures, which proposed the utilization of structural system, as shelves for example, in everyday life. Making walls thin, allowing the structure to stretch to the absolute edge of the site boundary and utilizing walls for unusual purposes are all considered to be aimed at making the most of the small site.

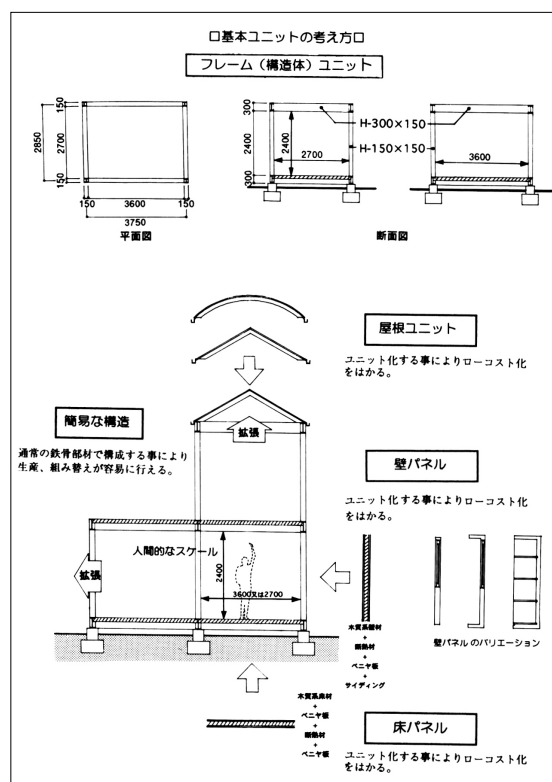
(3) Low cost house experiments

Though not so popular as in the 50s, there are some examples of seeking solutions to smallness and low cost. “Minimum House (2002)” by Yasuhiro Yamashita and “Wood Box – Tokura” by Kiyoshi Kasai are some of such low cost examples. All of them were intended to seek the way to build a house at low cost, which is similar to seeking a particular solution in other words, like seeking the way to eliminate unnecessary planning factors under specific family and site conditions. The low cost efforts here are made, not only in terms of the prefabrication of materials but also in terms of the client’s lifestyle, contract style and building system.

Since 1990, mass production and prefabrication have not really been shared concerns in dealing with small houses, though there are few but some examples. The common concept is to propose a new lifestyle in cities. The diverse structural experiments described above can be regarded as architects’ endeavor on the subject of living in the

Figure 1-1-1 is a detailed floor plan of a house. The plan shows a front entrance leading into a living area with a sofa and coffee table. To the right is a dining area with a table and chairs. Behind the living area is a kitchen with a sink and stove. To the left of the kitchen is a bathroom. At the back of the house are four bedrooms, each with a bed, and a study area with a desk and chair. The plan includes dimensions: 17.175m by 3.405m overall, and 2.280m by 3.3925m for the main living and dining area.

Figure 8. “Framework unit method of Y Studio” by Yasutaka Yamasaki (ext. *JT*, 1995.9, p. 119.)



In this section, the relationship between architect-designed small houses and prefabricated houses is reviewed. The important issues involved in introducing the mass production and open building concept are the standardization of dimensional system and joints, proven construction performance, maturity of prefabrication procedures including material supply, and corporate strategies that help establish an industry. It is no doubt that dimensional systems, joint specifications and construction performance were all fully explored by the small houses of the 50s, and the ideas generated through such efforts were successfully realized in prefabricated houses later years.

On the other hand, most architects were not interested in the aforementioned

corporate strategies. As Shuichi Matsumura pointed out, there were huge differences in the standpoint taken by architects and prefabricated housing manufacturers, though they might produce houses with similar forms. The differences lie in whether there were entrepreneur spirits and ability to lead or not⁹.

As a result, architects and prefabricated housing manufacturers took separate directions. While prefabricated housing manufacturers, who supply a large number of reasonable and high-quality “ordinary houses”, have established themselves as an industry, architects are studying how individual small houses are related to the urban tissue. Today’s small houses are diversified. Though there is the common awareness of the problem of living in the urban environment, small houses continue to be individual and unique as it is not possible to yield a single common solution.

7. Concluding remarks

This study brought the insights described below.

First, the small houses of the 50s were found to have the following characteristics:

- Most of them were wooden structures and many were single stories.
- The aim was to reduce cost, as well as the realization of richness in lifestyle in a small space.
- The idea of integrated space was generated in trying to put everything in a small area. The major issue in cost reduction was the development of rational building systems.

