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Smart cities

The adoption of smart grid technology by Japanese developers: A real estate perspective on the smart city

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ABSTRACT.— **Despite the influence of real estate companies on the production of the built environment, their role of in smart city initiatives has been overlooked. As part of a smart city demonstrator program implemented by the national government, Japan has witnessed the large-scale adoption of smart grid technology by condominium developers. The article shows how the practical implementation of this government initiative was determined by the strategic motivations of the developers, the latter having equipped their mid-range condominiums with smart grids in order to attract buyers with "club" services. The analysis is based on a corpus of 137 condominiums equipped with this technology and a case study analysis of a residential complex.**

CONDOMINIUM, JAPAN, REAL ESTATE, SMART CITY, SMART GRID

RÉSUMÉ.— **L'adoption du *smart grid* par les promoteurs japonais : une perspective immobilière sur la *smart city*.— Malgré l'influence des entreprises immobilières dans la production de l'environnement bâti, leur rôle au sein des initiatives *smart city* a été peu étudié. Dans le cadre d'un programme gouvernemental de démonstrateurs de *smart city*, le Japon a vu l'adoption à grande échelle d'une technologie de *smart grid* par les promoteurs de condominiums. L'article montre comment les modalités concrètes de mise en œuvre de cette initiative gouvernementale ont été déterminées par les motivations stratégiques des promoteurs, ces derniers ayant équipé de *smart grids* leurs condominiums de gamme intermédiaire afin d'attirer les acquéreurs par des services de « club ». L'analyse repose sur un corpus de 137 condominiums équipés de cette technologie et sur l'étude ciblée d'un complexe résidentiel.**

COPROPRIÉTÉ, IMMOBILIER, JAPON, RÉSEAU INTELLIGENT, VILLE INTELLIGENTE

Initially related to cybernetic utopianism (Picon, 2013), the notion of a smart city is widely used by experts as well as in scientific literature despite the lack of a clear consensus on its definition (Douay, 2016). Most of the definitions highlight the generalised use of digital technology and the strong focus on big data (Batty et al., 2012; Townsend, 2013; Cocchia, 2014). These constants continue to be vague and cover a range of extremely heterogeneous aims and practices. Projects laying claim to the smart city concept involve various players, technologies and scales: dashboards for visualising data (Kitchin et al., 2015), a control centre for environmental risks (Douay 2016), optimised energy management systems (Faivre d'Arcier et al., 2016a), electric vehicle experiments

(Faivre d'Arcier et al., 2016b), new cities (Carvalho, 2015; Datta, 2015), public access to socio-spatial data or professional training applications (Shelton et al., 2015). The absence of stable content regarding the notion has led to conclusions of a "terminological confusion" (Hollands, 2008), or even a chaotic concept (Glasmeier, Christopherson, 2015).

Subsequent to Hollands' analysis identifying a "labelling process" in the use of this term, critical studies concluded that smart city projects had nothing in common except their underlying neo-liberal agenda (Hollands, 2008; Vanolo, 2014; Grossi, Pianezzi, 2017).

Yet, Shelton, Zook and Wiig (2015), without refuting the neo-liberal nature of certain initiatives, show that these analyses do not help in evaluating the actual impact of smart city projects on the urban environment. They propose to study already existing smart cities, rather than a generic smart city with uniform effects, by grounding the analysis of these projects in their respective historical and geographical contexts. Like in the case of sustainable cities (Theurillat, 2011; Piganiol, 2016), the heterogeneity of the discourses and practices can only lead one to observe the existence of a wide range of agencies related to smart city projects that are the outcome of negotiations among stakeholders with specific interests[1]. This article[2] seeks to address this issue with the help of a case study of a defined object, the smart mansion. The smart mansion designates a condominium building (called mansion in Japan[3]) equipped with the Energy Management System (EMS), a smart grid technology. The EMS, called "MEMS" (Mansion EMS) when it is installed in a mansion, is an instrument for measuring and controlling energy consumption with the objective of optimising it. It was tested first under the smart city demonstrator programme in four Japanese cities from 2011 to 2015 and later put to widespread use in the regular production of mansions by real estate developers. In this article, we will examine the challenges and the motivations behind this spread in the context of the Japanese real estate market.

