

UNIVERSITY COLLEGE LONDON  
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Lessons from Japan: A comparative study of the market drivers for prefabrication in Japanese and UK private housing development

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Being a Report submitted to the Faculty of The Built Environment as part of the requirements for the award of the MSc European Property Development and Planning at University College London:

I declare that this Report is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

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## **Abstract**

UK Government and construction industry advisors are becoming ever more interested in increasing the use of offsite modern methods of construction (MMC) within the private housing sector as a solution to current quality and efficiency problems. However, industry uptake remains below that of many countries with comparable economies, with UK housebuilders seemingly reluctant to invest in innovative building technologies. The Japanese private housing sector, on the other hand, paints a very different story, with prefabricated housing manufacturers dominating a significant proportion of the housing market.

After an introduction to the key themes, this report will explore the drivers for offsite fabrication in the Japanese housing market, paying particular attention to building cycles and prevailing development systems, the cultural preference for new-build houses, attitudes towards land ownership and the demand for customised dwellings. Next, the report will investigate the major drivers for innovation in the UK housebuilding industry, focusing on Government reports and initiatives that promote offsite MMC, perceived advantages and barriers for greater uptake within the construction industry, and strategies used by the housebuilding industry to minimise market and site-specific risk in the emerging market environment. The final chapter will discuss the applicability of the Japanese model of prefabricated housing manufacture in the UK context, highlighting some possible crossover benefits and making some suggestions as to how these can be realised.

## Chapter 1: Introduction

*“We accept that developers, like any other private enterprise, seek to maximize returns on their investments. The very best developers combine this with delivering high quality attractive places that recognise the importance of sustainability and the benefits of mixed uses and activities. But we believe that all too often, the financial bottom line is used as an excuse for delivering mediocre design and poor building quality – the numerous examples of isolated ‘placeless’ estates with near identical houses across the country are testament to this.”* (The Egan Review, 2004: 47)

For more than a decade the UK housebuilding industry has been under increasing governmental pressure to improve its productivity and efficiency, as well as the overall performance of new housing stock being delivered. Innovative approaches to procurement and construction processes, with emphasis on cross-sector learning and international best practice, have been widely accepted by both the Government and many industry stakeholders to be the optimum solution to the domestic industry’s inherent problems. The problems are outlined above in an excerpt from Egan’s 2004 review of the skills and training built environment professionals require to deliver the Government’s 2003 Sustainable Communities Plan. For many of those who advocate innovation within the industry, modern methods of construction (MMC; see Appendix A1 generally for definitions of terms) – particularly offsite technologies – are expected to play a central role in bringing about industrial change. (Pan et al, 2007: 183) However, despite this increasing interest in offsite technologies and innovative building processes from industry advisors and experts, uptake within the UK construction industry still remains behind that of similar economies – Japan arguably being the most striking comparison. (Goodier & Gibb, 2006: 585) In clear contrast to the apparent reluctance of UK housebuilders to embrace offsite technologies, Japanese prefabricated house manufacturers have maintained a consistent and influential position within the domestic housebuilding industry, helping to shape the evolution of the Japanese housing market since Daiwa House Industry released its first model, the prefabricated ‘Pipe House’, in 1955. (See Figure 1)

While prefabricated single-family homes have only accounted for approximately 14% of all housing completions in Japan over recent years, the particularly high volume of housing starts means that on average over 160,000 prefabricated units are produced annually.

(See Figure 2; Sekisui House Ltd., 2004) This is almost equivalent to the *entire* output of the UK housebuilding industry, which produced 213,372 residential units in 2006; with only around 1% fabricated offsite. (DCLG, 2007c; TimesOnline, 2006.) With continued investment in efficient manufacturing and procurement techniques, research and development (R&D), and customer-orientated design, Japanese prefabricated housing manufacturers (hereafter, PHM) have developed sophisticated production and marketing processes to maintain their competitive position within the domestic housing market. It is therefore not surprising that the Japanese prefabricated housing sector has received particular attention from UK academics and industry experts as a potential measure upon which the future development and marketing of offsite MMC in the UK can be based.

### ***The aim of the report***

As Craig et al (2000: 2) remind us, “It is important that the key criteria in prefabrication and standardisation are recognised as relating to the processes as opposed to the product. ... The quality of the finished product depends as much on selection of materials and attention to detail as it does on the construction method”. With this in mind, Chapter 2 will investigate the major market drivers that have shaped the Japanese ‘prefab’ model; Chapter 3 will briefly analyse the current drivers for the use of offsite MMC in the UK housing market; and Chapter 4 will assess the applicability of Japanese practices to the UK housebuilding industry, and whether these can be replicated. The report will enquire whether the UK Government’s current emphasis on using offsite MMC in the production of ‘affordable’ housing, exemplified in the Department for Communities and Local Government (DCLG)’s Design for Manufacture competition to build homes for a construction cost of under £60,000, will inevitably undermine wider consumer confidence regarding the quality of prefabricated housing as a ‘product’, and propagate offsite MMC’s association with design and construction mistakes of the past. (DCLG, 2007a) It will be argued that for offsite technologies to flourish in the UK market, the government should encourage housing producers to market prefabricated houses to a wider market, emphasising design quality and potential for custom design, facilitated by the selling of ‘land with conditions’ as in the Japanese model. (Interview: E. Takarafuji; Noguchi, 2003) Only through such marketing strategies is it likely that viable economies of scale and potential economies of scope can be realised.

## ***Literature review and methodology***

While a significant amount of literature has been produced on the topics of Japanese prefabricated homes, the history of Japanese PHM, and potential crossover benefits which the Japanese model offers the UK construction industry, less attention has been paid to the question of whether the market drivers that brought about the successful utilisation of offsite MMC in Japan are applicable or replicable in the UK context. This report will therefore attempt to build upon a range of academic, corporate and governmental resources to analyse the extent to which the Japanese 'prefab' model can be implemented in the UK. As the background literature is too plentiful to review in its entirety here, the following paragraph will provide an overview of the major resources used by topic.

*Academic resources:* On the topic of 'quality-orientated production' in the delivery of Japanese prefabricated homes, Uchida (2002) and Noguchi (2003; 2005) have been particularly informative. On cross-sector learning and investment in R&D, see Gann (1996) and Bennet (1993). Barlow (1999; 2003) and Ozaki (2003) have provided significant analysis into Japanese 'mass-customisation' production methods and the benefits of customer-focused innovation. Yamada's (1999) comparative investigation into housing affordability in Japan and the UK has also provided a useful bibliographic reference. Cook (2005) and Goodier et al (2007) have given a strong overview of the potential opportunities for offsite MMC in the UK, while MacKenzie et al (2000) have paid particular attention to its relevance in the UK construction skill shortage which has existed through most recent decades. Craig et al (2000) have focused on the social acceptability of prefabricated housing in the UK, where Pan et al (2007) have conducted a detailed investigation into the perspectives of UK housebuilders on offsite MMC.

*Government resources:* A range of government papers, statistics and publications have been referenced in this report, many of which have been made available via the DCLG homepage.

*Other web resources:* A wide array of corporate marketing and media articles related to prefabricated housing and standardisation have been referenced, providing insight into corporate marketing strategies as well as media and social perceptions on offsite technologies.



This research has been supplemented via a series of site visits and interviews with academics and industry stakeholders in both Japan and the UK.

A recent research trip to Japan provided the author the opportunity to conduct semi-structured interviews with a range of professionals with a particular knowledge of the Japanese housing market, including: three leading professors of architecture; two representatives from leading PHM; and two planners, one working within the private sector, and the other within the public sector. These interviews were conducted in both English and Japanese. (The author has some fluency in the Japanese language, which has been supplemented with the kind assistance of bilingual Japanese associates.) Similar interviews were conducted with UK stakeholders, including a representative from a housing development company that specialises in timber-frame housing systems for the UK market, and a leading architect with experience in showcase projects utilising offsite technologies for the Peabody Trust. (See: Appendix A)

**Figure 1: Daiwa House Industry prefabricated homes since 1955**



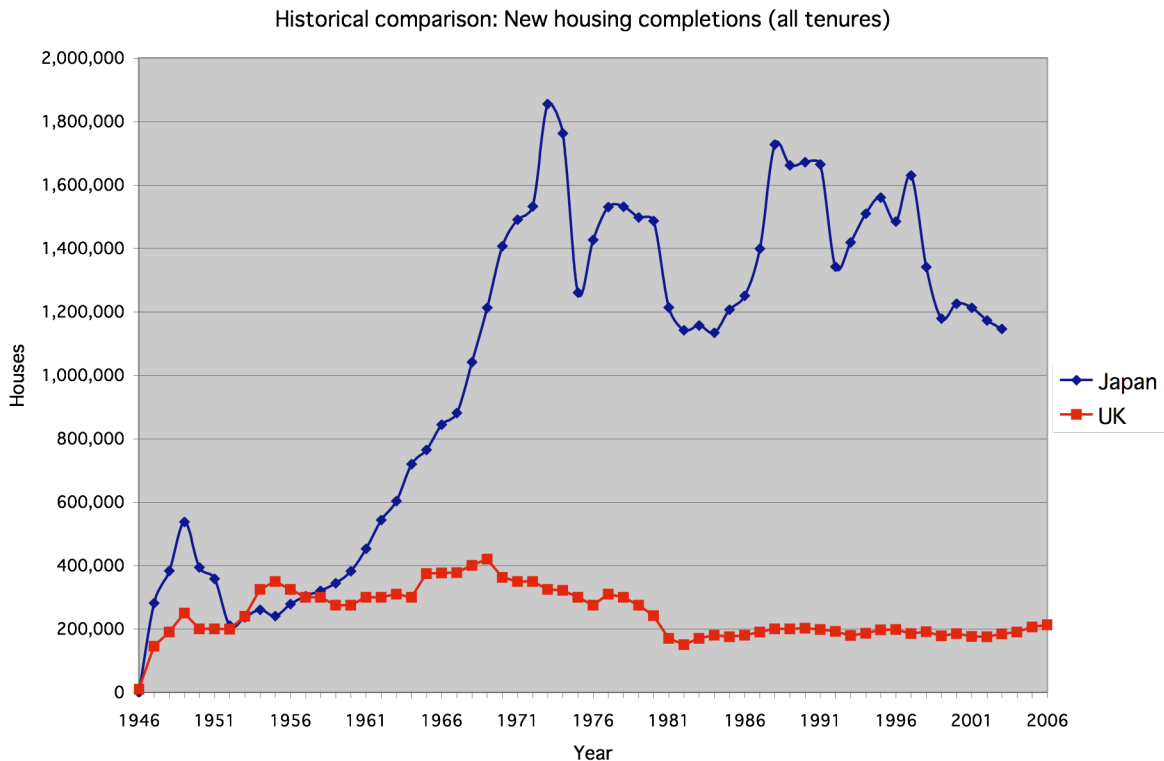
(Source: Daiwa House Industry Co., Ltd., 2007)

## Chapter 2: The evolution of the Japanese housing market and the major drivers for offsite fabrication

*“The Japanese model presumes that the physical house will be replaced every generation, with the mortgage mechanism concentrated on site value. This is being realistic about the longevity and flexibility of offsite constructions, but of course it is also culturally appropriate... The British prefer to constantly repair and remodel, valuing patina and historic character.”*

(Richard Saxon CBE. Personal email, 3 July 2007.)

**Figure 2: Housing completion in Japan and the UK since 1945**



(Source: Adapted from Ministry of Land, Infrastructure and Transport (MLIT) statistics, supplied by Professor Seiichi Fukao, Tokyo Metropolitan University; Parliament Research Paper, 1999; Communities and Local Government, 2007c.)

