

# WILLINGNESS TO PAY AND PREFERENCES FOR GREEN HOUSING ATTRIBUTES IN HONG KONG

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## ABSTRACT

*Promotion of green housing is of utmost importance in the achievement of sustainability in the built environment. While the states often use legislation or offer subsidies to motivate developers to build green, market forces can lead to green housing provision without any state intervention if the market players are willing to pay extra for the green attributes of housing. This study aims to explore residents' willingness to pay (WTP) and preferences for green housing attributes based on the findings from a structured questionnaire survey in Hong Kong. The housing attributes under investigation include the uses of green materials and construction methods (e.g. timber from sustainable sources), energy-efficient technologies (e.g. LED lighting) and water-saving devices (e.g. grey water recycling system). Results indicate that apart from moral or altruistic reasons, residents' WTP was mainly motivated by economic incentives. Green housing attributes which can directly reduce residents' utility bills corresponded to greater WTP. Besides, environmental attitude was found a strong determinant of the WTP. Policy implications of the research findings then follow.*

## KEYWORDS

willingness to pay, green building, environmental economics, green consumerism, sustainability

## INTRODUCTION

In the past two decades, real estate or building is generally thought to play a prominent role in the wider debate on climate change (CB Richard Ellis, 2009). Housing construction and operations consume a very large proportion of energy throughout the world (e.g. Suzuki *et al.*, 1995; Swan and Ugursal, 2009). With a view to the significant proportion of carbon emissions coming from these sources, the house-building sector has faced a paradigm change, and green or sustainable housing has become a new orthodoxy in the field of architecture. Although it is widely accepted that the house-building industry should shoulder their environmental responsibility by providing green buildings (e.g. Bhatti, 1996; Maliene and Malys, 2009), sole reliance on altruism, norms or environmental citizenship cannot help achieve a sustainable built environment for the community. There has been a widespread belief that green buildings cost much more to build than traditional buildings, which created barriers to the supply of

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green buildings (Casals, 2006). Therefore, different instruments have been devised to promote green buildings in the industry. In some countries, requirements of energy efficiency have to be fulfilled in building designs in the building control systems (Casals, 2006). For example, it has been compulsory for all new houses in Australia to acquire a minimum acceptable house energy rating since 2003 (Australian Building Codes Board, 2006).

It is widely believed that a mandatory or so-called command-and-control approach is more effective in promoting green buildings as legislation can ensure code compliance. Yet, this approach has been criticized for creating market inefficiency and being liable for rent-seeking problem. Market force has been considered an alternative to the legislative approach in tackling environmental problems. Market-based policy instruments are commonly devised to encourage pro-environmental behaviour through price signals or economic incentives. However, market force is useful in encouraging the provision of green buildings only if voluntary pro-environmental actions can financially benefit the action-takers. In the house-building industry, for instance, green housing construction can be mobilized by market forces only if green buildings themselves (or compliance with a voluntary scheme or attainment of an eco-label) are perceived to be of value to the end users or owners of the properties. Producers will supply eco-friendly housing to the market if the purchasers are willing to pay for it. In this sense, it is interesting to know how the home purchasers perceive green building attributes, and their willingness to pay (WTP) for them.

The evidence base in environmental consumerism in the housing market is small but growing (CB Richard Ellis, 2009). However, the empirical literature mainly works with the revealed preference approach which cannot tell the underlying reasons for the proven price or rental premiums. Therefore, this study attempts to straddle the research gap by exploring residents' WTP and preferences for green housing attributes in Hong Kong using a stated preference approach. Hong Kong is a good laboratory for this kind of study because promotion of building sustainability in the city is still relying largely on voluntary approaches. More importantly, there is an urgent need for rationalizing subsidies for promoting green buildings in the city because the local government has been criticized for offering too many incentives for the private developers to provide the so-called 'green building features' in their new developments (Council for Sustainable Development, 2009; Ming Pao, 2009; South China Morning Post, 2009, 2010). By looking at the residents' WTP, this study attempts to validate whether state subsidies for provision of green housing are justified.