French and Swiss researchers presented a new perspective to the role of developers in urban production (David, Halbert, 2014; Halbert, Rouanet, 2014; Theurillat et al., 2014; Trouillard, 2014; Guironnet et al., 2016; Pollard, 2018). However, there were few studies on the real estate dynamics in smart city projects. The Japanese case provides a particularly interesting opportunity for studying developers in the context of a smart city initiative. As part of the national programme of smart communities, the Ministry of Economy, Trade and Industry (METI) pursued a policy of subsidies and labelling in order to encourage Japanese developers to install MEMS in their mansion production. This article aims to examine the extent to which the strategic interests of the real estate developers determined the modalities for the implementation of the government's smart city initiative in Japan. Based on the statistical analysis of a sample of 137 smart mansions, along with field research, the article shows that the MEMS are used strategically by developers to attract clients to their new mid-range programmes in a slow market where providing innovative services in the form of "club goods" allows them to justify production of new housing.

The article is made up of two parts. The first part introduces the context in which mansion production by Japanese developers was subject to an initiative specific to METI's smart city policy, as a response to a series of crises; it presents the way the dataset is defined and analysed. The second part describes the results of the statistical analysis and presents the characteristics of smart mansions in the light of the developers' strategic concerns.

1. The authors are grateful to the reviewers of l'*Espace géographique* for their recommendations. Many of their observations have been included in this article.

2. Material for this article is taken from a master's thesis titled "La Smart city au prisme de l'immobilier. Émergence et diffusion des Smart Mansions au sein du marché japonais des condominiums", produced as part of Géoprisme master's programme at Paris Diderot-Paris 7 University and defended by Omar N'Diaye in 2016 under the supervision of Natacha Aveline-Dubach and Renaud Le Goix.

3. The term mansion is transcribed in Japanese as (*manshon* in Romanised transcription). That term smart mansion used by METI is transcribed as (*sumāto manshon*).

4. Ministry of Economy, Trade and Industry.

The smart mansion, from crises to opportunities

Systematic introduction of technologies in the residential sector has been theorised in the concept of a smart home. Defined as "the integration of technologies and services in residential environments for greater comfort and quality of life at home" (Roe, 2007, p. 110), the smart home concept was developed in 1984 by the National Association of Home Builders, a federation of professionals from the housing industry in the United States. Even though it preceded the smart city, which appeared in 1992 (Gibson et al., 1992), the smart home is today often included in the latter. While it was not developed significantly at the time, it has been popularised over two decades by researchers from various fields (architects, psychologists or sociologists) studying the evolution of the ways of living and activities in the housing industry with relation to digital technologies (Allameh et al., 2011). Yet, the smart home concept came to be used widely in the context of upheavals for real estate actors in industrialised countries. As a result of the fall in economic and population growth rate, the conditions for urban expansion, which prevailed in the post-war period, could not be fulfilled anymore. There was thus less room for creating real estate capital gains, which led to the expansion and enhancement of real estate services. This approach made the real estate spaces more productive in terms of rent extraction: "Financial assets must be subjected to the management process to achieve the desired goals of owners, renters and other consumers of the space. Owners must engage in marketing research about human activities to make the real property assets productive" (Black et al., 2003, p. 86).

Our analysis pertains to the introduction of a smart grid technology called Mansion Energy Management System (MEMS)" in new mansion production in Japan. EMS of which MEMS is a variant, is an electricity management optimisation system based on the principle of demand-response[4] (Granier, 2016). Coupled with a system of financial incentives, it encourages residents to reduce their consumption during peak hours. It records energy consumption of the apartments (smart metering) through a wall-mounted box with a screen and an Internet platform, which allows the residents to get information in real time. Thanks to these instruments, the service manager, the aggretator, notifies them of the start of the peak period, during which over-consumption would be penalised. METI, the historical monitoring agency for the Japanese developmental State (Debanes, Lechevalier, 2014), encouraged real estate developers to adopt this technology with a programme of subsidies and accreditation of smart mansions. Having done that, METI substituted the generic term "smart home" (transcribed in Japanese *sumāto hōmu*) according to the typology of Japanese housing, with "smart house" (*sumāto hausu*) for a detached house equipped with Home EMS (HEMS) and smart mansion (*sumāto manshon*) for an apartment building equipped with Mansion EMS.