As Figure 2 illustrates, the Japanese market for new housing has evolved very differently from that of the UK. While both experienced a rapid increase in housing completions in the immediate post-World War II period, peaking around 1971 and 1968 respectively, the

relative volume of new development marks a stark comparison: Since 1970 Japan has on average produced approximately 1,400,000 new houses per annum – the UK around 200,000. (Interview: S. Fukao; Parliament, 1999) Approximately 80% of the Japanese market is accounted for by locally-based housing suppliers using conventional post-and-beam timber framed construction techniques, with 90% of these firms building fewer than 10 units annually. (Barlow et al, 2003: 138) However, despite the predominance of conventional housing, prefabricated detached homes built using industrialised panel or modular frames by factory-based manufacturers maintain a significant share of the market. Since peaking around 1992 at nearly 18%, the share taken up by PHM in the new housing market has stabilised at around 14%. (Woudhuysen & Abley, 2004: 18) In 2004, therefore, of the 1,160,083 houses built in Japan, 159,224 (13.7%) were ‘prefabricated’ according to the official Japanese government definition. (Noguchi, 2005: 1; Interview: S. Matsumura.) This means the volume of factory-produced prefabricated houses manufactured in Japan in 2004 actually exceeded that of total new build completions in England for that year. (DCLG, 2007c)

In 1963 the Ministry of Construction (MC) and the Ministry of International Trade and Industry (MITI) established the Japanese Prefabricated Construction Suppliers and Manufacturers Association (JPA) to encourage consumer confidence in prefabricated homes during a time of strong housing demand. (Noguchi, 2003: 354) However, a gradual increased use of prefabricated components by ‘conventional’ house builders since this time has made the official government definition of prefabrication – associated with the prefabricated houses of the factory-based JPA members – somewhat “misleading and unscientific”. (Interview: S. Matsumura.) Exemplifying this, an association of around 800 Japanese firms currently provide pre-cut and jointed wooden frames for more than half of the conventional wooden houses built in Japan, pre-ordered to specifications by both major construction firms and individual carpenters. (Woudhuysen & Abley, 2004: 18) This, and the increasing use of standardised windows and mass-produced interior and exterior component parts by conventional housebuilders, suggests that while only approximately 14% of new housing is entirely prefabricated, a far greater share of the market exhibits some degree of prefabrication in production. (Interview: S. Matsumura.)

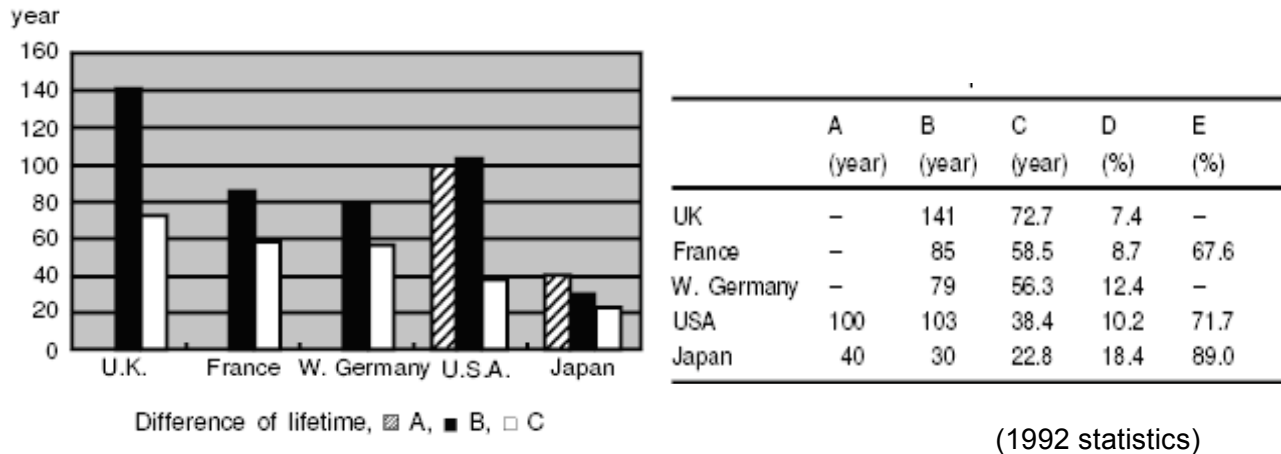
The JPA recognises the Japanese prefabricated housing industry as essentially monopolistic in nature, admitting, “local housing manufacturers have difficulty competing

with their large-scale counterparts". (Noguchi, 2003: 356) An estimated 50,000 conventional housing suppliers occupy their share of the domestic housing market, whereas ten suppliers dominated the prefabricated market, producing 97.2% of all new prefabricated detached homes in 1995. (Ibid; Interview: S. Matsumura.) Large regional or national suppliers have developed sophisticated factory-based systems, manufacturing predominantly steel-frame or steel modular units, with some producing wooden and concrete structures. (In 1995 these construction types accounted for approximately 78%, 17% and 5% of the market respectively.) (Interview: M. Hatsumi; Noguchi, 2003: 356) Barlow et al (2003: 138) stress that some of these factory-based suppliers are extremely large even when compared with housebuilders in other economies. Sekisui House, for example, is currently the largest manufacturer of prefabricated housing in Japan, supplying over 60,000 houses and flats annually. Misawa Homes, Sekisui Heim and Toyota Home further highlight the comparative dominance of some companies, supplying over 30,000, 20,000 and 2800 units respectively each year. (Ibid: 138 - 139) Sekisui Chemical's interest in the prefabricated housing market provided them with a turnover of over £5000 million in 2000. These figures compare to the UK's top housebuilder, which in 2003 had a turnover of £2062 million, producing 13,480 unit completions. (FT.com, 2001; Pan et al, 2007)

### ***Housing longevity, economic growth and the 'scrap and rebuild' culture***

It is estimated that since 1945 the average lifespan of Japanese detached houses has risen from around 20 years to 40 years – with replacement on average occurring every 26 years. (Interview: S. Fukao; Barlow et al, 2003: 137) It has therefore been argued the Japanese housing market is "characterised by active housing construction sustained mainly by the demolition of existing houses, leading to a 'scrap and rebuild' spiral". (Oizumi, in Hirayama & Ronald, 2007: 57) This assertion is supported by statistics on housing longevity and renewal rates. MLIT Construction Statistics show that the ratio of demolished houses to new houses was 42% in 1963, peaking in the mid-1980s at 54% and declining to 39% in 2003. This contrasts greatly with that of the UK, which throughout this period did not exceed 5%. (Ibid) Figure 3 provides further evidence of this 'scrap and rebuild' culture. In 1992, Japan invested over double that of the UK in new construction relative to its gross domestic product (GDP), (7.4% and 18.4% respectively), with the replacement rate (B) differing by over 100 years. This has provided a sustained high level of demand for new housing.

**Figure 3: Housing replacement: International comparison**



**KEY:**

- A The 50% replacement rate (years) of the total residential stock. (The period of time when half of all residential buildings built in the same year were scrapped.)
- B The replacement rate (years) calculated by dividing the total number of existing housing units by total number of completed residential units in certain year.
- C The replacement rate (years) calculated by dividing the total number of households by the annual number of completed residential units.
- D Investment in construction as percentage of the total GDP.
- E Investment in new buildings as percentage of total investment for construction.

(Source: Kimata, 1999: 297 – 298)

It is possible to observe the effect of the ‘scrap and rebuild’ cycle within the housing production statistics illustrated in Figure 2. The establishment of PHM such as Daiwa House in 1955, Sekisui House in 1960 and Pana Home in 1963 coincided with a period of consistent growth in the housing market, driven primarily by the process of replenishing the housing stock damaged during World War II. The focus of these companies on factory-based production using non-traditional materials meant they were able to enter a growing market at a time when timber shortages and rising labour costs were pushing up the prices of conventional housing, allowing prefabricated houses to be competitive on the open market. (Barlow et al, 2003, 138) With low performance and small floor-areas, the single-story units produced by PHM until around 1970 had an average lifespan of twenty years, and were predominantly replaced along with most of the immediate post-war housing stock by the 1980s. (Interview: S. Fukao) This process of housing stock replacement combined with the increasing affluence of the population created a second peak in housing

demand in the late 1980s of a similar magnitude to that of the early 1970s – one in which PHM could market their products.

### ***National characteristics conducive to offsite technologies***

#### *Attitudes towards land ownership and the preference for 'modernity' in Japan*

Barlow et al (2003: 137-8) assert that roughly half of all new completions in Japan are houses, of which over 90% are detached. Three-quarters of these newly built detached houses are commissioned by individuals and built on their own land, with speculative development accounting for just 25% of the market. This contrasts with the UK, where 80% of new homes are supplied speculatively. (Ibid) The tendency for most Japanese to independently commission private houses can be explained in several ways. Firstly, it has been argued that the Japanese have a strong attachment to family land, which often remains in the possession of an individual family over several generations. (Interview: M. Hatsumi) A cultural affinity with 'freshness' and 'modernity' is also a driver for new-build housing, as landowners opt to replace their seemingly outmoded homes with an upgraded version. (Ibid; Interview: S. Matsumura) The concept of renewal is central to the Japanese Shinto religion, with its clearest articulation arguably being the ceremony of the *Shikinen Sengu* at the Ise Shrine complex, Mie Prefecture, where the main buildings are rebuilt in their entirety every twenty years. (Jingu-shicho, 2007) An appreciation of the new – as opposed to the British appreciation of "patina and historic character" – is similarly reflected in wider opinion towards the housing stock. (Personal email: R. Saxon, 2007) Individuals in Japan rarely fix or modernise their homes themselves, normally hiring professional builders, who, if it is nearing its presupposed lifespan of twenty to thirty years, encourage homeowners to 'scrap and rebuild'. (Interviews: E. Takarafuji; M. Hatsumi)

