



## Article

# Aging-in-Place and Home Modifications for Urban Regeneration

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**Abstract:** The rapidly growing aging population is a global phenomenon imposing societal challenges on many cities. ‘Aging-in-place’ as a popular concept accommodates both the elderly desire to age in a familiar environment and adaptive old home modifications for aging. However, this concept has not been explored in-depth systematically in the urban regeneration context. This article explores a form of aging-in-place that is suitable for large and dense residential urban areas using the case of Hong Kong as an example of a *laissez-faire* fast-growing dense city, with a focus on home modifications. As in many other Asian cities, with a low tax rate and without a pension scheme, the elderly in Hong Kong are concerned more with the basic needs of health care and rely on public housing. Housing affordability is the primary concern. The government is expected to take the lead in aging-in-place in urban regeneration, in particular, to provide necessary home modifications for the elderly who live in public housing with primary health care provisions. A survey of 294 respondents revealed that housing expenditures, housing size, income level, and residential location are indicators of whether home modifications or health care in cities such as Hong Kong can be afforded by the locals, under tight budget constraints.

**Keywords:** aging-in-place; home modification; health care; Hong Kong housing



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## 1. Introduction

Global attention is paid to climate change, the extreme weather conditions across the world, their impacts on people in the urban environment, and sustainability. In Hong Kong, urban regeneration gives the outlook and opportunity for the city to rethink and redevelop itself into a more sustainable environment. Now, is an important moment, to seek a holistic vision of how the city can be redeveloped sustainably. Yet, it is not only the buildings, infrastructure, and urban areas that are aging but also the citizens. Hence, the research focus on ‘*double aging*’ in major dense cities. How can housing be renewed sustainably so that people can age-in-place?

Previous studies have already pointed out that the relationship between people and the environment is especially important when people are in their senior years [1,2]. As the local population ages, housing features should be altered to follow the life course of individuals and satisfy their safety and comfort desires [3,4]. Although along their life course, older adults may have increasing constraints due to physical and functional limitations, the majority of seniors still choose to maximize their independence in their own residences, whether privately-owned or publicly-funded [5,6]. The ecological theory of aging elaborates on the interactions between levels of competence (e.g., functional limitations) and settings with different levels of environmental stress (e.g., barriers at home), leading to behavioral adaptation (or person-environment fit) and comfort versus maladaptation (or person-environment misfit) and negative effects [7].

The concept of the home goes beyond the purpose of mere shelter. It also brings an embedded identity and is inculcated with personal meaning, taking account of the feelings of belonging and community [8–11]. ‘Home’, therefore, integrates physical, social, individual, collective, and emotional dimensions into one commodity [10]. The meaning of home, along the course of life—in particular, at the senior phase—can be considered sustainable for human well-being in a broader sense [12–14]. To avoid the deterioration caused by the functional demand for environmental support, older adults would benefit to grow old in a place that allows them to take part in physical activities at their various levels of health in later life [15,16]. An important aspect not to be ignored is that the environmental context in which daily living and daily tasks take place can be crucial to the well-being of older adults [17]. Inappropriately demanding environments with limited accessibility may constrain the freedom and independence of older adults to grow old at home and in a familiar local community [18].

In many densely-populated Asian cities with a free economy, such as Hong Kong, Seoul, and Singapore, the basic need for housing is provided by public housing. Over half of the population in Hong Kong finds their housing comfort and stability of life through public housing, and many of them stay in public housing for their whole life [19]. However, the public housing provisions are to meet the general public demand, and very little public housing is purposely catered to older adults. Those who live in this public housing and become an advanced age may not have the extravagant wish to move into a new home, but have the aspiration to modify their old flats to meet their housing needs and changing demands for health care for aging-in-place.

This article studies empirically the changing needs of the living environment within the concept of aging-in-place, particularly in old urban districts with the case data obtained from Hong Kong. Based on the questionnaire survey results obtained from 294 survey respondents in eight old Hong Kong districts (Appendix A), it aims to: (1) understand the needs and constraints for elderly housing and their changing demands for health care to support the concept of aging-in-place; (2) investigate the extent that the elderly perceive home modifications or health care as the most important thing to help them stay in their original homes for aging-in-place; and (3) establish an estimated model to explain the choice between spending money on home modifications or health care for the elderly in Hong Kong. The study will deploy both qualitative and quantitative research methods. The key findings derived from qualitative and quantitative analyses are discussed, with policy and practical implications. The empirical results shed light on the understanding of aging-in-place situations in densely-populated Asian cities with a free economy, such as Hong Kong.