As part of a comprehensive reflection on the energies of the future and new systems for controlling and monitoring consumption such as the new EDF meters in France, the field study in Japan turns out to be particularly pertinent for observing the relationship between real estate and smart city initiatives. With the Fukushima disaster revealing the vulnerability of the energy production and distribution system, the government chose to give a fresh impetus to market deregulation reforms and open its energy mix to green technologies (Leprêtre, 2017). From 2011 to 2015, METI initiated a movement of territorialisation of energy policies with the help of a national programme based on four demonstration sites, where the formation of smart communities, especially pertaining to the EMS, was experimented at a large scale in collaboration with consortiums of private companies (Granier, 2015; Faivre d'Arcier et al., 2016b; Languillon-Aussel et al., 2016). At the same time, private initiatives such as *Kashiwa no Ha* (Languillon-Aussel, 2015), often based on real estate development projects, were launched by companies or local authorities. As part of a third step, METI supported the use of EMS at a national level, besides these experimental projects, in the regular production of mansions. From 2013 to 2016, under the Project for Measures to Promote the Introduction of Smart Mansions, METI financed two-thirds of the cost of EMS in the mansions, MEMS. To a lesser extent, it also implemented a non-binding system of accreditation of residential buildings as smart mansions, on a gradient of five stars, depending on the extent of MEMS functionalities (consultation of consumption, demand-response, the existence of a programme of energy efficiency incentives, combining MEMS with renewable energies, and remote control system for home appliances). The objective as stated by METI was not only to promote smart communities in experimental areas but also, more generally, to enable the development of a "green social system" (Faivre d'Arcier et al., 2016b) by steering property owners towards targeted constructions. Large-scale adoption of this technology in regular real estate production, outside the exceptional framework of experimental projects, provides an example of an actually existing smart city as envisaged by Taylor Shelton, Matthew Zook and Alan Wiig (2015).

In order to clearly understand the issues pertaining to the development of smart mansions in Japan, it is necessary to go back to the conditions in which they emerged. These are directly linked to the three major crises that struck the archipelago in recent times. Firstly, the bursting of the financial bubble in the beginning of the 1990s led to an era of low GDP growth (Aveline-Dubach, 2008). The recession completely changed the way Japanese society perceived the value of real estate. Until then, only land was considered as a store of value with constructions perceived as minor, because they had to be reconstructed every thirty years. By putting an end to the "land myth" which was nourished by an almost uninterrupted growth in real estate prices since 1955, the bursting of the bubble made the stakeholders shift their interest to built property. Two processes contributed to it: on the one hand, the "urban renaissance" policy which has, since 2002, led to a massive densification of constructions in the central areas of major cities with the objective of halting the fall in land prices (Sorensen et al., 2010); on the other hand, the development of a real estate investment sector, which was also meant to sustain the property industry, brought about valuation norms and methods that gave larger weight to real estate returns as opposed to traditional expectations of land capital gains. As a consequence of these changes, the built part of real estate property, which was previously ignored to the benefit of the land component, became the main source of capital gain in the face of sluggish land prices (Aveline-Dubach, 2014).

This new interest in the potential of constructions was reinforced by the population crisis (falling fertility rate, followed by a net population loss from 2005 onwards), which reversed the urban dynamics from expansion to shrinkage and which contributed to a change in the residential model. By accelerating the de-growth of the urban peripheral areas where remaining senior households are increasingly left captive (Buhnik, 2010, 2014), ageing has led to a drop in the status of suburban houses that once incarnated social success in a society with full employment. As a result of changes in family relationships and gender relations at work (Buhnik, 2015), collective mansion housing came to be accepted as the solution for achieving a high degree of urbanity, connectivity (proximity to collective transport infrastructure) and security, in particular for single women. It is also proposed as an interesting medium for developing an entire panoply of exclusive services for the residents. The success of mansions remains relative because there was a decline observed in the new production of this residential model also.

Finally, the third crisis was the Fukushima disaster, which occurred in March 2011, which accelerated the project of deregulation of the electricity market by METI. The objective is to dismantle the ten regional monopolies, which is said to sustain high prices, nearly twice the OECD average for industrial electricity (Arnaud, 2015, p. 18). These monopolies continue to have control over production but since 2016, electricity supply has been partially liberalised, notably for buildings with more than fifty apartments. Rather than choose their supplier individually and directly, the mansion's joint owners have the possibility of entering into a collective contract with an intermediary or the "aggregator" who negotiates a bulk price. This system is called *ikkatsu juden* or "aggregated electricity demand" (Arnaud, 2015). The aggregation of consumption authorises the provider to supply high tension current to the whole building, which is up to 30% cheaper than low tension.

As part of the production liberalisation planned by METI with intra-daily markets and prices varying according to the demand and supply, the MEMS management allows aggregators to optimise consumption by their clients. MEMS applies the principle of demand-response: display of consumption in real time, price signals, alarm and buying coupons should encourage the condominium unit owners to reduce their consumption during peak times, in order to even out the overall demand for electricity (Granier, 2016). It thus prevents expensive volume variations for the producers, which is then reflected in the prices. MEMS users are thus expected to benefit from lower prices, once the necessary reforms are implemented. The price of MEMS, including installation costs, is not more 100 million yen (around 760,000 euros in 2018[5]) for 300 apartments (that is, an average of 2,530 euros per unit). Two-thirds of this cost was subsidised by METI between 2013 and 2016. It is borne by the developer in the case of new real estate projects. In addition to this, there is a monthly package which may amount to up to 2,900 yen per month per household (around 22 euros) for aggregation services and eventually fringe benefits such as internet.