With the shortage of housing supply as well as material supply, the architects of the time aimed to create richness in lifestyle with the minimum budget, materials and space¹⁰. The specific objectives were integrated layouts, modernization of services, reduction of construction cost and rationalization of production. Many experimental efforts were made for prefabrication and mass production, which led to the development of prefabricated houses in the 60s and onwards. However, there was little awareness of the site issue.

On the other hand, the following insights were gained with regard to the small houses built after 1990:

- In addition to wooden structures, various structural types appeared, including steel and reinforced concrete structures.
- Occasionally, there are efforts to seek new ways of applying existing prefabricated materials or put in practice new structural ideas. Cost reduction is not necessarily at issue.
- As compared with the 50s, the total floor area has become larger and building/site areas smaller. There is a heightened awareness of building houses on small sites, namely living in the crowded urban environment.

While prefabrication of traditional building systems was the main issue in the 50s, recently there have been many examples where existing prefabricated materials were used in completely new manners, exercising more creativity in design at the same time. The search for the minimum possible space, exploring the question of to what extent a dwelling space can be made small in the 50s, has not been observed since the 90s. At issue instead has been the creation of as richer space as possible under

restrictions of small urban sites.

While small houses in the 50s took the form of cost reduction experiments through prefabrication of the traditional open system based on the *Ken* module, those in the 90s can be regarded as experimental efforts to explore new approaches to skeletons within the context of urban tissue.

¹ *Shinkenchiku* (JA) and *Kenchiku Bunka* (KB) have been published since the end of World War II to this day, and are representative architectural periodicals of Japan. JA was first published in 1925. Though it suspended publication during the war, it restarted in 1946 and has been issued since. *Shinkenchiku Jutaku-Tokushu* (JT) was first published in 1985 as the quarterly special issues of *Shinkenchiku* specializing in residential buildings, and has been published monthly since 1986. The publisher of JA and JT is Tokyo-based Shinkenchiku-sha. KB was first published in 1946. Though still in publication, it has been bimonthly since February 2001. The publisher is Tokyo-based Shokokusha Publishing.)

The houses studied here were all cited from architectural periodicals, which might receive criticism of subject validity for dealing with fashionable aspects rather than the real-world situations. However, it is a fact that these periodicals picked up many houses that were considered suitable as the object of small house studies, and the significance of studying periodicals lies here.

On the other hand, there is a problem of using periodicals as research source because the works were originally selected according to editors' subjective judgments. This problem should be solved through research on many periodicals. This study is intended to take the first step by analyzing JA and KB; the authors are planning to study other periodicals to elaborate the research.

² With regard to JA, it should be noted that JT came out as a periodical specializing in dwellings in 1985. That is why housing coverage showed a notable increase after 1985, which accordingly increased the number of small houses. Still, it is observed that small houses increased their presence after 1994.

³ Kazumasa Yamashita. (1980). "Wavering housing design" in "Thirty-five postwar history of architecture" (in Japanese), *Shinkenchiku (Japan Architect)*, June 1980 Extra edition, p. 98.

⁴ Some other good examples of the core plan include "Residence No.15" and "Residence No. 21" by Yoh Ikebe, "Residence for Mr. Okino" by Bunzo Yamaguchi and House with Horse Chestnut (1954)".

"House of prof. Dr. Otto MORI (1951)" by Kiyoshi Seike and "House & Atelier of Mr. T (1952)" by the Research Institute of Architecture.

⁶ Other examples are: "Minimum House Suits Surroundings (1952)" by Shunichi, Katsuyama, "Architects House (1953)" by Keiichi Kondo and "House in Kamakura (1955)" by the Research Institute of Architecture.

⁷ Shoichi Ikegami. (1961) “Small houses today – Ready-made and custom-made” (in Japanese), *Shinkenchiku (Japan Architect)*, Vol. 36, No. 1, p. 116.

⁸With regard to one of the masterpiece small houses of the 50s, namely “Experimental Minimum House”, the architect Makoto Masuzawa clearly stated that he had aimed to materialize mass production in his descriptions of the work in the periodical. He claimed that the house “would allow materialization without being affected too much by the conditions of a given site”. It is quite telling that a contemporary version of this house was actually put on the market as “9-*tsubo* House” in 2002. The differences in the attitude towards small houses between the 50s and today are most clearly demonstrated by the fact that the original name “Minimum House” was changed to “9-*tsubo* House”, which stresses the building area.

⁹Shuichi Matsumura. (1999). “A concept called ‘House’ – genealogy of houses in the 20th century” (in Japanese), University of Tokyo Press, p. 124.

¹⁰ Kazuko Kinoshita. (2001). “Postwar small houses of Japan” (in Japanese), *Kenchiku Bunka*, December 2001, pp. 121 – 123.