#### *Perceptions of property value: the separation of land and buildings*

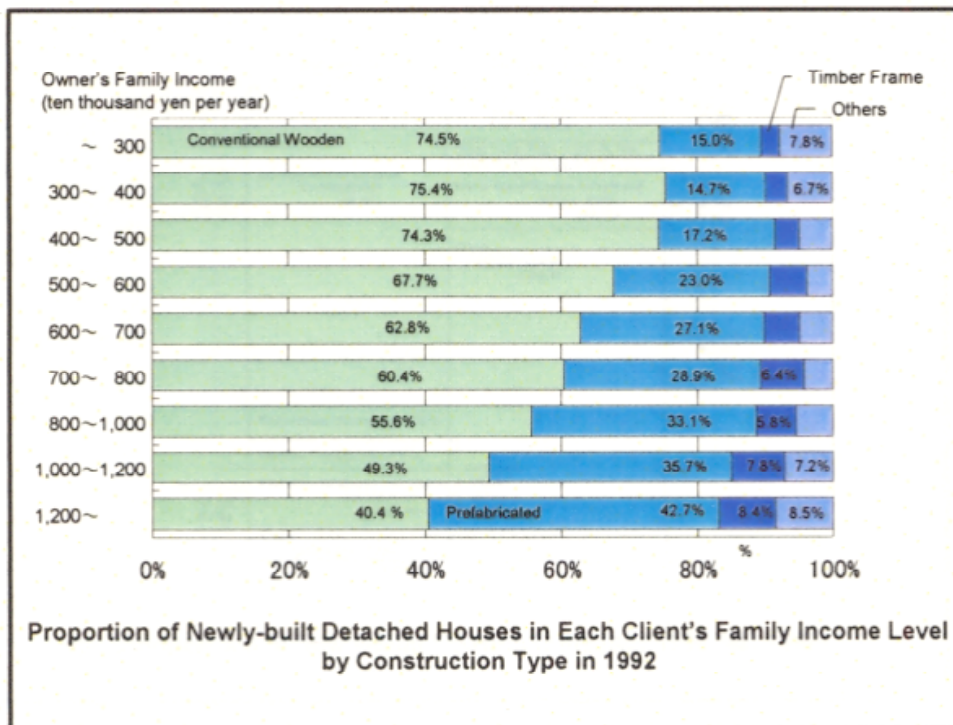
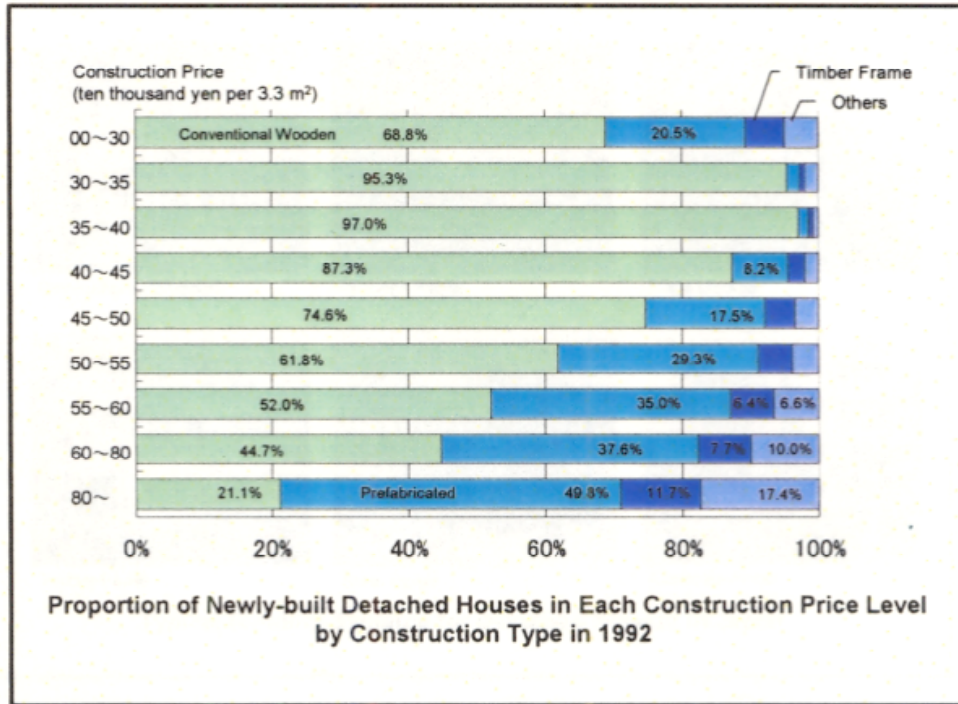
Readiness on the part of private homeowners to demolish their homes and build anew can be further explained by reference to the traditional separation of the value of land and the value of buildings. (Interview: S. Matsumura) In contrast to the unified notion of property in the UK freehold housing market, the distinction between the value of land and that of the

occupying buildings is particularly apparent in property valuations for sales purposes and in mortgage negotiations. Due to their traditionally short lifespan, buildings in Japan are perceived as transient rather than permanent; a factor which is compounded by the Japanese preference for new homes. Residential building values consequently depreciate rapidly after construction – with many houses being deemed to be of little or no value after 10 or 15 years and likely subject to demolition costs upon renewal or sale of land. (Ibid; Interviews: E. Takarafuji) One striking example is the financial value attributed to the historical buildings of Kyoto. While the component parts can be valuable separately, the entire buildings are not considered to be of high value. (Interview: M. Hatsumi) With mortgage lending orientated towards new-build properties, this combination of factors has resulted in considerable squeezing of the second-hand housing market, which, while accounting for over 90% of total annual domestic property transactions in the UK, represents only 20% in Japan. (Barlow et al, 2003: 137; Interview: S. Matsumura) PHM have therefore been able to focus their business strategies within a large market in which demand for new-build heavily outweighs demand for older dwellings.

### ***Quality and mass-customisation as competitive strategies***

Noguchi (2003: 353) asserts that the prefabricated housing industry in Japan has “successfully overcome the inferior image of industrialised houses prevalent in the industry’s early stages when the ‘mass production’ of housing was the key factor in creating monotonous, boxy units which the public subsequently regarded as being of ‘low quality’”. Since the JPA was established in 1963, makers of prefabricated homes have demonstrated a focus shift away from the delivery of lower-cost homes, to the production of “value-added” *quality* homes. (Interview: S. Matsumura; Noguchi, 2003: 354 - 355) This has allowed them to focus on the middle to upper-end of the new houses market, producing highly customised units that can be sold on the mass market at a comparatively high selling price. (Interview: S. Fukao) This has resulted in average costs for prefabricated houses on average 8% higher than comparable site-built wooden houses, and up to 20-30% more than some local low-cost ‘Power Builders’. (Noguchi, 2003: 358; Interview: M. Hatsumi) Noguchi (2003: 353) argues that high sales have been achieved despite high prices by marrying their “production methods to specially developed marketing techniques to skilfully satisfy local housing demands”.

**Figure 4: Construction type comparisons for new-build housing in Japan by construction price and purchaser income level.**



(Source: Matsumura, 2001: 5)



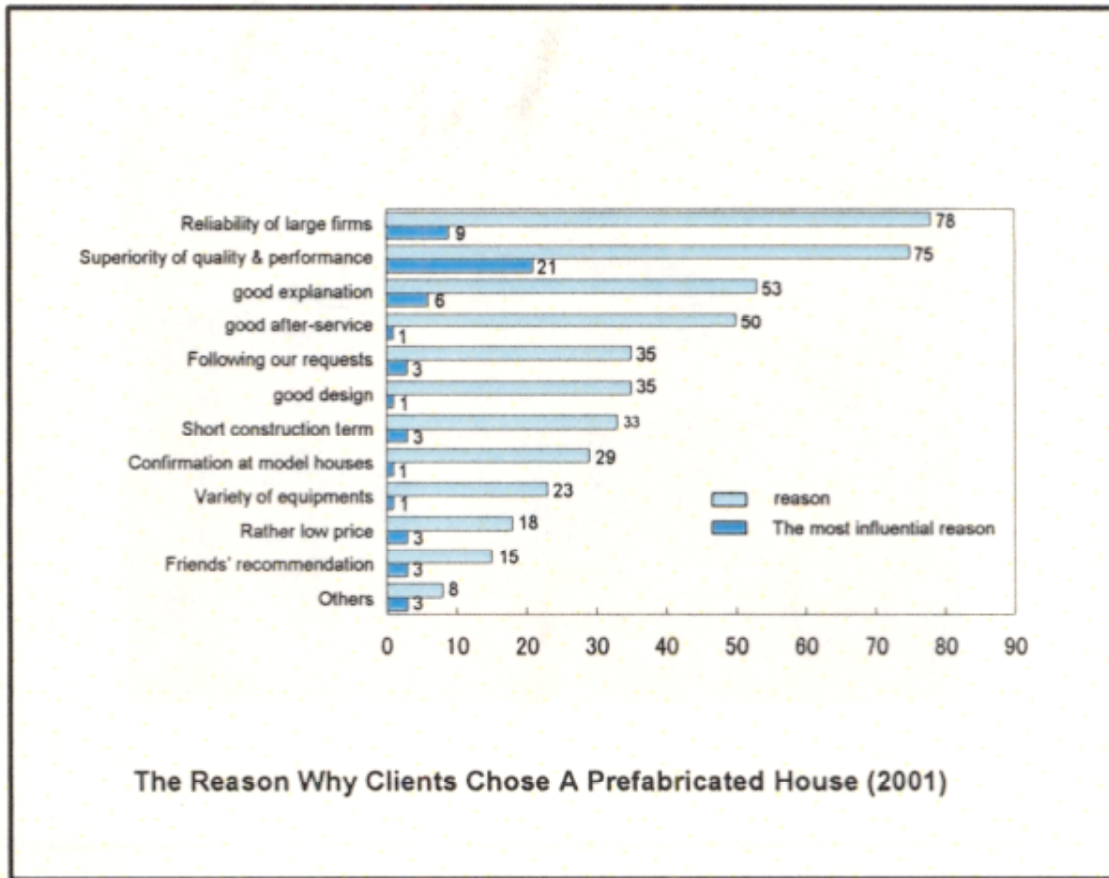
### *Finding competitive advantage: the costs of marketing*

As shown by 1992 statistics in Figure 4, the majority of consumers still elect to purchase houses of conventional wooden construction than the higher-priced prefabricated alternatives. However, what is also clear is that higher-income households are more likely to choose a prefabricated house. This is largely the result of a deliberate marketing strategy by PHM to bypass the already heavily saturated lower-cost housing market in the pursuit of higher profit margins. (Interview: E. Takarafuji) PHM have several disadvantages in the lower-cost housing market. The first is the high volume of annual sales they need to achieve in order to maintain sufficient economies of scale for their factory production lines. Factory-based prefabricated manufacturers must typically sell over 10,000 units at a comparatively high level of profit to fulfil their obligations to shareholders, whereas many small, local housebuilders need only sell around ten units annually with a comparatively low profit margin to be sustainable. (Interview: S. Matsumura) This has significant implications for their marketing strategies and associated costs. Local builders are often able to achieve their necessary annual quota through localised marketing, utilising personal connections, word-of-mouth recommendations and limited door-to-door sales. (Interview: E. Takarafuji) Regional or national PHM however must conduct wide-scale marketing campaigns, including expensive newspaper advertisements and television commercials, sales pamphlets, wide-area door-to-door sales, and a series of regionally based sales outlets with associated staff. To exemplify this, sales, marketing and management costs represent on average 25% of Sekisui House's overheads. (Gann, 1996: 446) A significant proportion of these marketing costs are taken up with maintaining show houses in *Jutaku Tenjijo* or 'Housing Parks'. These parks are leased by competing companies and usually contain up to 20 different luxury-model prefabricated show-houses. (Interview: S. Fukao) It is estimated that one model house costs around 100 million yen (over £400,000) to maintain annually, including the salaries of on-site staff. These costs are further increased as show-houses are replaced with newer models every four years or so. (Interview: S. Matsumura) In 1996 Sekisui house had 519 show houses throughout Japan; it is therefore easy to perceive the importance that marketing has in maintaining a competitive advantage for Japanese PHM. (See Appendix C2)

### *Regulatory differentiation driving product quality*

Another consideration that has reduced the competitive advantage of Japanese PHM in the lower-priced housing market is government anti-seismic regulation and the regulatory distinctions it makes between construction systems. The Building Standard Law of Japan of 1950 stipulated regulations relating to the quality and durability necessary within existing construction methods. To maintain the economic viability of conventional housebuilders, these regulations offered a degree of leniency for traditional construction methods. However, new technologies had to undergo rigorous testing, subject to the approval of a ministerial committee, before licences were granted. Factory-based prefabricated housing developed subsequent to this Act therefore required manufacturers to invest heavily in R&D to ensure high levels of earthquake resistance. (Interview: S. Matsumura; MIAC, 2007) This had several consequences for PHM. Firstly, it increased the initial and ongoing costs of developing new offsite technologies, pushing up overall selling costs in turn. Secondly, it has increased appeal at the higher-cost end of the market. (Ibid) Product quality and performance has therefore become a dominant part of manufacturers' marketing strategies to keep competitive advantage in a shrinking and crowded market. Misawa Homes advertise their homes as more cost-effective than conventional homes, with 67% less air-leakage than conventional houses and heating and cooling cost reductions of up to 32%. Similarly, Daiwa emphasises that its ventilation system exceeds requirements by the building code in Japan to provide higher levels of natural air circulation. (Noguchi, 2003: 361) Furthermore, Government regulations and quality improvements are increasing the longevity of prefabricated housing. Toyota Home report to be producing houses that can last for 90 years, and Hebel Haus are marketing 'Long Life Housing'; offering a 60-year maintenance programme for their new homes. (Interview: E. Takarafuji; Habel Haus, 2007) These business strategies are reflecting consumer demands for 'value-added' homes at comparable prices to conventional alternatives and wider concerns about the lifecycle costs generated by their future homes. (Noguchi, 2003; Interview: S. Matsumura)