## 2. Literature Review

### 2.1. Population Aging in the Hong Kong Context

Population aging has become one of the most pressing societal issues in many developed economies. Hong Kong is one of the international metropolitans with a *laissez-faire* economy experiencing the same challenge—in particular, with its dense population and old urban context. Thanks to hygiene, nutritious food and water, adequate exercise, and better medical care, Hong Kong ranks high worldwide in the records for the longer lifespan of an average person [19]. Official statistics suggest that, in Hong Kong, the average lifespan is 81.2 years for males and even 86.7 years for females, as of 2014. The Census and Statistics Department in Hong Kong forecasted that the number of elderly aged 65 or above will rise from 1 million in 2013 to 2.6 million in 2041, while the median age of the population will increase from 43.3 to 51.8 during the same period [20]. In other words, one in three persons will be elderly by 2041, while one in eight persons will be aged 80 or above. This new generation of old people demands a built environment and home conditions with less accessibility constraints but higher independence and civic participation to grow old at home in a familiar local community [11,18].

## 2.2. Human Desire for Aging-in-Place and Rationale

There is no doubt that individuals desire to grow old in their familiar place called home. Housing for most individuals, or better yet, call it home, is more than just the physical space. The home and neighborhood, where the individual has spent decades of their time and activities, form the core part of one's identity and living history, which evokes a sense of belonging [21]. The place where people live and create their memories brings the attachment of emotional, spiritual, and cultural identities, which are especially important aspects for older adults to feel pride. It is not hard to imagine that, for many older adults, a home is symbolized largely by their independence and human dignity [22,23]. Therefore, it is quite reasonable to understand why older adults would like to keep maintaining their homes and communities as long as they can.

Previous studies also stressed the desire of individuals in their later life to postpone leaving their homes and losing their independence for institutional care, even though their health conditions on the physical and cognitive competence levels show otherwise [24]. Human beings have the capacity to adapt to a new living environment, even if it means overcoming new barriers and obstacles by altering their needs with suppressed desires for comfort and life satisfaction [25]. When it comes to aging, human beings may face environmental pressure from their forever-familiar homes, yet do not feel safe and comfortable due to their changing needs. From a behavioral perspective, human cognition and emotion attached to a certain space can involve several facets of meaning for an individual, which will later stay with the same individual when he or she grows older and relate to their identity. People feel a sense of belonging to such a place filled with memory and personal history [26]. These desires and rationales for aging-in-place will be considered in this study to see how they affect the new demand for housing conditions.

## 2.3. Housing Preference and Physical Environment for Aging-in-Place

Previous studies also demonstrated that housing criteria will change when people grow old. In general, older adults prefer living in a safe, barrier-free home, especially if it is close to public facilities and a natural environment. Hence, they may have to decide between renovating their apartments and moving to a new apartment to have a tailor-made living environment for them. Safran-Norton [13] investigated physical building features and potential home modifications to achieve aging-in-place in the transition of elderly household homes. Utilizing data from the published sources of the government for the Health and Retirement Survey 1998 and 2000, Safran-Norton's study performed univariate, bivariate, and multivariate analyses to test what factors influence older adults to either stay in their current homes or drive them to move. The empirical results suggest that the absence of a lift (elevator) has a significant relation to predicting the housing transition of multi-family residences with couples, and interior modifications are a strong indication for single households who prefer remaining to reside in the same place at home.

The Heuristic Framework on Domains of Meaning of Home in the Old Age model [9] indicated there are several dimensions to the meaning of home in later life. It has a physical dimension, which relates to the physical components in terms of housing, community, etc. Another dimension involves the social connection aspect of the home, which stresses the home as a place of connection and socialization. Then, the third dimension comes to the individual level, where behavioral, cognitive, and emotional components are the center of focus. This heuristic framework takes into consideration the housing experience and preferences of the elderly. It can also inform housing service providers and stakeholders about how to address the changing needs regarding the housing modification of older adults. The decision concerning older adults aging-in-place is associated with a variety of influencing factors [9], for example, individual and social demographical characteristics, such as health, income, neighborhood social cohesion, and environmental considerations such as open space. To safeguard a successful aging-in-place outcome, the integrated process included maintaining health and vitality and accessibility to services necessary for daily life. Older adults' recreational and utilitarian physical activities are proven to have a

positive impact on their health, which, in turn, help them enjoy more independent years at home.

To understand more about the seniors' preferences for housing in their later lives, Severinsen et al. [27] interviewed 143 elderly persons through face-to-face conversations in New Zealand. Their analysis demonstrated that a number of elderly would prefer to age in a place where services are accessible. They would agree to move their living place according to their physical condition, meaning that, as their health condition declined, it was a clear choice to move. Based on the information gathered through questionnaires and fieldwork, Bamzar [28] assessed the quality of the indoor living environment of rental housing for seniors aged 65+ in Hässelgården, Stockholm. Regarding the principles of universal design (UD), the living room, which has been found to attain the highest UD score relative to the kitchen and bedroom, is the place where the elderly spend most of their time when they are at home. Based on a survey of 256 potential homebuyers of elderly housing in South Korea, Kim et al. [29] suggested that most of the respondents preferred living in the vicinity of Seoul. The availability of medical care and community services affects the choice of location of their residence.