## ECONOMICS OF GREEN HOUSING

### *Costs of Developing Green Buildings*

Green buildings are commonly thought to be more expensive to construct (Kats *et al.*, 2003; Ding, 2006). For example, quantity surveyors in the UK had a perception that more energy-efficient and eco-friendly buildings cost between 5–15% more to build, compared with the conventional ones (Bartlett and Howard, 2000). For the development of a zero-carbon building, the construction cost premium was estimated around 12.5% (CB Richard Ellis, 2009). In order to obtain a Platinum grade in the Leadership in Energy and Environmental Design (LEED), a building costs 7.6–10.3% more to produce (Matthiessen and Morris, 2004). The cost increment will be smaller when a lower level of LEED (e.g. Gold or Silver) is targeted. On the other hand, when comparing the construction costs of 33 green buildings with those of conventionally-designed ones, Kats *et al.* (2003) uncovered that the average increment in cost for greener

buildings was slightly less than 2% of the total cost, which was substantially lower than the level commonly perceived. It is probably because less plant and equipment is required to serve a more environmentally friendly building (Bartlett and Howard, 2000). In other words, the construction of a green building requires fewer resources. Hence, its construction cost should not be significantly higher than the one with a non-green configuration. At the same time, the costs of producing green buildings are declining owing to richer experience in green construction and scale economies. Yet, the non-transparency in sharing of building cost information still results in the common misperception about the higher costs of green buildings (Kats *et al.*, 2003).

### **Returns from Building 'Green'**

The mistaken belief in the high costs of building green calls for state interventions in the housing market. Prescriptive-based or performance-based regulations are set out to require buildings to achieve a certain standard of environmental performance. Inherent in this command-and-control approach is the presumption that regulatees are unwilling to take necessary actions to comply with regulations and thus they have to be compelled to do so (May, 2004). Yet, a lot of resources are needed for enforcement to obtain greater compliance of the regulations (Karp and Gaulding, 1995). Besides, command-and-control regulations are accused of being costly and inefficient and attracting rent seeking activities (e.g. Moran, 1995; Millimet *et al.*, 2009). Focusing on end-of-pipe solutions, they also stifle innovation (Porter and van der Linde, 1995). Therefore, market-based approaches have been advocated.

A market-based approach will work if the benefits of green buildings are valued by different market players, including developers, valuers, homebuyers and renters. In fact, the body of evidence on the returns from the incorporation of greenness or sustainability in building design in the broader property market is growing. Potential benefits come from different origins. First, given the links between occupiers' health and productivity as a function of building environment, a greener building can preserve or even increase the productivity of its occupants (Bartlett and Howard, 2000; Kats *et al.*, 2003; Robinson, 2005). As estimated by Kats *et al.*, the productivity gains from occupying LEED certified buildings in the US are significant. The productivity gains, coming in the forms of lower absenteeism, fewer headaches at work and greater retail sales *etc.*, were estimated between US\$36.89–55.33 per square foot per year (Kats *et al.*, 2003). Another benefit from building green, which is more direct, is the saving in energy consumption (Robinson, 2005).

Other than the added values to the occupants, green buildings also bring benefits to the owners or investors. Occupancy rate of a building increases with its level of environmental sustainability (Fuerst and McAllister, 2010). Besides, the investigation of Miller *et al.* (2008) into the Energy Star and LEED-certified office buildings in the US evidenced that the Energy Star and LEED certifications, on average, increased the selling prices of the buildings by 5.76% and 9.94%, respectively. Another study by Eichholtz *et al.* (2009) analyzed the relationship between actual energy consumption in buildings and financial performance of the properties in the US. An increase of 10% in the energy utilization efficiency of a green building was found to give rise to a 0.2% increase in the effective rent of the building. Overall, a US\$1 saving in energy costs from increased energy efficiency yielded a return of US\$18 in the increased valuation of an Energy Star-certified building. The findings from these two studies echo with other empirical evidence (Fuerst and McAllister, 2008a, 2008b, 2011). Moreover, investing in green buildings can allow institutional investors to fulfil their corporate social responsibilities (Lorenz and Lützkendorf, 2008).

### ***Willingness to Pay for the 'Green' Products and its Determinants***

While the previous section suggested that greener or more energy-efficient buildings commanded higher values or rents, it is still unclear that whether these premiums were ascribed to increased costs associated with higher product or system specifications or willingness of the purchasers to pay extra for contributing to a more sustainable world (Fuerst and McAllister, 2008a). Therefore, to predict whether market-based approach to promote green housing will be successful, the stated preferences or WTP of the homebuyers should be researched.