Our method relies on the analysis of a geo-localised database of 137 new mansions equipped with MEMS, called smart mansions according to METI[6].

The database, which was cross-tabulated with figures on the total supply of new mansions on the scale of Japan and Greater Tokyo, was subject to a cartographic and statistical analysis (box 1). It involves characterising the supply and situating smart mansions within the overall supply of new mansions, by cross-tabulating location and price. A field study in a smart mansion apartment complex was carried out in order to provide some additional analysis on the nature of these real estate products and throw light on the strategies of MEMS adoption by the developers.

5. The exchange rate of Yen is 100 yen for around 0.76 euro as on 31st March 2018.

6. A very large majority of the developers do not use specific terms to distinguish mansions equipped with MEMS but include them on their promotional brochures as part of the list of equipment.

Box 1/ Data processing method

The smart mansions studied in this article have been taken from a list published by METI (2013a) which includes some of the buildings that received a subsidy for installing MEMS under the Project for Measures to Promote the Introduction of Smart Mansion launched in May 2013. These mansions are all condominiums. The list includes 154 new buildings (at the planning stage or under construction as of 2013) with a total of 17 476 apartments. When this list was published, the dates on which these mansions were put for sale ranged from 2013 to 2017. In 2013, 941 mansions, with a total of 1,07,895 apartments including 30,858 apartments in new mansions (28.6%), benefited from METI's subsidy programme for the promotion of smart mansions (METI, 2013b). This article pertains only to new buildings, for which the decision to install MEMS is taken by the developer. The METI list analysed here thus represents a sample of 57% of these 30 858 apartments in the new smart mansions. When several buildings are part of the same development project, we grouped them together, bringing the number of mansions studied down from 154 to 146. The initial data on the list was completed with the help of the website https://www.e-mansion.co.jp/, which aggregates listing and characteristics of mansions on sale in Japan. We thus built a database with the name, address, size, geographic coordinates, start of sale date, number of floors, name of the developer and the advertised price at the time of the sale for 146 smart mansions.

The results of the database were compared with the volume and the average price of the entire range of new mansions available at the level of the major regions of Japan, notably Greater Tokyo and Greater Osaka, and at the level of the prefectures (ken) covered by Greater Tokyo. Greater Tokyo is made up of the Tokyo, Kanagawa, Saitama and Chiba prefectures for a total of 36.1 million inhabitants according to the 2015 census. Greater Osaka is made up of Osaka, Hyōgo, Kyōto, Nara, Shiga and Wakayama prefectures with around 20.7 million inhabitants according to the 2015 census. Greater Tokyo and Greater Osaka are not administrative structures but only statistical constructions. National and regional data on the new mansion supply from 2014 and 2015 are taken from Japanese Real Estate Statistics, an annual statistics report on real estate in Japan, published annually by Mitsui Fudosan Group (2016). It incorporates public and private sources. The figures from the prefectures in Greater Tokyo and Greater Osaka come from two reports published in 2015 and 2016 by Real Estate Economic Institute (2015; 2016a), a private company producing studies on the mansion market in Japan. The data in the report was collected by Real Estate Companies Association of Japan, a national federation of real estate industry.

It should be noted that the number of new smart mansions is bound to be underestimated. On one hand, the METI list only includes 57% of the new mansions that benefited from the programme. On the other hand, as the list has not been updated, it does not account for the projects for which subsidy applications were submitted after its publication in 2013.

Characteristics of smart mansions

The smart mansions given in the database were put up for sale between 2013 and 2017, but the years 2014 and 2015 account for 88% of the sample (table 1). This can be explained by the fact that the METI list was published in 2013 and that planning for most of new mansion projects to be delivered after 2015 had not yet been finalised with certainty. In order to be as representative as possible, the analysis is limited to mansions put up for sale in 2014 and 2015.

Geography of the smart mansions: Ordinary locations

The smart mansion sample was placed in the context of the mansion market in 2014 and 2015 (table 2) at the national and the Greater Tokyo levels. The proportion of smart mansions in the total number of mansions available can be used as a proxy for measuring the spread of MEMS in home ownership schemes. The phenomenon is not negligible since, in 2014, our sample represents 14.1% of the national supply of mansions and 16.8% in Greater Tokyo. The lower intensity in 2014 is due to the starting date of METI's initiative. At the time of publishing the list in 2013, for some of the 2014 projects, it was seemingly too late for the developers to take the decision of installing MEMS.