However, other older people would stress the importance of aging-in-place, even though it means the function of their dwellings does not suit their needs, nor do they wish for home modifications. This group of older adults has a strong belief that their home holds the secret symbol of both their value and identity, as well as their relationships with those living and dead. The loss of their social relationships can damage their identity and housing as part of situated lifelong narratives. For this group, their home situation and condition provide the backdrop to alternative narrative identities that keep them in their existing home, even though their homes are not suitable for them. This study will refer to several dimensions of the meaning of home in later life and the influencing factors associated with aging-in-place to guide the data collection process.

#### *2.4. Financial Constraints for Housing Modifications*

Sierminska and Takhtamanova [30] explored the interlocked relationship between household spending and income across different age groups by looking at the elasticity of spending from different income groups. Their study utilized a new source of harmonized microdata on wealth for Canada, Finland, Italy, Germany, and the US. It indicated that there is a positive relationship between housing wealth and financial wealth in Finland, Italy, Germany, and the US. It also applies to Canada for specific age groups. Their study also found that consumption responsiveness to housing wealth is statistically lower for the younger age group. Moreover, the existence of between-country differences has been confirmed. It is even more justified for this study to find out the differences existing in Asian cities such as Hong Kong.

Besides physical health, affordability is one of the essential factors that contribute to aging-in-place. Bian [31] studied how the financial impact can leverage the senior householders' decisions in downsizing their homes using the measurement of loan-to-value (LTV) ratios. The higher the LTV ratios are, the greater chance the seniors will choose to move into properties with less spacious living environments. It could mean the choice of moving from single-family properties into multifamily properties, which are cheaper and more affordable home options. On average, a 10 percent rise in the LTV ratio is associated with a 7.7–9.7% increase in the probability of downsizing their homes. The essential factor of affordability is one of the key issues to be investigated in this study.

The above review first focused on Hong Kong as a case study to identify the latest situation in Hong Kong concerning the provision of elderly housing. The review of the existing literature also provided the background of the study, the preliminary conceptual framework with possible factors to be considered for aging-in-place, and identified the research questions to help the questionnaire design for empirical surveys. The framework for this study assumes that elderly people have the aspiration to modify their old flats to meet their housing needs and changing demands for health care for aging-in-place. It is

hypothesized that home modifications are a function of gender, age, housing expenditure, housing size, income, and the district in which they currently live.

### 3. Methodology

Following the methodology of modeling a dichotomous dependent variable, this study utilizes a logit model to explain whether the elderly prefer to have home modifications or health care, given tight budget constraints. The statistical technique is an estimation that can be adopted to examine the relative strength and significance of the explanatory variables in predicting decision outcomes. In this case, the outcome involves only two discrete choices, 1 (home modification) or 0 (health care). Suppose that the representation of a respondent's preference for home modification takes on the following form:

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-(\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_n x_n)}} \quad (1)$$

Let  $Z_i$  be  $\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_n x_n$ ; in which case, it would have

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-Z_i}} \quad (2)$$

Equation (2) shows that, when  $Z_i$  reaches near to infinity,  $e^{-\infty}$  and  $P_i$  will reach near to 0 and 1, respectively. When  $Z_i$  reaches near to negative infinity,  $e^{-\infty}$  and  $P_i$  will reach near to infinity and 0, respectively. Therefore,  $P_i$  lies between 0 and 1, since  $Z_i$  lies between  $-\infty$  and  $\infty$ . If it assumes that  $P_i$  refers to a respondent who has a preference for home modification, then  $1 - P_i$  refers to a respondent who has a preference for health care.

$$1 - P_i = E(Y = 0|X_i) = \frac{1}{1 + e^{Z_i}} \quad (3)$$

Dividing Equation (2) by Equation (3) gives Equation (4):

$$\frac{P_i}{1 - P_i} = \frac{1/1 + e^{-Z_i}}{1/1 + e^{Z_i}} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \quad (4)$$

If Equation (4) is put into natural logarithms, Equation (5) will be as follows:

$$L_i = \ln_e \left( \frac{P_i}{1 - P_i} \right) = Z_i = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_n x_n \quad (5)$$

$L_i$  represents the odds ratio in natural logarithms, which is the ratio of the natural logarithms of the two probabilities.  $L_i$  is a linear equation in  $X$  and a constant. If  $L_i$  increases, the probability of a respondent's preference for home modification will also increase. In this paper,  $L_i$  is modeled as a function of a respondent's gender, age, housing expenditure, housing size, income, and residential location. The estimated equation takes the following form:

$$L_i = \ln_e \left( \frac{P_i}{1 - P_i} \right) = \alpha_0 + \alpha_1 \text{MALE} + \alpha_2 \text{AGE}_{71-80} + \alpha_3 \ln(\text{HE}) + \alpha_4 \text{SIZE}_{301-450} + \alpha_5 \text{INCOME}_{25000+} + \alpha_6 \text{SSP} + \epsilon_i \quad (6)$$

where

$\ln_e$  is the natural logarithm;

$P_i$  is the probability of a respondent who has a preference for home modification ( $0 \leq P_i \leq 1$ );

$\text{MALE}$  is a dummy variable that takes the value of 1 when the respondent is a male, 0 otherwise.