**Figure 5: Homebuyers' reasons for purchasing prefabricated homes in Japan.**



(Source: Japan Prefabricated Construction Suppliers and Manufacturers Association (JPA) statistics, in Matsumura, 2001: 5)

### *The corporate nature of PHM*

“People in Japan tend to buy only one house in their life, so they will pay extra for a company they can rely upon”. (Interview: S. Matsumura) This assertion is substantiated by the statistics illustrated in Figure 5 that show the reasons purchasers gave for buying prefabricated houses. The primary reason is a perception that PHM are reliable. For many Japanese, the brand name associated with large companies offers quality assurance and a guarantee that should the company’s product prove to be defective, the company would be accessible and willing to fix or replace it at no cost to the consumer. (Ibid) This is particularly relevant to the housing industry due to the huge levels of investment involved. While there is little guarantee that a small, locally-based housebuilder will be in business

several years after a house is built, the reputation of the prefabricated housing 'brands' offers extra reassurance for those who can afford to pay for it; usually in the form of a ten-year warranty and post-purchase services such as free regular quality checks. (Noguchi, 2003: 357; Interview: E. Takarafuji)

The major PHM have developed particularly strong brand images, helped by a strong connection with large multi-sector conglomerates. When these companies were founded after the mid-1950s, there was strong supply-side push from materials and components industries (particularly steel, plastics and plywood) seeking new markets. The Korean War resulted in over-capacity in light-gauge steel production and by 1963 several private companies had begun to develop their own industrialised construction techniques to manufacture detached houses to exploit this. For suppliers the motive for the industrialisation of house building was not cost reductions but to create a new market for their products, demonstrated by the fact that out of the top ten leading manufacturers, only Misawa Homes was not established by a large conglomerate and none had formerly been involved in traditional housebuilding. (Gann, 1996: 443) For example, Daiwa House was established as a market for Daiwa's steel tube production; Sekisui Chemical Company, a leading plastics manufacturer, established Sekisui House to create new markets for plastic products in its panel-based system, and Sekisui Heim in 1972 to compete in the market for modular housing; while Pana Home was established as the housing division of the Matsushita Group, the electrical products conglomerate. (Ibid: 444; Interview: S. Matsumura) Whereas initial start-up costs are relatively low in traditional housing, high entry costs for new competitors in the industrialised housing industry have necessitated new companies being able to invest heavily, particularly in factory facilities and associated R&D laboratories. Sekisui House, for example, has invested more than ¥17 billion in its Shizuoka factory since it was built in 1980. (Ibid)

**Figure 6: Early models by Sekisui House**



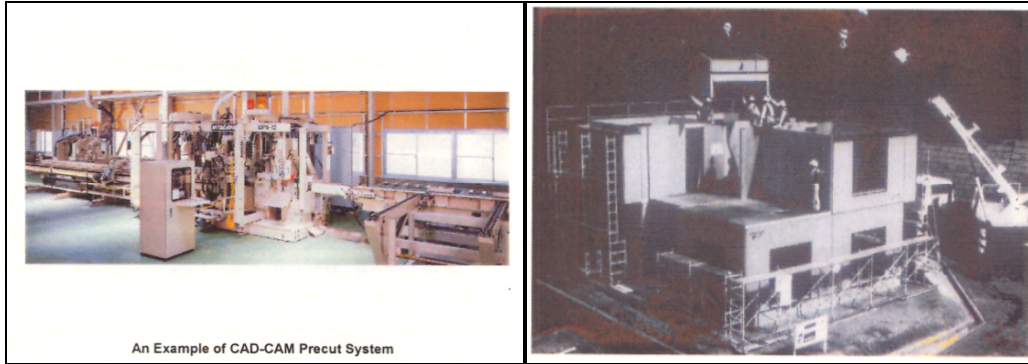
(Source: Matsumura, 2001)

### *Procurement strategies enable design flexibility to reflect market demands*

This close connection between prefabricated homes manufacturers and large conglomerates has also fostered close supply-side partnerships to promote efficient procurement strategies – often with manufacturers retaining shareholding interests in supply-chain partners and sub-contracting firms. (Barlow et al, 2003; Gann, 1996: 447) These procurement arrangements have become an important consideration within manufacturers' house design processes, in which every detail relating to component choice and availability is complete before manufacturing and construction begin. (Bennet, 1993) This has many benefits, including minimised lead-in times for each project and improved design flexibility. Early models of prefabricated housing were produced from a small range of standardised components, utilising many techniques learnt from the West. However, these failed to provide the level of quality and choice of design required by the domestic market. (Gann, 1996: 443) The first model produced by Sekisui House (Figure 6, left) sold only 100 units in its first year; proving unpopular due to its radical design (steel frame, with aluminium and plastic exterior) and inflexible floor plan. Conventional Japanese houses in contrast offered a wide variety of styles due to their traditional modular co-ordination system. (Interviews: S. Matsumura; S. Fukao) By 1970, the number of houses being produced by the housing industry had reached the level of new household formation; so with the market satisfied in terms of quantity, PHM sought competitive advantage and shifted their production processes from maximising production towards improving the quality and range of houses manufactured. (Gann, 1996 443) Sekisui House, for example, instead of manufacturing only 'large' or 'small' models, developed a system offering high-design flexibility to suit specific customers' needs. (See Figure 6, right; Interview: S. Matsumura)

**Figure 7: Components and production lines**





*Illustrations of flexible production lines, components and modular construction used by PHM. (Source: Matsumura, 2001)*

PHM have implemented significant cross-sector learning, particularly from the automotive and manufacturing industries to develop production lines that offer economies of scope as well as scale. (Gann, 1996) Manufacturers are offering what has been described as ‘mass-custom’ design, in which “the user directly determines the configurations from choices given as client input during the design stage”. (Noguchi, 2005:6) Production-side cost reductions due to rationalisation of manufacturing processes are passed on to the consumer not in the form of reduced sales prices, but in the form of ‘value-added’ extras as standard. (Noguchi, 2003; 2005) The range of design variation available to customers depends on the business strategy adopted by individual companies. Sekisui House markets high-end, highly flexible units typically comprising of around 30,000 component types; however, to satisfy all the permutations of options available in its catalogues the company currently produces more than two million different parts on its flexible production line. Sekisui Heim offer slightly less design variation, with each house typically made up of around 10,000 different component types out of over 270,000 components options, and Toyota Home market slightly lower-price modular-based homes with typically 4,000 component types for each house from a total of 120,000 components options. (Gann, 1996: 446 – 447; Interview: S. Matsumura)

Customer preference for customised housing is further recognised in the nature of the speculative development in Japan, which typically takes two forms. The first is the same model used by most UK developers – land is acquired and houses are constructed prior to buyers being identified. The second model is known as selling ‘land with conditions’, where developers sell plots of land before construction takes place to buyers under obligation to

employ their services to build a house on the land, which is customised to the specific requirements and preferences of the landowner. (Interview: S. Fukao) The latter option not only minimises risks to the developer via identifying the buyer prior to the build, but can also result in higher returns, as customers tend to be willing to pay more for the option of customising their house during the design phase. (Interview: E. Takarafuji)

Following the perception that prefabricated homes manufacturers offer reliability, superior quality and performance, homebuyers cite salesperson's explanations as one of the major reasons for purchasing a prefabricated house. (See Figure 5) Manufacturers have invested heavily in national sales networks employing specially trained sales and design staff – often graduates from the faculty of architecture. (Interview: E. Takarafuji) For companies like Sekisui and Daiwa the sales and design teams are unified allowing the use of using CAD systems to match customer preferences with the range of components the company has to offer. (See Figure 7) Other companies such as Misawa and Tokyo elect to use franchise sales networks. Through the use of show-houses and exhibition centres customers can see design and product samples, which are then explained by sales staff in terms of quality, cost and time implications to the customer. (Gann, 1996: 444; Interview: S. Fukao) This is an interactive activity that can last anything from a few days to several months, depending on the customer. (Barlow et al: 2003: 141) These mechanisms for delivering choice through 'mass-customisation' using standardised parts have allowed PHM to remain competitive against the highly flexible conventional housing systems, while simultaneously increasing quality at high economies of scale.

### *Demands for reduced on-site times*

Because a large proportion of housing orders come from individual families who must find temporary accommodation during the building process, PHM have a competitive advantage in terms of on-site building duration compared to conventional housebuilders. It is estimated that the "assembly of traditional carpenter-built houses takes around 120 days on site, conventional 50% prefabricated panel houses around 90 days, and modular unit houses as little as 40 days on site, including preparation of foundations, interior furnishings and inspection." (Gann, 1996: 444) For many house-buyers such on site time reductions can considerably lessen both the inconvenience and the costs of living in temporary

accommodation during the construction period, and as Figure 5 shows, can be a significant motivating factor behind housing purchasing decisions.

In summary, prefabricated housing has flourished in Japan. A variety of factors are responsible for this: competition producing well integrated links between housebuilders, suppliers and sub-contractors; cultural receptiveness to newly built housing and a 'scrap and rebuild' model; and a high level of customer choice and involvement in house design. This has created a virtuous circle where high demand allows maintenance of efficient economies of scale, high levels of R&D and appropriate marketing which promotes prefabrication as a source of quality and choice in housebuilding. Some of these factors are peculiar to Japan, whilst others are capable of informing practices in the UK. The next chapter will explore the current state of offsite MMC within the UK housing market, to lay the basis for a comparison between Japanese and UK practices in Chapter 4.



## **Chapter 3: Drivers for innovation in the UK housebuilding industry**

### ***Growing Governmental interest in offsite MMC in the UK***

Notable Government-sponsored reports have been explicit in asserting a need for significant change within the UK construction industry. Sir Michael Latham's *Constructing the Team* of 1994 identified a necessity to overcome the industry's 'adversarial' and 'fragmented' nature through enhanced supply-chain partnering and collaboration, proposing a 30% reduction target for construction costs by the year 2000. (Latham, 1994; CIB, 2005) Sir John Egan's *Reconstructing Construction* of 1998 similarly highlighted concern about the industry's apparent under-achievement, low profitability and under-investment in capital, R&D, and training. (Construction Task Force, 1998: 4) In response to these problems the report promoted industry benchmarking, while identifying five key drivers for change: committed leadership; a focus on the customer; integrated processes and teams; a quality driven agenda and commitment to people. (Ibid: 13 - 14) The establishment of the Housing Forum as a direct result of this report signifies the Government's desire to take these recommendations forward. (CIB, 2005)

### ***A market for quality and quantity***

Market factors are also placing pressure on the housing industry to improve performance, not only in terms of efficiency and build-quality, but also in terms of the range and quantity of housing produced. UK housebuyer preference "tends to be directed at the second-hand housing market", as current new-build housing is perceived to offer "less choice and flexibility". (Craig et al, 2000: 4) Furthermore, recent customer satisfaction with new-build housing suggests this trend is unlikely to shift unless significant strategic change occurs within the industry. (Osaki, 2003: 562) The Housing Forum's 2001 National Customer Satisfaction Survey of new house purchasers showed that while 27% were very satisfied with the service provided by their housebuilder, 43% were only fairly satisfied and 30% dissatisfied. With regard to overall quality of their house those who were fairly satisfied or dissatisfied accounted for 44% and 23% respectively. (Osaki, 2003: 558) Through

Government initiatives such as the Housing Forum, housebuilders are demonstrating a growing interest in more customer-oriented strategies. (Ibid: 57) However, at current levels of demand for new house building, particularly 'affordable' housing, without continued regulatory and monetary political intervention to promote the adoption of innovative procurement and construction processes (including MMC), quality-driven customer-focused approaches are unlikely to greatly encroach upon the dominance of traditional methods.