While, in 2014, the MEMS were more present in Tokyo, this dominance disappeared for the smart mansions in 2015: we observed a notable increase in the adoption of this technology in the rest of the country (table 2). In terms of proportion, the distribution of smart mansions in 2015 was similar to the distribution of ordinary mansions and the construction of this type of product is not the prerogative of the two major metropolitan centres. If Greater Tokyo is over-represented with 62% of the smart mansions as against 52% of the mansions, it is at the expense of Greater Osaka, as the rest of the country has a quarter of both mansions and smart mansions (table 3).

Table 1/ Year of start of sale of the smart mansions in the sample

Start of sale date	Number of buildings	Number of apartments	Total units in %
2013	1	312	2
2014	38	4,272	25
2015	85	11,001	64
2016	11	823	5
2017	1	670	4
Total*	137	17,078	100

* Six buildings with a total of 398 units do not have the start of sale date. They have not been included in the total in the table.

Source: From METI, 2013 and its updated version from 2017 https://www.e-mansion.co.jp/ 2017; N'Diaye, 2016.

Table 2/ Percentage of smart mansions in the total national supply of new mansions in 2014 et 2015

Zone	2014		2015	
	Total number of mansions (A) – appartments	Number of smart mansions (B) – appartments (%: B/A)	Total number of mansions (A) – appartments	Number of smart mansions (B) – appartments (%: B/A)
Greater Tokyo	44 913	3 386 (7.5)	40 449	6 806 (16.8)
Greater Osaka	18 814	551 (2.9)	18 930	1 649 (8.7)
Rest of the country	19 478	335 (1.7)	18 710	2 546 (13.6)
Total for Japon	83 205	4 272 (5.1)	78 089	11 001 (14.1)

Source: From METI, 2013 and its updated version from 2017 https://www.e-mansion.co.jp/; Real Estate Economic Institute, 2015, 2016a; N'Diaye, 2016.

7. Since a mansion includes apartments of different types and prices, an average price does not make sense other than as an order of magnitude – in order to identify its price positioning on the mansion market. The indicative price of a mansion was calculated simply as the average of the highest and the lowest apartment prices within it.

At the level of Greater Tokyo, it is in the 23 central districts that the proportion of smart mansions in the new production is the lowest (14%) in 2014 and 2015. The MEMS were clearly greater in number in the adjoining prefectures, in the neighbouring areas that form the capital's suburbs. In Saitama prefecture, the analysed sample, without being exhaustive, represents one quarter of the new mansions for the year 2015 (table 4).

Smart mansions have an average price positioning

The smart mansions for which we have the prices[7] are located in Greater Tokyo (63 buildings), and marginally in Greater Osaka (6) and Nagoya suburbs (6). Greater Tokyo also has the most extreme values of the sample, from

Table 3/ Region-wise distribution of smart mansions and new mansions in 2015

Zone	Percentage of smart mansions	Percentage of new mansions
Greater Tokyo	62	52
Greater Osaka	15	24
Rest for the country	24	24
Total for Japon	100*	100

* As the numbers have been rounded off to the first decimal and to the unit, the total does not amount to 100%.
Source: From METI, 2013 and its updated version from 2017 https://www.e-mansion.co.jp/; Real Estate Economic Institute, 2015, 2016a; N'Diaye, 2016.

Table 4/ Prefecture-wise distribution of smart mansions and new mansions in 2015 in Greater Tokyo

Prefecture	Number of smart mansions (% of the new mansion supply)	
	2014	2015
Tokyo 23-ku	974 (5)	2 542 (14)
Kanagawa-ken	965 (10)	1 594 (20)
Saitama-ken	594 (13)	1 043 (24)
Tokyo-to (hors 23-ku)	291 (7)	853 (16)
Chiba-ken	562 (11)	774 (19)
Total Greater Tokyo	3 386 (14)	6 806 (17)

Source: From Meti, 2013 and its updated version from 2017 https://www.e-mansion.co.jp/; Real Estate Economic Institute, 2015, 2016a; N'Diaye, 2016.

344,850 yen/m2 (2,639 euros/m2 on 31st December 2015) to 1,112,323 yen/m2 (8,515 euros/m2), a threefold difference. This reflects the disparity of the territories that are a part of it as illustrated by figure 1. Since there is no public data on the average price of the mansions at a smaller scale than that of a prefecture[8], it is at this scale that the prices were compared.

The average prices of the smart mansions were stable in 2014 and 2015 (table 5), except in the prefectures of Tokyo and Chiba for which the difference of price from one year to another reflects a very small sample size: Just 2 and 4 buildings for Tokyo in 2014 and 2015 respectively and 3 buildings for Chiba in 2015. This data has not been taken into account. Two conclusions can be drawn from the price analysis:

• In the capital's periphery, in Kanagawa and Saitama, the average prices of smart mansions are close to the mansion market averages for each prefecture, included in the lower margin of 90,000 yen/m2 (689 euros/m2)(table 5). As a consequence, the smart mansions here represent the mid-range segment of the market.