$\text{AGE}_{71-80}$  is a dummy variable that takes the value of 1 when the respondent is aged between 71 and 80, 0 otherwise.

$\text{HE}$  represents the monthly housing expenditure spent by a respondent;



$SIZE_{301-450}$  is a dummy variable that takes the value of 1 when the respondent lives in a public sector housing of 301–450 square feet, 0 otherwise.

$INCOME_{25000+}$  is a dummy variable that takes the value of 1 when the respondent has a monthly household income of more than HK\$25,000, 0 otherwise.

$SSP$  is a dummy variable that takes the value of 1 when a respondent lives in Shum Shui Po District, 0 otherwise.

$\alpha_0$  is the constant term;  $\alpha_1, \alpha_2, \dots, \alpha_6$  are the estimated coefficients associated with the explanatory variables; and  $\epsilon_i$  is the error term.

#### Stratified Random Sampling

Using the case of Hong Kong for data collection and analysis, the questionnaire mainly focuses on the respondents' demographic characteristics and housing conditions. The target respondents are people aged 61 years old and above who live in public rental housing units subsidized by the Hong Kong SAR Government. An on-street questionnaire survey was conducted among local pedestrians and residents from the following districts: Central, Fan Ling, Hung Hom, Kwun Tong, Sham Shui Po, Sha Tin, Sheung Shui, and West Kowloon (see Table 1). Table 2 shows the descriptive statistics of the data used in this study.

Figure 1 shows different districts of Hong Kong. Three specific districts, Sha Tin, Fan Ling, and Sheung Shui, are chosen because these three areas are classified as new development areas (NDA) by the Planning Department. Sha Tin, as one of the new towns built over 40 years ago, is the most densely-populated administrative district in Hong Kong, comprising over 60% of the residents living in subsidized homes. In addition, about 29,000 people reside in indigenous villages. Fan Ling and Sheung Shui belong to the North District, which is an area in the New Territories East of Hong Kong. Fan Ling North is one of three new development areas currently being planned for the North District in parallel with Ta Kwu Ling and Kwu Tung North. Sheung Shui Town, as a part of Sheung Shui, now is the Fan Ling-Sheung Shui New Town in the North District. In Fan Ling and Sheung Shui, the population size has been increasing continuously.



**Figure 1.** Map of Hong Kong (Source: [19]).

The other five areas, namely West Kowloon, Kwun Tong, Sham Shui Po, Central, and Hung Hom, are chosen because all these areas are representative districts of Hong Kong. The West Kowloon Cultural District claims to be one of the largest cultural, art, and open-space projects in the world. It creates an open space in Hong Kong to showcase

the local arts and artists locally, and internationally to interact and collaborate. Having twenty-three hectares of public open space with two kilometers of the harbor-front promenade, the cultural gallery and facilities offer world exhibitions, performances, arts, and cultural events.

Kwun Tong is one of the first developed urban neighborhoods and the most densely-populated district, as well as a new town in Hong Kong. Recently, it has been transformed from an industrialized center to a commercial center. Kwun Tong has the largest percentage of the aging proportion in the population among 18 districts in Hong Kong [32,33]. Kwun Tong Town Centre, as a pilot for a major urban renewal project, is now being redeveloped into a commercial and business center [33]. Additionally, some urban renewal projects, including the redevelopment of old housing estates and the construction of major parks, have recently been completed.

Sham Shui Po is composed of the population who have an average lower household income and an average higher proportion of the elderly population. Moreover, many new arrivals choose to reside temporarily in the district. Public and private housings fairly share the same percentage of occupancy in this district. It is an old but busy shopping and lower-income residential district, with a population density of about 36,495 persons per km<sup>2</sup>. There are 14 public housing estates, including the Shek Kip Mei Estate, the first Hong Kong public rental housing estate built in 1954. Many standalone private residential blocks were built during the 1950s and 1960s. Sham Shui Po is, therefore, considered to be the poorest district [19], with 13 small-scale urban renewal projects implemented [34].

**Table 1.** Profile of the selected districts.

Major Elderly Precincts in HK	Population ('000 Persons) (2013)	Percentage of Population above 65 Years Old (2013)	Average Household Monthly Income (HKD \$) <sup>1</sup> (2013)	Percentage of Elderly with Secondary Education or above (2013)	Number of Residential Care Homes (2013)	Number of Park/Garden (2012)	Existing and Planned Provision of Open Space (2008)	Gross Area per Capita for Elderly (m <sup>2</sup> /Person) (2013)
Sha Tin	643	12.6%	24,900	36.6	40	86	240.0	29.7
Fan Ling and Sheung Shui (North District)	303.2	11.0%	21,400	26.4	58	137	119.9	35.9
Yau Tsim Mong (West Kowloon)	311.9	13.8%	22,000	45.6	56	97	105.4	24.5
Sham Shui Po	382.1	16.3%	17,900	33.6	79	58	119.2	19.2
Central and Western	250.1	13.1%	34,300	51.8	47	116	57.1	17.5
Hung Hom (Kowloon City)	376.9	15.0%	25,100	46.4	94	86	164.5	29.1
Kwun Tong	638.9	16.8%	17,500	30.9	53	109	231.6	21.5

Sources: by the authors and Chan et al. [35]. <sup>1</sup> Under the linked exchange system, USD \$1 is equivalent to HKD \$7.8.