Responding to the Barker Review's warning that "a weak supply of housing... hinders labour market flexibility, constraining economic growth", the Planning White Paper of May 2007 represents the Government's attempt to promote more efficient, sustainable development procedures. (DCLG, 2007b: 3) The July 2007 Housing Green Paper states that "while the housing stock is growing by 185,000 a year, the number of households is projected to grow at 223,000 a year." (DCLG, 2007a: 7) To resolve this imbalance it confirms government targets for the delivery of 2 million homes by 2016 and 3 million homes by 2020, assuming that housing supply will rise over time towards the target of 240,000 per year by 2016, and continue at around 240,000 homes per year up to 2020. (Ibid.) At such levels of demand however, many Government and industry representatives remain unconvinced that traditional building methods can be relied upon to realise the targets whilst maintaining the desired design and build quality. The Government's Sustainable Communities Plan of 2003 is an attempt to rectify these tensions, outlining a major housebuilding programme to help meet housing growth. £5 billion has been allocated for more affordable housing and £300 million to encourage modern-build housing, building upon the Housing Corporation's £45-million 'Kickstart' programme for MMC projects. (DCLG, 2003)

### ***Potential benefits of offsite MMC in the UK context***

Government reports such as the 2007 Housing Green Paper have asserted that the use of MMC and offsite technologies can provide significant "economic, social and environmental benefits":

### *Economic*

A 2005 National Audit Office study states that MMC could provide the UK construction industry with a reasonable degree of cost comparability to traditional methods, offering reductions in on-site construction time of over 50% and four times as many homes built with the same on-site labour, thus reducing labour costs. (DCLG, 2007a) This could also act to alleviate construction labour shortages that, despite recent influxes of foreign labour, threaten to drive up construction costs. Moreover, faster construction times can enable developers to sell units earlier and reduce financing costs. Less visible financial benefits could also include fewer on-site accidents and better standards of health and safety through greater production carried out in factory conditions, resulting in fewer unexpected delays and reduced insurance liabilities. Furthermore, building lifecycle costs can be lessened as factory production can reduce defects caused by weather damage during construction, with materials more easily standardised and tested to ensure quality. (POST, 2003: 2)

### *Social*

The Health and Safety Executive, the construction regulator, is encouraging the use of MMC because of the aforementioned reduced risk of accidents. It can also have less impact on local residents during construction than traditional methods due to the reduced on-site time involved. (Ibid: 1 - 3) Factory-based production may also boost employment in the manufacturing sector, and potentially be a source of lower-cost, higher-performance housing for low-income and first-time buyers.

### *Environmental benefits*

Research conducted by the Building Research Establishment (BRE) has found houses built using MMC typically require less energy to heat because of increased levels of insulation and reduced air leakage. It further suggests the amount of waste MMC produce is likely to be less than traditional methods as factory-produced components can be ordered to exact specifications, with lower risk of damage on site. MMC could also reduce transport use by reducing trips to building sites. (POST, 2003: 3; For supplementary SWOT analysis of offsite MMC see Appendix B)

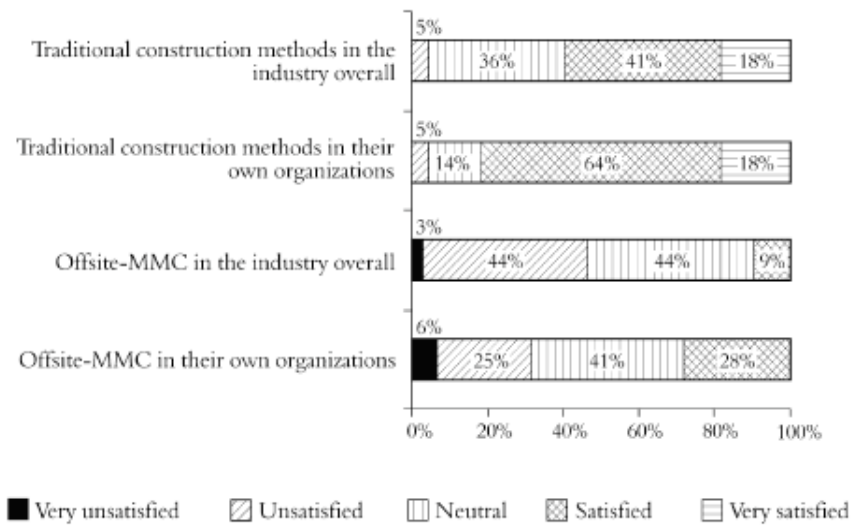
### ***Government initiatives within the social housing sector***

*Reconstructing Construction* emphasises that the main initial opportunities for improved performance in housebuilding exist in the social housing sector. Subsequent Government initiatives and targets have consequently been implemented to this intent, with the aim of encouraging greater use of MMC within private housing development. (Construction Task Force, 1998: 32; POST, 2003) From 2004 the Housing Corporation has required a quarter of new houses it funds to be built using MMC; approximately 5,000 homes per year, or 3% of new UK housing. Large-scale development schemes such as the Thames Gateway and the seven Millennium Communities initiatives run by English Partnerships are also allowing housing associations to use MMC to promote efficiency in construction and design. (Ibid; Architecture Week, 2001) Smaller case-studies have been cited to emphasise the benefits of innovative construction techniques; for example the Sustainable Communities Plan makes direct reference to the Peabody Trust's use of prefabricated volumetric construction to create its apartments at Raines Dairy in Hackney, highlighting the flexibility it provides and reporting that "the procedure maximised space available on site to the benefit of the tenants and the developer... (with on-site time savings of) 40 per cent compared with traditional site-based construction". (DCLG, 2007)

### ***Private sector perspectives on offsite MMC***

While private house building accounts for almost 90% of new UK homes, the Government admits its "influence on private sector house building is comparatively limited". (POST, 2003: 2) Government initiatives such as the £1.5 million DTI-funded 'Prospa' (Promoting Off-site Production Applications) research programme and 'Buildoffsite' have aimed to investigate the views of the UK industry on offsite MMC, however, "such initiatives are relatively modest, and Government has not so far provided direct incentives for private sector MMC, e.g. through planning policy or building regulations". (Goodier & Gibb, 2006; *ibid*) In addition to this, the government admits "many of the benefits of using MMC for housing are as yet unproven or contentious." (POST, 2003: 1)

**Figure 8: Housebuilders' satisfaction with the current use of offsite MMC and traditional construction methods**



(Pan et al, 2007: 186)

The National House Building Council estimates that about 10% of new homes in the UK are built using timber frames, and 5% using other MMC – equivalent to about 25,000 MMC homes in 2003. (POST, 2003: 2) Despite growing interest in offsite and MMC from the Government and from within the housebuilding industry, uptake remains low in comparison with other countries, with the industry seemingly reluctant to adopt innovative technologies. (Goodier & Gibb, 2006; Pan et al, 2006) A survey of the top 100 UK housebuilders' perspectives on the use of offsite MMC conducted in 2003 has highlighted that mixed feelings remain towards these technologies within the industry. (Pan et al, 2006) Figure 8 shows the survey's results relating to housebuilders' satisfaction with current industry use of offsite MMC and traditional construction methods. Showing clear divergence from government opinion and that of many UK consumers, housebuilders demonstrated general satisfaction with the use of traditional methods in their own organisations and the industry as a whole. However, 47% of respondents reported dissatisfaction with the limited use of offsite MMC in the industry, and 31% were dissatisfied with its use in their own organisations. Overall, 64% identified a need for increased use of offsite MMC in the industry, and only 15% stated that no increase was needed. (Pan et al, 2007: 186)

**Figure 9: Most important advantages and barriers for using offsite MMC for UK construction industry practitioners**

Advantages	Clients/designers		Contractors	
	% of respondents	% as 1st choice	% of respondents	% as 1st choice
Decreased construction time	87	38	92	69
Increased quality	79	28	77	15
More consistent product	77	18	54	0
Reduced snagging and defects	79	8	69	0
Increased value	51	5	23	0
Increased sustainability	49	3	31	0
Reduced initial cost	44	3	15	8
Reduced whole life cost	41	0	15	0
Increased flexibility	33	0	15	0
Greater customization options	33	3	0	0
Increased component life	28	0	15	0
Other	18	15	8	8

Note: 'Other' includes improved health and safety and reduced requirement for skilled labour.

Barriers	Clients/designers		Contractors	
	% of respondents	% as 1st choice	% of respondents	% as 1st choice
More expensive	67	54	77	38
Longer lead-in times	46	8	62	8
Client resistance	38	13	31	23
Lack of guidance & info	33	5	46	0
Increased risk	36	0	15	0
Few codes/standards available	33	3	23	0
Other	31	18	15	8
Negative image	28	0	46	8
Not locally available	18	5	15	0
No personal experience of use	18	3	38	15
Obtaining finance	18	3	8	0
Insufficient worker skills	21	0	23	0
Reduced quality	13	0	15	0
Restrictive regulations	13	0	31	0

(Goodier & Gibb, 2007: 588)

Figure 9 shows the main advantages and barriers cited by UK construction industry practitioners in surveys conducted by Prospa and Buildoffsite regarding the increased use of offsite MMC. Many of the perceived benefits stated reflect wider Governmental opinion promoting its use. However, the construction industry identifies significant barriers relating to its uptake, particularly relating to cost, market risk and wider attitudinal resistance due to its use. With most housebuilders seemingly satisfied with how their organisations are using traditional construction methods, these barriers are likely to limit significant adoption of offsite MMC in the UK private housing sector, despite its perceived advantages, unless

new competitive strategies can be identified. This is particularly relevant in the UK context due a prevailing institutional resistance to innovation resulting from strategies housebuilders currently adopt to minimise risk.

### ***Adapting to the market: housebuilders' competitive strategies***

*“The speculative housebuilder builds for a general market where demand varies sharply... Emphasis is placed, therefore, on maximising profits through development gain and production methods are subordinated to this economic necessity.”* (Ball, 1983: 144)

Today, unlike Japan where housebuilders cannot rely on land speculation for profitability but must rely on efficient production methods, the UK housebuilding industry remains characterised by speculative developers basing business strategies around development gain. (Gann, 1996; Interview: J. Pickard) Cook (2005: 52 – 53) has distinguished between two particular types of risk that the UK housing industry faces: market risk arising from the volatility of house prices (effected by factors such as interest rate changes and mortgage availability), and site-specific risk associated with land acquisition, gaining planning permission and the construction process. To minimise the first kind of risk, Ball argues that speculative developers have tailored their production processes and output to respond to prevailing market conditions, concluding:

*“Handicraft assembly of ‘traditional’ but standardised and partly pre-assembled building components has allowed building firms to achieve standardisation within small-batch production whilst minimising the fixed capital tied up in productive equipment... and has survived in the speculative sector not because... speculative building is backward and conservative, but rather because traditional building methods are the most profitable”.* (Ball, 1983: 167)

This flexibility provided by traditional construction techniques has been further facilitated by the nature of its workforce; predominantly self-employed labour-only sub-contractors hired and released according to developer need. (Ibid: 157) In order to protect themselves against site-specific risk, Ball contended that developers have adopted a system of holding stocks of land with outline planning permission, allowing production to proceed smoothly when demand is high and avoiding delays created by “the long gestation period” between the initial purchase offer for a plot of land and attaining planning permission. (Ball, 1983: 143) The factory-based production of houses, therefore, while “ostensibly the least-cost building method”, has not necessarily produced the largest profit for housebuilders, due to

its propensity to require higher levels of capital tied up in the production process and “continuous and long production runs, which are anathema to the speculative builder.” (Ball, 1983: 160) Risk strategies have therefore led to housebuilders taking a conservative approach to investment in offsite MMC, through fears about “being caught out by a period of housing market decline”. (Cook, 2005: 53)

The use of traditional building methods and land banking to minimise risk may, however, be becoming less appropriate in the emerging market environment, with concern growing amongst private-sector housebuilders that new competitive strategies will be needed to maintain profitability. (Barlow et al, 2003: 135) Real housebuilding costs are rising, and a lack of sufficiently skilled construction workers, particularly electricians, joiners, bricklayers and plumbers, has resulted in labour cost inflation of up to 40% since the 1990s. (Interviews: D. Panchal; J. Pickard) Although these inflationary pressures have been somewhat assuaged by the recent influx of eastern European construction workers into the UK, it has been argued that this has impeded communication on site; limiting efficiency and standards of health and safety. (Interviews: D. Panchal) These issues have been further exacerbated by national targets stating that over 60% of development should take place on brownfield land – constraining the amount of easily developable land available for housebuilders. (DCLG, 2007a) In the current UK market context, the Japanese model of prefabricated housing manufacture may therefore present crossover benefits for private housebuilders as they attempt to develop new competitive business strategies.