• In the 23 central sectors, on the other hand, the average price of the smart mansions is much lower than the average for new mansions: up to 227,000 yen/m2 (1,737 euros/m2) less in 2015. The smart mansions thus represent the bottom end of the market. It is not

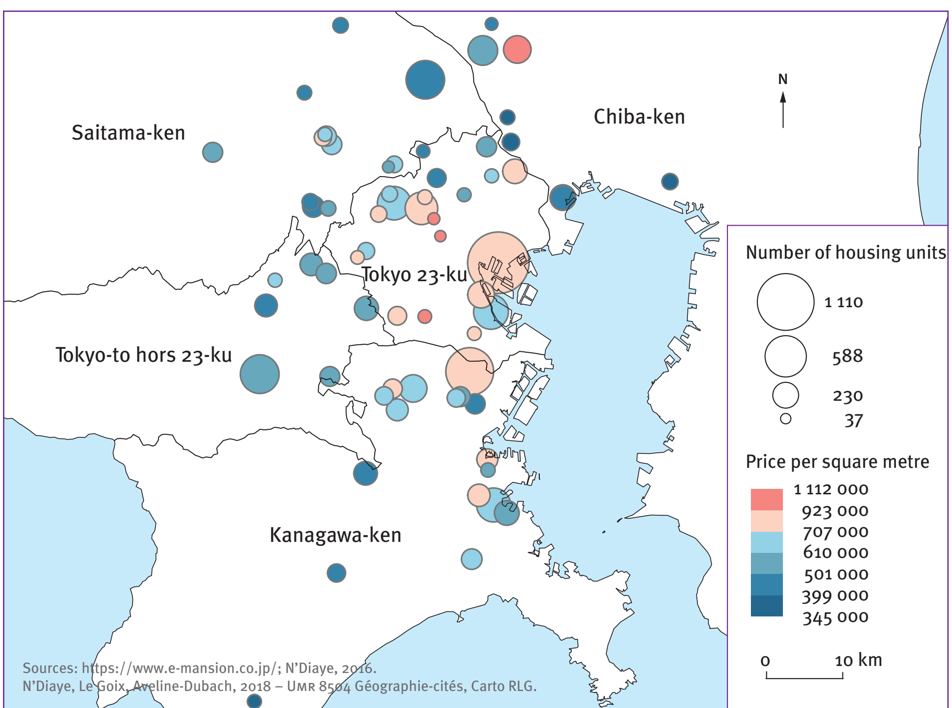

Fig. 1/ Un état du marché des *smart mansions* dans le Grand Tokyo en 2014 et 2015 : prix moyen et nombre d'appartements produits

8. The prefectures of Greater Tokyo and of Greater Osaka include territories with a heterogeneous profile, from rural to urban.

that they belong to a different typology than that of Kanagawa or Saitama but since high-end mansions account for a bigger share of the capital supply (Kubo, Yui, 2011, p. 14), the average price of the market is pushed up. As a result, if we take all the prefectures considered, Kanagawa, Saitama as well as the 23 districts, the average prices of the smart mansions correspond to the middle segment of the market.

Table 5/ Gap between the average prices of smart mansions and new mansions in Greater Tokyo in 2014 and 2015

Prefecture	Average price in 2014 (thousands of ¥/m2)		Average prices in 2015 (thousands of ¥/m2)	
	Smart mansions	Mansions	Smart mansions	Mansions
Tokyo 23-ku	764	873	760	987
Tokyo-to (excluding 23 ku	564	648	510	621
Kanagawa-ken	613	610	602	690
Saitama-ken	521	544	533	578
Chiba-ken	446	500	763	514
Greater Tokyo	603	711	653	779

Source: From METI, 2013 and its updated version from 2017 https://www.e-mansion.co.jp/; Real Estate Economic Institute, 2015, 2016a; N'Diaye, 2016.

Medium-sized buildings: A distinct phenomenon of the urban renaissance policies

The size is also a useful criterion for characterising the phenomenon of smart mansions. The surge in high-rise buildings in the big city centres of Japan is the consequence of relaxation in urban planning and construction rules authorised by the 2002 "urban renaissance" law (Sorensen et al., 2010). At the heart of Tokyo, they encouraged an influx of young, single men and women (Kubo, Yui, 2011). The large proportion of high-rise buildings among the smart mansions suggests a hypothetical link between these socio-spatial transformations and the adoption of smart city technologies by developers. In Greater Tokyo, in 2015, new mansions with more than twenty floors account for 14,738 apartments, that is, 36% of the entire production (Real Estate Economic Institute, 2016b). Yet, in the smart mansion sample, buildings with more than twenty floors account for only 8% of the total, which is five times less than the average. This under-representation indicates that smart mansions follow different patterns than those seen under the urban renaissance policies.