Being a financial, commercial, legal, and political center of Hong Kong, Central has many historical monuments and skyscrapers, best known as the CBD of Hong Kong. Some of the commercial buildings there are ranked among the most expensive ones in the world. In recent years, a number of urban redevelopment projects have been implemented to increase the quality of life and living standards of the local residents. The intention has always been clear that it is very important to preserve the cultural heritage of the unique mixture of Chinese and Western cultures kept in this district. Over 90% of the population lives in private residential buildings, ranging from old tenements to luxury homes in the Mid-levels and on the Peak.

**Table 2.** Descriptive statistics.

	IMPROVEMENT	MALE	AGE <sub>71–80</sub>	ln(HE)	SIZE <sub>301–450</sub>	INCOME <sub>25000+</sub>	SSP
Mean	0.89116	0.46939	0.24490	8.02325	0.07143	0.29592	0.19048
Medium	1	0	0	8.16052	0	0	0
Mode	1	0	0	7.31322	0	0	0
Minimum	0	0	0	7.17012	0	0	0
Maximum	1	1	1	10.59663	1	1	1
Skew	−2.52480	0.12331	1.19254	0.53588	3.34529	0.89880	1.58458
N	294	294	294	294	294	294	294

Hung Hom is the administrative area of the Kowloon City District in Kowloon. There are several luxurious housing estates and a lot of old residential blocks, with some industrial buildings located in the north. There are five public housing estates located within the Kowloon City District.

Once the questionnaire had been designed and confirmed, our next step was to choose when the survey should be conducted. The interviewers were recruited and trained to guarantee and safeguard that all surveys were conducted similarly and effectively. Our target respondents were people who are aged 60 and above. Hence, we adopted stratified random sampling to partition them into smaller subgroups (such as aged 61–70, aged 71–80, and aged 81 and above), each of which is homogeneous with respect to some characteristic of interest. During the interviews with the respondents, some difficulties were identified and tackled through the thoughtful and excellent design of the interview questions. Generally, respondents, mainly the elderly, may give vague answers when the questionnaire was too long to be completed. On the one hand, the questions were set to be precise and kept short. On the other hand, the answers were set in a multiple-choice format so that respondents could choose the answers quickly to save completion time. Another issue was that some respondents were not willing to reveal their true preferences for some reason. They might have been afraid of being penalized for suggesting their own opinions. Hence, while conducting the surveys, the respondents were fully aware that the purpose of collecting their opinions was purely for academic purposes and that the questionnaire respondents were kept anonymous.

After collecting and formatting the data, a logit model was used to identify and estimate the relationships between demographic factors and the preference for home modification by the elderly in Hong Kong. This estimation technique has been commonly used in many fields, such as social science, biology, economics, and political science. It involves data collection, organization, and interpretation, which are commonly adopted in conducting surveys and experiments. The discrete choice model is one statistical approach that involves modeling and estimating the relationships between independent variables and a dichotomous dependent variable (1,0). To estimate the home modification model, the logit model was chosen as a straightforward and appropriate methodology that could satisfy our needs.

#### 4. Results

Table 3 presents what people perceive as the most significant improvement in terms of housing conditions in their senior life. The highest proportion of respondents considers home modification as the most crucial issue at 89.08%, followed by health care at 10.92%. Though, the results with a clear need for housing are expected, because public housing is in dire shortage for the whole population in Hong Kong, with the current units usually small and not well-ventilated. Currently, apart from the very limited amount of housing specially designed for elderly people, most of the elderly are living in ordinary housing units in crowded environments. People, mainly the elderly, are very fearful of falling. If an elderly person is injured and loses his/her mobility and independence, it means he will leave his home and will have to move into an elderly care center for special care. The study



findings show that elderly people put extreme emphasis on home modification followed by health care when compared to other improvement needs, which score zero importance.

**Table 3.** Most important improvement in the living environment of the elderly.

Home Modification	Health Care	Add-On Facilities and Services	Public Activity Area	Unspecified
261 (89.08%)	32 (10.92%)	0 (0%)	0 (0%)	0 (0%)

Add-on facilities and services are also housing characteristics. In the respondents' opinion, this category is not favored by the elderly. The reason for this is probably due to the group of people who live in such rented public housing belonging to the lower social class, who mainly consider only their basic needs, such as better ventilation, a brighter environment, and bigger housing size. As Hong Kong has its low tax-rate and low welfare systems, coupled with the higher living costs and high housing expenses, the local elderly population is happy to be able to live in their public rental housing and enjoy the low cost of rent, without additional expectations on governments for extra housing welfare.