This Chapter has attempted to highlight the disparity between, on the one hand, the demand for increased levels of new housing and dissatisfaction with current build quality and performance, with the limitation of offsite MMC in the UK market to Government building of ‘affordable housing’, and a focus on speculation rather than a smoothed cycle of house creation, leading to significant resistance from private housebuilders to an increased use of MMC. The next Chapter will argue that this disparity can be eased by allowing the lessons from Japan explored in Chapter 2 to inform current UK offsite MMC practices.



## **Chapter 4: The applicability of the Japanese model to the UK context**

Many aspects of the Japanese housing market are not applicable, or indeed favourable, to a UK context, most notably the 'scrap and rebuild' culture. However, the model developed by Japanese PHM offers some important crossover strategies for UK housebuilders to overcome some of the perceived barriers that have to date prevented any significant uptake of offsite MMC in the private housing sector. Suggestions pertaining to the application of competitive benefits offered by the Japanese model will be explored, and some recommendations for future Government initiatives posed.

### ***Obtaining cost competitiveness and economies of scale in UK offsite MMC***

The most significant barrier cited by UK construction practitioners was offsite MMC being more expensive than traditional building methods. (See Figure 9) UK industry sources suggest costs can be up to ten percent higher with offsite MMC. (Pan et al, 2007: 188; POST, 2003: 2) The Peabody Trust's 1999-2000 modular-constructed Murray Grove development – winner of 9 awards and promoted as setting “new standards in cost-effective quality housebuilding” – is estimated to have incurred a 15% construction cost premium. (Yorkon, 2001; Design For Homes, 2000) While housebuilders are aware of the benefits of offsite MMC in decreasing construction times, increased quality and reducing whole life costs, all of which have positive fiscal implications, it is unlikely statistics like this will encourage the increased use of offsite MMC in the private sector. (See Figure 9) The Japanese model of prefabricated housing manufacture offers the UK industry some valuable clues to how initial construction cost can be lowered to overcome this barrier.

**Figure 10: Houses by ecoTECH (UK) and Sekisui House (Japan)**



(Source: ecoTECH, 2007; Sekisui House Ltd., 2007)

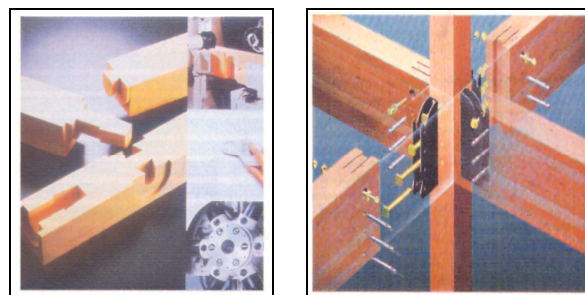
### *Procurement partnering and cross-sector learning*

In Japan, Sekisui House has a reputation for producing high-performance, highly customised houses aimed at the mid-upper pricing bracket. A basic Sekisui model sells for approximately £870 per sqm, and a luxury model at around £1,220 per sqm. (Interviews: S. Fukao; S. Watanabe) An example of offsite MMC homes on the UK market is Swedish manufacturer ecoTECH's ORGANICS model, advertised at a £1,066 per sqm. (ecoTECH, 2007) In terms of cost the products offered by these manufacturers are comparable, yet the product finish and marketing strategies are very different. ecoTECH's product is focused at the niche sustainable housing market, with a finish that is quite clearly 'prefab'. (See Figure 10, left.) Sekisui differentiate themselves by offering a product for the mass market, which while being prefabricated in terms of process, has largely avoided the means of construction being apparent within its design range. (See Figure 10, right.) Sekisui, like other leading Japanese PHM, demonstrates how efficient procurement and production process can be used to reduce costs, enabling an enhanced quality and range of standard features to market 'value-added' houses for a 'reasonable' price. (Noguchi, 2005) For example, Sekisui have started offering solar photovoltaic systems as standard, resulting in a 7% increase in orders in 2004. (Ibid: 4)

Pan et al (2007: 188) assert that improving procurement is the key to achieving long-term success for offsite MMC in UK housebuilding, noting many housebuilders admit that partnering has not been fully understood by the industry and "cooperation between housebuilders and manufacturers and suppliers was weak in many cases". In this context

the Japanese model has many lessons to offer. Housing manufacturers in Japan have developed sophisticated relationships with both their suppliers and sub-contractors who deal with on-site processes, which is described in detail in Barlow et al (2003). Mutual benefits between these stakeholders in the manufacturing process are augmented by a mixture of company loyalty fostered by long contract histories; mutual shareholding interests; supplier participation in the design process; and investment in training to familiarise subcontractors with the systems and standardised components involved in production. (Ibid; Bennet, 1993; Gann, 1996) The affiliation of large non-housing related conglomerates with manufacturing experience in the Japanese model further signifies the importance of cross-sectoral learning for the efficient production of prefabricated houses, as well as identifying a source of capital for the initial investments that are associated with entering the factory-based housing market. In the UK market, perhaps the best example of this crossover learning is that of IKEA, with its BoKlok Flatpack housing range, arguably presenting an exemplar to other non-housing based manufacturers thinking of entering the housing market. Japanese procurement systems not only offer a model of how to lower construction costs to make 'value-addition' possible, but provide clues on how to reduce lead-in times, which are the second major barrier cited by UK construction practitioners. (Figure 9) For example, Sekisui Heim's production system can be organised to produce a complete house in only 3.5 hours. (Gann, 1996: 446) A lack of high-level manufacturing assembly skills in the UK can also be mitigated through the greater participation of suppliers and project managers in the design process; as techniques to aid easy-assembly can be developed, as shown in examples from Japan in Figure 11. Therefore profit can be generated from a consistent supply of lower cost housing in general, rather than from land speculation.

**Figure 11: Aids to construction developed by Japanese housing manufacturers**



(Source: Matsumura, 2001)

### *Client involvement in the design process facilitated by selling 'land with conditions'*

The nature of the Japanese housing market offers PHM an advantage not currently present in the UK context – a preference for new-build housing. Figure 9 shows that industry practitioners perceive client resistance to be a significant barrier to increasing the use of offsite MMC in the UK. However, the Japanese model offers insight into how client acceptance of such technologies, and consequently market demand, can be increased. Craig et al (2000: 3) assert that greater client involvement is needed to overcome the current problems facing the UK housebuilding industry. The model provided by Japanese 'mass-customised' prefabricated houses facilitates this. The ability of prefabricated manufacturers to involve customers within the design process to produce bespoke designs using standardised components at high quality could provide a competitive strategy for the UK private housing sector in the changing market environment. Furthermore, while most mass-customised housing in Japan is customer commissioned for pre-owned land, the strategy of selling 'land with conditions' practiced by Japanese speculative housing developers provides an approach for how customer-focused design could be achieved in the UK to increase the market for offsite MMC. As mentioned in Chapter 2, the Japanese concept of selling 'land with conditions' describes the selling of a piece of land with an obligation that the purchaser use a predefined housebuilder to construct a house on the land. This allows the buyer to become involved in the design process for the house, directing specifications to the manufacturer relating to their specific individual needs and preferences to create bespoke housing. For this to be implemented in the UK, PHM could apply for Government certified Systems Type Approvals for their prefabricated construction systems, to be built on predetermined land that has outline planning permission. (Woudhuysen & Abley, 2004) Manufacturers could thus offer to build houses to prospective customers, customised within the limitations of the Type Approval and the outline planning permission. Detailed permission could then be sought for respective sites.

### *Image enhancement: marketing quality and range*

For cost reductions and effective economies of scale to be achieved in offsite MMC housing manufacturing in the UK, it is necessary to increase demand for such prefabricated housing. Client-orientated design and the selling of 'land with conditions' are two approaches to achieve this, but perhaps the most important approach is to improve

the image of the process of 'prefabrication'. Industry practitioners have identified the negative image of offsite fabrication as a significant barrier to increasing its uptake. Industry concerns reflect public opinion: in a 2001 MORI poll, 69% of respondents felt a brick built home would fetch a better sale price. (POST, 2003: 4) The Japanese model of marketing prefabricated housing as a *quality* product offering a *range* of design outcomes may be a solution to shedding enduring negative perceptions of the process that constrain its potential market in the UK. Investment in marketing strategies by UK housing manufacturers, similar to those used by Japanese PHM to emphasise design and construction quality would increase consumer confidence in prefabricated housing, and may help to overcome lingering negative connotations with the process from the post-war 'prefab', 1960s and 1970s mass produced social housing and the 'scares' about timber-frame housing of the 1980s. (Craig et al, 2000; Cook, 2005: 50) The Japanese model demonstrates the importance of developing a strong brand name, backed up by quality assurances and warranties, to inspire confidence in the product. Strong marketing based on quality, 'value-addition', and flexible design, supported by a brand name that inspires trust, would arguably not only increase the UK market for prefabricated housing, but enable manufacturers to seek higher returns for their products. It is also important for manufacturers to minimise the visibility of the construction method in the final product look, creating houses that conform to the sensitivities of the locality and look more like 'traditional' houses, as per the Japanese model.

### ***Potential Governmental intervention***

The Japanese prefabricated model of housing manufacture provides some ideas on how the UK Government could promote increased uptake of offsite MMC in the private housing sector:

#### ***Promoting professional associations***

The Japanese Government's backing of the JPA has arguably helped the industry overcome negative consumer perceptions relating to prefabricated housing in Japan. (Noguchi, 2003: 354) This suggests that UK Government initiatives should focus on promoting a strong association of offsite MMC manufacturers. This would help facilitate knowledge sharing between producers, promote self-regulation and enhance customer

confidence. This could be conducted through current organisations such as the Modular and Portable Building Association (MPBA). The promotion of an association to coordinate regional and national suppliers, following the model of the Japanese pre-cut wood association mentioned earlier, could increase levels of R&D investment from private finances by widening the market for suppliers, and potentially lower costs for small housebuilding firms using these methods.