Smart mansions produced uniquely by the major developers

An analysis of the developers can be carried out using data obtained from the Real Estate Economic Institute (box 1). At the scale of Greater Tokyo, ten developers produced 53% of the new mansion apartments in 2014, and 51% in 2015. The production of smart mansions is even more concentrated than the rest of the mansions, since ten developers produced 73% of the smart mansions recorded in 2014 and 61% in 2015[9]. All these housing units were produced by 14 developers including 13 who were among the top twenty at the national level in terms of the number of apartments produced. The production of smart mansions is thus the prerogative of a few developers among some hundred that Greater Tokyo has in the mansion sector. Thus it is exclusively the major developers who took the initiative of installing MEMS in their mansions as part of logic of brands and brandization (definition of a new standard). This brand strategy is essential for understanding the adoption of MEMS and the positioning of smart mansions on the Japanese market.

9. Includes the apartments developed in joint ventures between various developers. In the absence of data, we divided equally the joint venture apartment units of the mansion among the partnering developers.

Table 6/ Brands and product segmentation of Mitsui Fudosan mansions

Brand	Park Homes	Park Mansion	Park Tower	Park Court	Park Luxe
Segment	Mid-range, standard product of the firm, with the highest presence	Mid-range, city center, targeting families	Mid-range, high-rise tower residence	Most luxurious range, city center	High-end, small hyper center, for singles or wealthy couples
Price (thousand of ¥/m2)	450–600	400–600	600–1 200	1 200–3 300	900–1 500

Source: https://www.mfr.co.jp/ 2017 and https://www.e-mansion.co.jp/ 2017; N'Diaye, 2016.

Table 7/ Brands and product segmentation of Nomura Real Estate mansions

Brand	Ohana	Proud
Segment	Low end, targeting families for remote suburbs, more than a fifteen-minute walk from a railway station	Upper mid-range, targeting families
Price (thousand of ¥/m2)	350–500	600–1 200

Source: https://www.proud-web.jp/ 2017 and https://www.e-mansion.co.jp/ 2017; N'Diaye, 2016.

Smart mansion brands: A mid-range segment

In such cases, the major developers subject new mansions to a marketing strategy of product segmentation. Each developer has one or several brands under which mansions are sold according to specific criteria. While Daikyo, historically the most important developer in the residential sector, has only one brand (Lions Mansion), other companies have a more segmented positioning.

Mitsui Fudosan Residential proposes five main brands of mansions (table 6) while Nomura Real Estate only presents two brands (table 7). Yet, the smart mansion samples from these two developers only have middle segment brands: Park HOMES and Park TOWER for Mitsui Fudosan Residential, and PROUD for Nomura Real Estate. The absence of high-end brands in the first and of the bottom end brand in the second confirms the results of our price analysis: the developers install MEMS in mansions positioned on the mid-range segment of the new mansion market.

Mansion Energy Management Systems (MEMS) as club property

The analysis of a significant sample of smart mansions revealed that localistaion and price positioning in Japan as well as Greater Tokyo are relatively uniform and close to the overall average for the entire set of mansions produced in 2014 and 2015. In other words, smart mansions are average mansions, which form a part of the regular production of the urban fabric, with the energy specifications of the real estate product essentially corresponding to the main developers' market positioning. Consequently, the purpose behind equipping this intermediate typology of mansion with MEMS remains to be explained. The following interpretation relies on the study of a residential complex of smart mansions with 1,500 apartments, located in the city of Funabashi, on the outskirts to the east of Tokyo in Chiba Prefecture. We visited it twice in April 2016, guided by a property management company official in charge of the complex management, whom we had interviewed beforehand. At the time of the second visit, we were able to attend a meeting between resident unit owners and a team of the property management company, which is affiliated to the developer. It seemed to us that the choice of equipping certain residences with MEMS corresponded to a strategy of service offer by this developer.

More precisely, MEMS service seems to be governed by a system of "club goods" (Buchanan, 1965), in other words, goods that can be shared by several users, but whose usage is reserved to a specific social group. The MEMS service is shared by all the households of a residence, but it is exclusive as it is there only for the benefit of the residents of the equipped building. It is the legal organisation of the condominium complex which allows its functioning as a club (Glasze, 2005). As long as the system *ikkatsu juden*, which regulates the electricity aggregation business, is dependent on the legal form of condominium ownership, the MEMS can function only at this group level: the contract is drawn up collectively by and for all the residents.