Turning to the empirical results, Table 4 presents a logit model of home modification by the elderly in Hong Kong. This preference for home modification is hypothesized as a function of gender, age, housing expenditure, housing size, income, and the district that they currently live in. Our analysis concentrated on Model 1 only, since it is the most preferred one, as suggested by the Akaike Information Criterion (AIC). The McFadden  $R^2$  is estimated to be 0.11417, which seems to be very low. However, it is used when the outcome variable is a discrete choice rather than a continuous variable. In this case, such a  $R^2$  cannot be applied as a measure of goodness of fit. Rather, a commonly used metric to evaluate a logit or probit model is the number of correct predictions as a percent of total outcomes. Model 1 has a correct prediction of 74.16% (219 out of 294 observations) of the total outcomes.

**Table 4.** Logistic regression.

	Model 1	Model 2	Model 3	Model 4	Model 5
$\alpha_0$	−2.91827 (−1.11656)	−1.39105 (−0.56753)	−3.060815 (−1.17800)	−0.66440 (−0.29349)	−4.29755 *** (−1.71844)
MALE	0.69942 −1.6286		0.748908 *** −1.77984	0.54465 −1.39417	0.61676 −1.49363
	−0.49862 (−1.14171)	−0.33201 (−0.78926)	−0.687441 (−1.63463)	−0.33628 (−0.80690)	−0.45452 (−1.05702)
$\ln(HE)$	0.64754 *** −1.92835	0.47582 −1.5283	0.694675 ** −2.077766	0.32588 −1.13947	0.78173 ** −2.40477
SIZE <sub>301–450</sub>	0.98914 *** −1.89434	0.77936 −1.61237		0.72836 −1.53617	1.02704 ** −1.99172
INCOME <sub>25000+</sub>	−2.54088 * (−3.41181)	−1.94800 * (−2.85858)	−2.46784 * (−3.37514)		−2.31124 * (−3.18524)
SSP	−1.02043 ** (−2.36826)	−1.01744 ** (−2.40854)	−0.99496 ** (−2.34011)	−0.78448 *** (−1.92593)	
McFadden $R^2$	0.11417	0.07801	0.097962	0.05799	0.086
Akaike Information Criterion	0.6698	0.69965	0.67915	0.71547	0.693933
LR Statistic	23.5751	16.44755	20.749853	12.56233	18.1331
Prob (LR Statistic)	0.00063	0.00568	0.0009	0.02784	0.00278
Log Likelihood	−91.46033	−97.19787	−95.53304	−102.0352	−96.35509
Obs	294	294	294	294	294

Notes: The figures in the parentheses are the z-statistics; \* indicates statistically significant at the 1 percent confidence level; \*\* indicates statistically significant at the 5 percent confidence level; \*\*\* indicates statistically significant at the 10 percent confidence level.

Our logit model arrived at the following key findings:

First, gender is not an indicator of the decision of choosing either home modification or health care. Generally speaking, a male respondent has no preference for home modification over health care when compared to a female, as suggested by its insignificance at the conventional confidence levels. This finding is consistent with Bamzar [28] that male and female elderly are equally concerned about the home modification to live in their current residences. In Hong Kong, although the size of rental housing cannot be altered, some measures can be taken to promote home safety for the elderly. As pointed out by Bamzar [28], cooking stoves should have exhaust hoods and alarms (or automatic shut-off systems), while grab bars should be installed on the wall by the WC.

Second, age is also not a factor in making a decision. The probability of choosing home modification or health care by the elderly aged between 71 and 80 is not higher or lower than those of the elderly aged between 61 and 70 or those of the elderly aged at least 81.

Third, housing expenditure helps to indicate the choice of either home modification or health care. This independent variable is statistically significant at a 10 percent confidence level, suggesting that the elderly who spend more on accommodation tend to prefer home modifications to health care.

Fourth, housing size helps to indicate the choice of either home modification or health care. This independent variable is statistically significant at a 10 percent confidence level, indicating that the elderly who live in an apartment between 301 and 450 square feet tend to have a preference for home modification over health care when compared to the elderly living in other housing sizes. If the rental unit is very small, there is little room for home modification.

Fifth, income helps to indicate the decision of choosing either home modification or health care. This independent variable is statistically significant at a 1 percent confidence level. This implies that the elderly within the  $\geq$ HKD \$25,000 monthly income group tend to have a preference for health care when compared to the elderly falling within less economically affluent groups. The elderly living in the SSP district tend to have a preference for health care when compared to the elderly living in other districts, as suggested by its significance at the 5 percent confidence level. From the profile data of SSP, one can see that SSP represents a district with low household income and is less privileged in many aspects, such as public open space and education level.

## 5. Discussion

The elderly people in Asian cities with housing shortages such as Hong Kong put extreme emphasis on the importance of home modification. In contrast to the local elderly in Hong Kong, the elderly in more affluent Western countries are eager to modify their kitchens and bathrooms to prevent accidents. For example, most Western countries have a higher welfare system and higher taxation for individuals, and comfortable pensions for the elderly. In such a secure welfare system, the elderly in developed Western countries can afford to spend more money on modifying their living environments to suit their aging needs, as long as they would still feel safe living in their own home. Under different welfare systems and institutional arrangements, the aging-in-place concept can be fundamentally different in terms of expectations and preferences for home modifications and affordability for the elderly in Hong Kong and other parts of the world. This rationale also applies to the public activity area.