### *Encouraging confidence through regulation and accreditation*

The Government can play a role in diminishing the concerns of customers and financiers relating to prefabricated housing. It is important to reassure housebuyers that levels of quality are high and that there will be substantial resale value on the properties. Insurers and mortgage lenders are also cautious about greater use of offsite MMC due to unforeseen durability problems that may arise. The Japanese model has shown that strict regulations regarding performance and durability bring about higher levels of investment in R&D and a focus on quality from private house manufacturers. For example, the 1998 Japanese Green Building Challenge suggested that the Japanese building industry has achieved a high level of building performance with “little room to improve”. (Kimata, 1999: 297) The UK Government should therefore place increased importance in the accreditation operated by the British Board of Agrément and BRE Certification for offsite MMC systems to alleviate these concerns. It has been argued that current accreditation costs of up to £100,000 and time periods of up to a year are deterring some companies from this process. (POST, 2003: 3) The Government should therefore make efforts to make the accreditation process as quick and low-cost as possible, while maintaining high performance standards. The instigating of building regulations relating to energy efficiency and structural integrity would promote quality offsite MMC, while economic incentives such as the promise to waive stamp duty on new carbon neutral homes by 2012 will also help encourage a market for high quality offsite MMC design. (Ibid: 4)

### *Encouraging quality affordable housing through market mechanisms*

It is important to reiterate when considering build quality that prefabrication relates to a process not a product. (Craig et al, 2000: 3) Whereas Japanese PHM concentrate on marketing high-quality design and build to the private market, current UK Government

initiatives are promoting offsite MMC as a source of quality lower-cost housing, primarily for the social housing sector. While the Government is hoping to increase the uptake of these technologies through showcasing them through social sector projects, this is potentially a double-edged sword. It is arguable that the continued association of prefabricated housing as 'affordable' may pose the danger of continuing its association with low quality in wider public opinion and restricting its marketability as a source of high-quality mid-high end housing. In turn this may encourage prolonged use of traditional construction methods amongst private housebuilders, with potential negative consequences for the performance of the national housing stock as the wider benefits of quality offsite MMC are lost. Furthermore, with the majority of the Housing Corporation's Affordable Housing Programme being focused on London and the South East, social housing projects using offsite MMC are more likely to be on brownfield land, where higher densities and restrictive natures of sites will necessitate short runs of highly bespoke design, which is likely to mean increased construction costs and propagate private housebuilders' view that offsite MMC is more expensive than conventional methods. (See Appendix C4; Interview: D. Panchal)

Offsite MMC systems have been developed by some major housebuilders, such as Barratt Developments, George Wimpey and Persimmon Homes as part of the Government's Design for Manufacture competition for English Partnerships with a focus on construction cost reduction. However, these companies have so far been reluctant to adopt the technologies developed for non-social housing markets. For some of the prefabricated development on the market quality concerns have already been raised, including Westbury Home's 'Space4' off-site manufacturing system when adapted for bespoke sites, and Countryside Properties and Taylor Woodrow's Greenwich Millennium Village relating to noise. (Ibid; Saxon, 2007) It can be therefore contended that the Government's optimal approach to promote the utilisation of offsite MMC technologies in the private housing sector and to maintain high quality is to encourage private manufacturers to invest more money in marketing *quality* production and design rather than prefabrication as a lower-cost production system, as encouraged by the £60,000 construction cost target in the Design for Manufacture competition. If the private market for offsite MMC housing can be developed via a focus on customer-orientated design and quality, it is arguable that economies of scale created will prompt higher efficiency and cost reductions naturally.

### *Limiting land monopolisation: opening up developer land banks*

While the houses they design are subject to strict building regulations relating to structural durability, PHM in Japan benefited from Government initiatives that provided “financial and legal backing for technical development aimed at solving housing shortages, and encouraged more effective use of land.” (Gann, 1996: 444) Planning regulations in Japan generally focus on unit sizes and neighbouring buildings’ right to light, and have no power to control the external appearance or style of a house. (Interview: S. Fukao) Prefabricated houses are thus designed to conform to the specified building regulations, and within these design limitations, manufacturers have a significant amount of design freedom to meet customer demand, largely unfettered by planning regulations. (Interview: Y. Matsumoto) By contrast, it is arguable that without Governmental initiatives to reduce delays in the planning process, and significant change in the current system of land supply in the UK, the use of offsite MMC in housebuilding is unlikely to increase by any large extent.

The ‘drip-supplying’ of development land caused by housebuilding companies retaining large land banks is a major barrier to PHM in the UK. (Interview: J. Pickard) This could be restricted by the creation of Land Development Trusts that retain the freeholds on development land, granting building leases subject to ground rents, (Edwards, 2007) or instigating new Government rules to restrict the length of time developers can hold land with planning permission. This would provide incentives for developers to use factory-based manufacturing techniques by smoothing the construction cycle to allow a steadier supply of new houses on market and longer production runs. (Pan et al, 2007: 188)

The Japanese model of prefabrication is not exhaustive in the solutions it provides with regards to increasing the use of offsite MMC in the UK market context, and it remains important to examine case-studies from other countries in which prefabrication has been used for private housebuilding, as well as solutions provided by domestic MMC suppliers. However, as this chapter has argued, the Japanese model provides significant examples of competitive strategies and government initiatives that could be applied in the UK to promote offsite MMC’s marketability and use in the private housing sector.



## Conclusion

The UK housing market displays significantly different characteristics to that of Japan. While both have considerable land restraints, Japanese PHM have benefited from a high and relatively constant demand for new housing. The UK housebuilding industry is characterised by speculative development for target markets, whereas in Japan the speculative housing market is severely constrained due to the 'scrap and rebuild' culture and consumer preference for independently commissioned bespoke housing. Land speculation does not therefore guarantee the Japanese housing sector's profitability, and sophisticated competitive strategies have been developed to compensate for this through efficiency in production and investment in marketing. For the companies that dominate housing production in Japan, the flexibility, quality and cost-effectiveness of offsite fabrication has been key to their success.

By contrast, the UK market to date has had a relatively restricted appetite for new housing resulting from the longevity of the national housing stock and a general preference for second-hand housing. UK housebuilders have traditionally minimised risk and maximised profits through the control of production and the holding of land banks. This has constrained innovation within the private housing sector. Now, however, the emerging UK market environment is prompting concern from both Government and industry advisors that traditional construction methods are ill-equipped and inadequate to provide enough housing to satisfy Government targets for the increase in housing provision whilst maintaining standards of quality and efficiency. Simultaneously, housebuilders are becoming increasingly concerned about rising production costs, which will only increase further if the influx of foreign labour declines.

Prefabricated housing provides a possible solution to both of these problems, allowing an expansion of quality housing provision whilst reducing production costs to the housebuilders. While the scale of prefabrication in the Japanese housing market cannot be replicated in the UK for cultural and market reasons, this report has identified some areas of crossover that could allow a greater utilisation of MMC and offsite technologies in the UK housing market. These include enhanced procurement partnering and cross-sector learning; client-focused design, facilitated through the selling of 'land with conditions'; improving the image of prefabricated houses through marketing their quality and range;

the promotion of professional suppliers' associations and increased regulation and accreditation. The current narrow focus on offsite technologies as a source of 'affordable' housing is likely to restrict its appeal in the private housing market, and as such the government should encourage a marketing system for MMC similar to that used by Japanese PHM. This involves both a greater emphasis on both quality and customisation through the increase selling of 'land with conditions'.

Through Government initiatives to promote more efficient practices, including MMC and offsite technologies (such as the Housing Forum), more innovative housing designs and improved supply-chain management, social and private housebuilders are increasingly becoming aware of the benefits MMC can offer. These initiatives are, however, limited in two ways. They are limited in terms of their scope, as they are still confined to 'affordable' social housing, which may itself damage the long-term prospects of MMC. They are also limited in their scale, as a sustainable model of quality MMC requires a market large enough to allow sufficient investment in R&D and true economies of scale. Moreover, despite the recent White Paper, the planning system remains relatively slow at releasing land for development. (Barlow et al, 2003: 135; Interview: D. Panchal) This paper has endeavoured to show that the strategy behind these initiatives is counter-productive, and that a radical change of approach, materially informed by the Japanese experience, is required for prefabricated housing to assist in the satisfaction of present and future housing demand.

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## Appendices

### ***Appendix A: Methodological approaches / tools***

#### **A1: Definition of terminology**

For this report, technical descriptions are as follows:

**Modern Methods of Construction (MMC):** “MMC is a term introduced by the ODPM, initially as a link to grant funding for social housing.” (Goodier & Gibb, 2007: 586) The term embraces “a range of technologies and processes involving various forms of supply chain specifications, prefabrication and off-site assembly”. (DCLG, 2007a: 126)

**Offsite technologies:** “The manufacture and pre-assembly of components, elements or modules before installation into their final location. Other terms in use for offsite include offsite production (OSP), offsite fabrication (OSF), offsite manufacturing (OSM), offsite construction (OSC), pre-assembly and prefabrication. Whereas most offsite may be considered to be MMC, not all MMC can be regarded as offsite.” (Goodier & Gibb, 2007: 586)

**‘Traditional’ UK housebuilding technologies:** “Brick / concrete block cavity wall methods. Most traditional low-rise, individual houses in the UK are built using brick/concrete block walls with timber or precast floors and timber truss roofs. Traditional medium-rise apartment blocks tend to be considered with steel or in situ concrete frames and in situ brick cladding.” (Pan et al, 2007: 183)

## **A2: List of interviews**

### Japan:

- Professor Fukao Seiichi, Department of Architecture, Tokyo Metropolitan University. (Tokyo, 7/8/07)
- Dr. Masafumi Ota, Project Manager, Planning and Administration Division, Railway Business Unit, Tokyu Corporation. (Tokyo, 7/8/07)
- Professor Shuichi Matsumura, Department of Architecture, Tokyo University. (Tokyo, 8/8/07)
- Mr. Esuke Takarafuji, Planner, Toyota Home Ltd. (Shizuoka, 9/8/07)
- Mr. Yoshimi Matsumoto, Planner, City Planning Division of Hamamatsu City Council, Shizuoka. (Shizuoka, 10/8/07)
- Professor Manabu Hatsumi, Department of Architecture, Science University of Tokyo. (Tokyo, 16/8/07)
- Ms. Shoko Watanabe, Research & Development Engineer, Sekisui House Ltd. (Tokyo, 17/8/07)

### UK:

- Dr Richard Wiltshire, Associate Head of the School of Social Science and Public Policy, King's College London. (London, 2/8/07)
- Mr. Dharmesh Panchal, Managing Director, Ebt Europe Limited. (Telephone, 4/9/07)
- Mr. James Pickard, Director, Cartwright Pickard Architects. (Telephone, 4/9/07)

### **A3: List of sites and exhibitions visited**

- Project name: Murray Grove  
Address: Shepherdess Walk / Murray Grove Way, London Borough of Hackney.  
Developed by: Cartwright and Pickard Architects & the Peabody Trust, 1999 - 2000.
- Project name: BedZED  
Address: Sutton, Surrey.  
Developed by: Bill Dunster Architects, BioRegional Development Group & the Peabody Trust, 2000 – 2002.
- BRE Offsite2007 Exhibition 12 June 2007, Watford.
- Sakurajyousui Housing Park, Tokyo.
- Sekisui House Special Exhibition Centre, Tokyo.

#### **A4: Sample questions to Japanese stakeholders (English version)**

- What is the typical lifespan of prefabricated houses in Japan? When and why are they replaced?
- What are the drivers behind the high utilisation of prefabrication within Japanese residential construction? Are they predominantly economic (i.e. financial savings), market orientated (i.e. it's what people want to buy), or cultural?
- Who dictates the design of the residential units available on the Japanese market; is it architects, the construction industry or other market factors?
- To what extent does the Japanese housing market appreciate bespoke / customised design?
- Do prefabricated construction systems limit design flexibility? If so, does the relative inflexibility (for example, difficulty in modification, such as adding extra rooms) reflect in the nature of the Japanese housing market?
- Does environmental sustainability play a significant factor in the marketing of prefabricated houses in Japan?
- Does the nature of land ownership in Japan reflect in the typology of houses built? Who is more influential in the initiation of residential development, speculative developers or small landowners?
- What effect does the Japanese mortgage system have on the residential housing market?
- To what extent does the threat of natural disasters, such as earthquakes and typhoons, and Japan's climate determine housing design and construction methods?
- What role do planning and building regulations play in the development of prefabricated housing?

## **Appendix B: SWOT analysis for prefabricated and traditional construction methods in the context of UK housebuilding**

### STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

#### PREFABRICATION (Following the Japanese model)

- S** Potential reductions in: cost; time; defects (snagging); health and safety risks; construction waste; environmental impact. Potential improvements in: product quality; whole life performance; profitability; procurement processes. Enhanced customer and supplier participation in the design process; customer-focused design.
- W** Supply line weaknesses / fragmentation of procurement; shortage of manufacturing skills and related on-site skills in labour force; housebuilders lacking confidence in new systems; relatively small market restricting economies of scale; lingering negative connotations associating earlier 'prefab' systems with poor quality; availability of capital investment in manufacturing infrastructure; fire-crews inexperienced in tackling fires in such houses; potentially difficult to modify; potentially longer lead-in times; perceived higher capital cost.
- O** Government housing targets; Government initiatives such as the Housing Forum promoting innovation; customer demand for improved quality and choice; Housing Association readiness to pilot MMC systems; existing capacity to supply growth forecasts; shortage of traditional labour skills and related wage inflation.
- T** Reluctance within the private sector to market industrialised units; delayed planning process; resale doubts; concern over mortgage and insurance availability; underinvestment in relevant skills training.