A "clubbisation" launched by the developers

The collective nature of the MEMS services is not only a legal fact. The community aspect of MEMS was already at the core of the METI discourse in its experiments with the smart communities (Granier, 2016). The MEMS are configured to encourage positive competition between the inhabitants for ensuring collective energy efficiency. Everyone can consult his or her ranking in the classification of energy consumption in the resident community. At Proud Funabashi, the information screens installed in the halls of the five buildings of the complex indicate collective energy performances of each of these. The consumption is to be managed jointly by the owners' club and is expected to be subject to the community's commitment and sensitization.

For METI, the collective nature of the MEMS corresponds to an energy issue but for the real estate company, it is part of a larger "clubbisation" phenomenon (Charmes, 2009) that we were able to observe at Proud Funabashi.

Nomura Real Estate, the complex's developer and the then property manager, integrated several goods and services available to the unit owners: school bus, electric car on rent, guest room, reception room, club house, gardening club and even vegetal curtain fabrication workshops for the balconies. The real estate group, which took the lead in proposing these services, plays a true role of community facilitator. During the meeting with the property manager, the interviewed residents declared their satisfaction at finding in an apartment complex a community similar to the one they had in the traditional neighbourhoods with individual houses. The property manager encourages the constitution of a club so as to promote attachment between the owners and their residence complex and ultimately with the real estate group. Even if Proud Funabashi proposes a wide range of services, this "clubbisation" of mid-range mansions is not just the prerogative of Nomura Real Estate. It can be observed among all the major developers.

MEMS, distinctive features in a stratified market

In the context of a segmented and stratified market, providing innovative services in the form of "club goods", such as MEMS at Proud Funabashi, makes it possible to justify the existence of a new mansion supply on the mid-range segment. The development of such a market cannot be taken for granted as the bursting of the bubble in 1989 made old mansions, which were beyond the reach of certain households, affordable (Forrest et al., 2003; Hirayama, 2010), especially as new construction in a context of population loss leads to a decline in the market prices for existing housing by accelerating their obsolescence (Hirayama, 2005). In Greater Tokyo in 2015, the average price of an old mansion was 598,950 yen/m2 (4,570 euros/ m2) for an average age of twenty years as against 710,875 yen/ m2 (5,424 euros/ m2) for a new mansion (Mitsui Fudosan, 2016). The price difference constitutes a major advantage for the old mansions as compared to the new mansions.

The development of this service offer has to be understood as a part of the brand strategies defined by major mansion developers in Japan, allowing them to maintain new apartment supply. It is aimed at forming a distinct real estate product, not only in the face of new competition but also in the face of the existing building stock. This distinction is based on the brand, which identifies a club-based services package. Nomura Real Estate has thus created, in partnership with its aggregator Family Net Japan, its own brand of MEMS, for its mid-range Proud buildings. It is this dynamic of brand-based distinction and service offer that determined the modalities of the adoption of a smart city initiative such as MEMS in Japanese real estate.

Conclusion

This article aimed to study the modalities according to which a technology promoted under a smart city initiative, the MEMS, permeated Japanese territory through residential real estate production. It shed light on the strategic reasons behind the adoption of this technology by Japanese developers. As the analysis focused on the supply side, the social response to the introduction of MEMS in the developers' real estate schemes was not covered here. This work could thus be extended with surveys among the smart mansion residents to understand daily practices related to the MEMS in order to observe the potential gap between the expected and actual effects of the strategies implemented by the real estate companies.

The analysis of a sample of 60% of the new mansions equipped with MEMS identified in 2013 makes it possible to show the extent of the spread of this product (14% of the new national supply in 2015), which corresponds to a mid-range positioning on the market and which remains the prerogative of the major developers. The strategic reasons which pushed the developers to install MEMS almost exclusively in this type of mansions, with the exclusion of bottom-end and high-end ranges, remained to be explored. The study of the Proud Funabashi project revealed that the MEMS is part of a larger offering of goods and services, exclusively for the use of the condominium unit owners, who are thought to form a resident club. This "clubbisation", which was designed as part of the brand strategies, is an effort by the Japanese developers to maintain the distinctive attractiveness of their mid-range mansions among home buyers, given the competitive new supply but especially, given the existing mansion stock, which is relatively recent and more affordable. The modalities according to which a technology labelled as smart city was introduced into mansions of average location and mid-range positioning were determined by issues specific to the Japanese housing market. This allows us to highlight the central role that real estate companies can play alongside state bodies and technological firms in the implementation of smart city initiatives.

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