The existing literature suggests that most elderly prefer growing old in their familiar communities and homes. In this paper, the preference for home modification may reflect that the elderly see their homes as the core part of their identity, and the link between the elderly and their homes evoke a sense of belonging. Our results indirectly concur with the discussions of belonging suggested by previous studies, such as [8,15,24].

Improvement in medical and health care is important, but relatively less favored by the respondents when compared to housing modification. This may be attributed to the fact that Hong Kong has provided excellent public medical services to its citizens. The

Hospital Authority (HA) is an independent body that provides medical treatment and rehabilitation services to patients through hospitals, specialist clinics, and outreach services. The bed–population ratio in Hong Kong was about 5.2 beds per thousand population as of 2015. This figure was relatively high when compared to those of Britain at 2.8 in 2013, the United States at 2.9 in 2012, Japan at 13.3 in 2013, Korea at 11.0 in 2013, Malaysia at 1.9 in 2013, and Singapore at 3.2 in 2014 [36].

The picture painted by these results has been primarily attributed to the low taxation and rather low welfare system imposed in Hong Kong. Overall, by the end of 2000, other than civil servants, the majority of local residents did not hold pension funds. For example, university academic staff employed before July 1997 still can enjoy their pension, except those whose contracts started after 1997. After the end of 2000, with a mandatory provident fund effective, the Mandatory Provident Fund (MPF) accounts were established to collect 5% of the salary income with a cap of HKD \$1000 from all employees in Hong Kong on a monthly basis. The same requirement was stipulated for the employers to contribute the same amount, which would together contribute to the pension fund for their senior life after retirement. The MPF funds are administered by commercial banks and regulated by the Hong Kong Mandatory Provident Fund Schemes Authority (MPFA, 2018). The most recent cap was raised to HKD \$1500 for both employees and employers. Noticeably, the local MPF scheme is a rather relatively new concept, and those elderly who retired earlier than the effectiveness of the MPF scheme solely rely on their savings in the past.

The situation concomitantly is that Hong Kong does not have a central health insurance scheme. For Hong Kong residents, the charge for attendance at the Accident and Emergency Department is HKD \$100 only. Local residents are charged HKD \$50 for the admission fee for staying in the general wards of public hospitals, HKD \$100 maintenance fee per day occupying acute beds, or HKD \$68 per day occupying non acute beds [36]. A waiver can be applied in the case of financial hardship for those elderly who cannot afford the medical costs under the existing schemes. Conclusively, the local public medical care system provides excellent medical services to local residents, particularly for the low-income group. This explains why people, including the elderly, do not consider health care and medical care as the most significant improvement in their living conditions, but it will be a concern for those aspiring to seek health and medical care of a level higher than the basic level provided to all.

Despite assistance from the government, life has never been easy for those who are the low-income group and need financial subsidy schemes for basic needs and daily life to survive. These challenges only get more severe in their later stages of life, particularly affordability in housing and its adaptability for the elderly. Although the Hong Kong SAR Government has helped those residents below the poverty lines with reasonable medical and social assistance, housing for the elderly has been an issue too big to be solved [37]. Hong Kong has become an aging society. One solution for tackling this challenge of improving the housing conditions for the elderly can be through improving the current facilities for the changing needs of the elderly. This can succeed for at least two reasons. First, those elderly are living in public rental housing where they are not permitted to modify the layout of their dwellings. Second, the elderly are not economically affluent, so they only emphasize food and shelter. By comparison, the Australian NSW Government [38] suggests that open space can offer a location for entertaining activities to take place and improve the social lives of the elderly, therefore enhancing their mental health, sense of belonging, and sense of value for the elderly. Many medical studies have also shown that social interactions can reduce the suicide rate, risk of accidents, stress, or depression and improve cognitive health and self-respect [39].

The choice of residing in one's dwelling remains a popular theme for most older adults. If the situation allows, most elderly may prefer living in their current residence for the rest of their lives, even if they need help and care from volunteers, or unless they reside in an unsafe home environment. Remaining in one's current home is an essential part of the concept of aging-in-place. It provides the elderly with connection to their loved ones,

social circle, familiar community, and facilities and allows them to carry out daily activities and maintain safe interactions. Public housing, though it does not provide legal ownership of the property, still provides residents the feeling of long-term belonging and association that they can age in place.

Two necessary and sufficient conditions that support aging-in-place are home modifications and good health. Our results contribute to the understanding of the interlocked relationship between aging-in-place, home modification, and health. The data from Hong Kong reveals that gender, housing expenditure, housing size, income, and residential location are the indicators concerning decisions for home modification. First, the elderly paying more for accommodations or living in certain housing sizes tend to favor home modification. Second, specific income groups tend to have a preference for health care. Third, the elderly living in the poorest districts tend to have a preference for health care.