#### 'TRADITIONAL' UK HOUSEBUILDING TECHNOLOGIES (Brick / concrete block cavity wall methods)

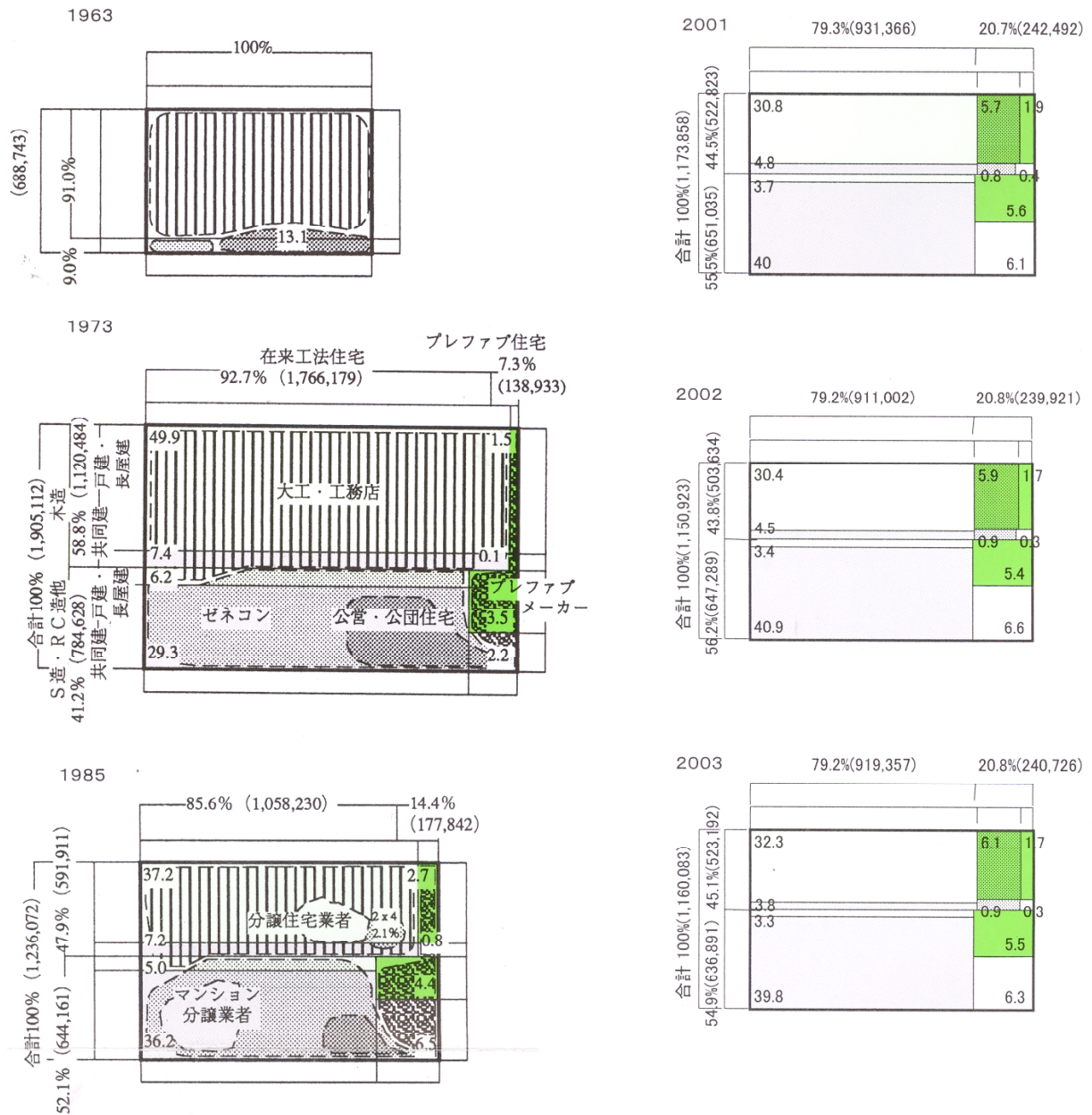
- S** Housebuilders have relevant procurement and construction experience; can offer high performance e.g. insulation; customer preference for traditional construction styles; high durability; relative ease of modification; tried and tested technologies; planners are familiar with design and construction methods used; fire-crews aware of how to tackle fires; relatively short lead-in times; relatively small initial capital outlay; well established companies with strong relationships with suppliers.
- W** Lack of performance constancy; quality concerns; housebuilders' tendency to produce generic designs; limited customer influence in the design process; often subject to defects and snagging; long on-site timescales;
- O** Government housing targets and planning reforms; customer preference for traditional construction methods over MMC; relatively large market.
- T** Low levels of customer satisfaction with recent new build houses / services provided by housebuilders; shortage of traditional construction skills; rising labour costs; concerns that long build times will make housing targets unattainable using traditional methods.

(Sources: Pan et al, 2007; Saxon, R., 2007; POST, 2003)

## Appendix C: Charts and tables

### C1: Illustrations demonstrating changes in housing production in Japan.

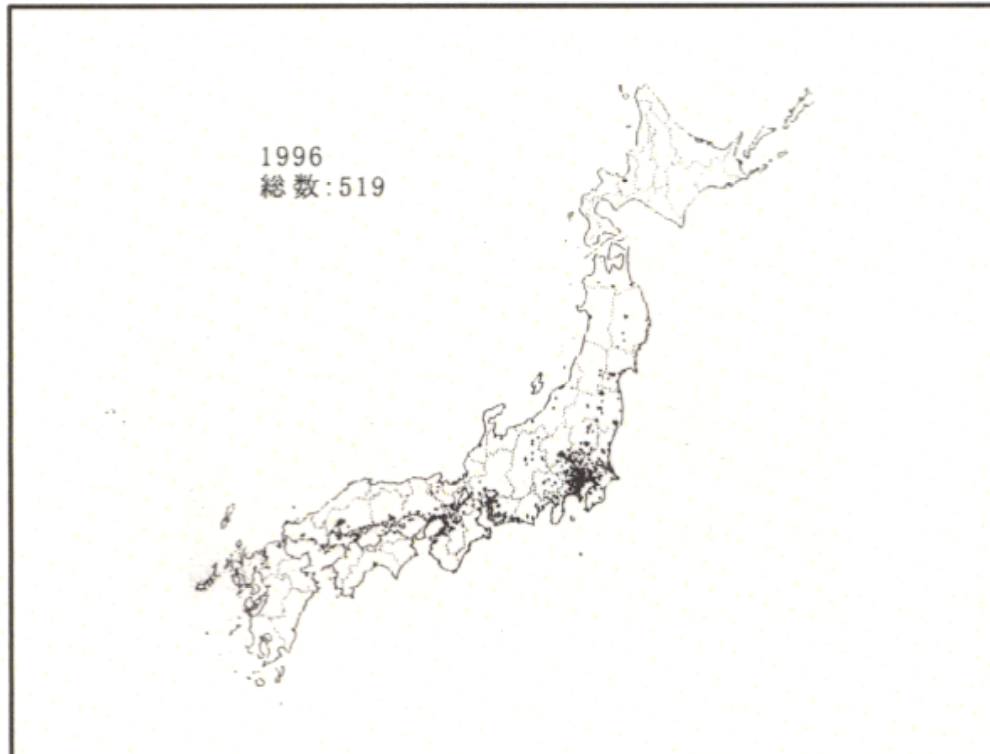
Note: In the graphs, the volume of annual housing starts is indicated by area. Wooden construction is represented by the upper section, and other construction methods the lower; conventional construction methods are to the left, and prefab housing is highlighted in green to the right. (Original explanation provided below). Prepared by Sekisui House using statistical data for 2004 Research Paper, provided by Professor S. Fukao of Tokyo Metropolitan University.



### Original explanation of illustrations:

- (1) The whole outline is a rectangle whose area presents the total number of construction starts per year. ( The rectangle is 100% )  
Numbers in parentheses right after the % marks indicate the number in each classification. The total number of housing starts for the shown in parentheses on the left line.
- (2) Horizontally divide the rectangle into two; wooden housing is above and non-wooden housing is below. The middle vertical line shows the number of each. ( 58.8% wood and 41.2% non-woo in 1973 )
- (3) Vertically divide both two of the rectangles made in the above process into two; conventional construction is shown on the left and prefabricated on the right. The top horizontal shows the total ( 92.7% conventional and 7.3% prefabricated in 1973 ) Prefabricated housing did not exist before 1963. Graphs after 1990 include 2x4 in the middle. ( 2.1% in 1990 )
- (4) Horizontally divide each of the four rectangles into two; detached & shown above and flats below.

### C2: Map showing the 519 model show-houses of Sekisui House, 1996.



(Source: Matsumura, 2001: 5)



**C3: Housing investment as a share of National income, 1956 - 2000: cross-country comparisons**

	Mean	Maximum	Minimum	Standard deviation	Standard deviation/Mean
Germany	6.4	8.1	4.8	0.9	0.15
France	5.7	7.8	4.1	1.2	0.20
Japan	5.6	8.8	3.6	1.3	0.23
Netherlands	5.3	6.4	3.9	0.6	0.12
Canada	5.3	7.4	3.8	1.0	0.19
USA	4.4	5.7	3.2	0.6	0.14
UK	3.5	4.7	2.6	0.5	0.14

Source: OECD.

(In: Ball, 2003: 901)

**C4: Actual and estimated expenditure through the Housing Corporation's Affordable Housing Programme in each English region for 2003-08.**

	Outturn			Estimated	
	2003-04	2004-05	2005-06	2006-07 <sup>(1)</sup>	2007-08 <sup>(1)</sup>
London	723.4	711.6	714.5	891.4	840.6
South East	296.0	297.2	261.1	368.9	365.0
South West	103.6	85.6	90.1	114.1	153.5
East of England	112.9	136.8	127.2	150.1	186.1
East Midlands	53.1	65.1	70.4	72.1	84.3
West Midlands	88.0	102.9	83.4	96.0	89.3
Yorkshire & Humberside	64.5	60.2	58.6	67.2	69.3
North East	41.2	40.1	34.8	39.7	35.6
North West	106.9	109.5	113.3	111.0	99.7
Total	1,589.6	1,609	1,553.4	1,910.5	1,923.4

<sup>(1)</sup> Regional expenditure limits as at end January 2007  
\* £ ('000,000).

Source: Parliament, Publications and Records, 2007.

## C5: Age of building by tenure for the UK

### Age of building by tenure

Households

Great Britain: 2000

Age of building* containing household's accommodation	Tenure									
	Owners			Social sector tenants			Private renters			Total
	Owned outright	With mortgage	All owners	Council†	Housing association	Social sector tenants	Unfurnished private**	Furnished private	Private Renterst††	
(a)	%	%	%	%	%	%	%	%	%	%
Before 1919	22	23	22	3	15	6	37	43	39	21
1919-1944	21	19	20	20	13	18	19	20	19	20
1945-1964	24	18	20	39	17	33	16	11	14	22
1965-1984	24	26	25	34	25	31	17	14	16	25
1985 or later	9	15	12	4	30	11	11	13	12	12
Weighted base (000's) = 100%	6,621	10,148	16,769	3,607	1,413	5,020	1,623	801	2,430	24,219
Unweighted sample	2340	3345	5685	1159	455	1614	501	223	726	8025

\* For an assessment of the reliability of age of building estimates, see Birch F, Age of buildings (OPCS Social Survey Division, GHS Series No.7, 1974).

Source: National Statistics, 2000.