Those elderly living in medium-sized housing (301–450 square feet) of the mid-income group with some spare for housing expenditures aspire for better elderly living and see home modification as the most important issue. To promote aging-in-place, the government in housing planning and providing resources for elderly housing could consider a stratified approach to first supply a sufficient need to meet the basic housing needs for the very poor and then divert some resources for home modification for the mid-income group ( $\geq$ HKD \$25,000), perhaps as an option at a reasonable charge.

Elderly people of high household incomes care more for health and medical care than for home improvement, as housing may not be their dire need already. To answer the needs of this group of elderly people, the government's aging-in-place policy could facilitate a market or provide economic incentives/subsidies for them to take out affordable medical insurance.

Those elderly living in the poorest district not only have basic housing needs but also tend to see improvements needed for health care. These poor districts need a multi-prong approach to address the various chronic problems in delivering aging-in-place results.

From the perspective of housing design or modifications for aging-in-place, it is suggested that governments can focus on better lighting and ventilation when new public housing estates, especially housing for the elderly, are built. The elderly need two to three times as much light in order to see the same as young people. Good natural lighting offers seniors a sense of safety. The sunlight also produces vitamin D and helps the body easily absorb calcium to strengthen teeth and bones. Hence, proper window retrofitting that enhances the sunlight will increase the health of the elderly, especially those who do not get outside frequently. Daylight can also promote psychological health. While building bigger apartments is costly, the cost of a better design of windows that provides natural light is modest, which could be the first low-hanging fruit to be targeted as part of a long list for home modifications.

## 6. Conclusions and Further Studies

This paper introduces a broader sense of urban regeneration in terms of sustainability in the concept of aging-in-place under the urban conditions of double aging. It investigated aging-in-place from older adults' perspectives and it emphasizes two factors: (1) housing characteristics should be modified to give the elderly a sense of belonging, safety, and independence; and (2) the government should take the lead to adopt a stratified approach to perform sustainable home modifications and health care provisions. The choice of residing in one's dwelling remains a popular theme for most older adults. If the situation allows, most elderly may prefer living in their current residence for the rest of their life, even if they need help and care from volunteers or unless they reside in an unsafe home environment. Remaining in one's current home is an important part of the concept of aging-in-place.

There are limitations to this study. First, the number of observations is not very large, while the second concern is the skewness towards the preference for lighting and ventilation deficiencies by most respondents, which may be the unfortunate reality in Hong Kong housing. Given these two issues, the authors had no choice but to resort to performing a

simple logistic regression. For further research on this topic, it will be beneficial to spend more effort collecting more data so that the number of observations will be larger. It is also expected that there will be less skewness toward the preference for ventilation and lighting due to the law of large numbers. Then, it would be possible to decompose home modifications into the modification of different parts of a housing unit so that a multinomial logit model can be utilized. Moreover, future directions of research should be focused on each district, especially the poorest districts of Hong Kong.

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## Appendix A

### Questionnaire Survey

#### Part I. Housing Conditions

1. How big is your current home in sq. ft.?

≤50 ☐ 51–100 ☐ 101–150 ☐ 151–200 ☐ 201–250 ☐ 251–300 ☐ 301–350 ☐ 351–400 ☐ 401–450 ☐  
451–500 ☐ 501–550 ☐ 551–600 ☐ 601–650 ☐ 651–700 ☐ 701–750 ☐ >750 ☐

2. Monthly Housing Expenditure? HK\$

≤5000 ☐ 5001–10,000 ☐ 10,001–15,000 ☐ 15,001–20,000 ☐ 20,001–25,000 ☐ 25,001–30,000 ☐  
30,001–35,000 ☐ 35,001–40,000 ☐ 40,001–45,000 ☐ 45,001–50,000 ☐ >50,000 ☐

3. Monthly Household Income HK\$

≤5000 ☐ 5001–10,000 ☐ 10,001–15,000 ☐ 15,001–20,000 ☐ 20,001–25,000 ☐ 25,001–30,000 ☐  
30,001–35,000 ☐ 35,001–40,000 ☐ 40,001–45,000 ☐ 45,001–50,000 ☐ >50,000 ☐

4. Which of the following improvement do you consider the most important issue that helps you reside in your current home?

Ventilation & Lighting ☐ Housing Size ☐ Kitchen & Bathroom ☐ Heath Care ☐ Add-on Facilities & Services (Entertainment/Fitness Room) ☐ Public Activity Area ☐

5. How long do you live in your current home? \_\_\_\_\_

#### Part II. Personal Information

6. Gender: Male ☐ Female ☐

7. Age: 61–70 ☐ 71–80 ☐ 81 or above ☐

8. Education: Illiteracy ☐ Primary ☐ Secondary ☐ Tertiary or above ☐

9. Occupation: \_\_\_\_\_

10. Residential Location: Kwun Tong ☐ Sham Shui Po ☐ Sha Tin ☐ Fan Ling ☐ Hung Hom ☐  
Sheung Shui ☐ Central ☐ West Kowloon ☐ Other ☐

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