Consumers' WTP for different green or eco-friendly products (e.g. organic food, green electricity and environmentally certified wood products *etc.*) have been widely studied (Viosky *et al.*, 1999; Roe *et al.*, 2001; Krystallis and Chryssohoidis, 2005). The literature indicated that consumers' WTP for the greenness varied with products with different natures. For example, Saphores *et al.* (2007) found that individual buyers were willing to pay a 1% premium only for 'greener' consumer electronic devices. In the arena of real estate, many different studies have been dedicated to reveal how much money market players are willing to pay for incorporating green or sustainable measures into properties. Research has shown that lessees were prepared to pay 5–10% higher rent for improved comfort and control of the environment (Maguire and Robinson, 2000). The WTP for a standard insulation window as compared to an old window was estimated 13% in Switzerland (Banfi *et al.*, 2008). In Hong Kong, Leung *et al.* (2005) empirically exemplified the willingness of the developers and designers to pay for improvements in the performance of an office building's envelope.

Other than the amount people are willing to pay for a green product, it is also valuable to identify who are willing to pay for it for the sake of more informed policy making. In general, socio-demographic characteristics such as age, gender, income and education are key factors determining WTP for green products (Diamantopoulos *et al.*, 2003). For example, income has been often found positively correlated with WTP for environmentally friendly products (Govindasamy and Italia, 1999; Roe *et al.*, 2001; Zarnikau, 2003). At the same time, numerous studies revealed that WTP for green products increased with education level (Jensen *et al.*, 2003; Zarnikau, 2003) although Seip and Strand (1992) found a slight negative effect of being more educated on WTP. On the other hand, WTP for eco-friendly products tends to decrease with age (Moon *et al.*, 2002; Gossling *et al.*, 2005; Zarnikau, 2003). As for gender, the evidence about its impact on WTP is rather mixed.

In addition, environmental attitude has been regarded a determinant of consumer's WTP for green products. Environmental attitude is commonly regarded as "a cognitive judgment towards the value of environmental protection" (Lee, 2009: 88). However, inconclusive evidence on the attitude-behaviour relationship was produced by the research in environmental consumerism. While Arbuthnott and Lingg (1975) and Weigel and Weigel (1978) found the attitude-behaviour relationship to be weak, Tanner and Kast (2003), Mintel Group (2006) and Lee (2009) unearthed a strong environmental attitude-behaviour link. Chyong *et al.* (2006) also found environmental attitude to be the most consistent explanatory factor in predicting consumers' WTP for green products. A survey on Swedish consumers by Hansla *et al.* (2008) also unpacked that WTP for green electricity increased with a positive attitude towards green electricity.

## **RESEARCH DESIGN**

### ***Sampling and Survey Instrument***

In order to meet the objectives of this study, private housing residents living in the Tai Kok Tsui constituency area, Yau Tsim Mong, Hong Kong was defined as the research population.

This area was chosen for two reasons. First, the share of private housing in this district is relatively high among all other constituency areas in the city. Second, there is a large variety of private housing (e.g. high-end luxurious apartments and old tenement blocks) in the area. This variety allows easy sampling of respondents with different socioeconomic backgrounds. The final sample size was calculated in accordance with the following principles: 1) that the total cost incurred in the design and implementation of the survey and data analysis was within budget, and 2) that the sample was representative enough for a preliminary study. The 2006 Population By-census reported that there were 16,553 people living in private housing in the area (Census and Statistics Department, 2007). A sample size of 300 was deemed appropriate because it fulfilled both of the principles aforementioned.

A self-administrated face-to-face survey was conducted, with the use of a preset questionnaire, to collect the required information from the residents. This approach was adopted to maximize number of valid questionnaires from the survey. Before the survey, the questionnaire was pretested and adjusted according to the testers' feedback. The final questionnaire comprised four sections. The first section contained questions on the respondents' perceived importance of a list of green housing attributes towards sustainable development on a five-point scale (5="very important" while 1="not important at all"). In this section, the respondents were asked about their perceived value of environmental protection. This question on environmental attitude was again assessed on a five-point scale (5="very important" while 1="not important at all"). What comes next was a set of questions on the respondents' preferences for a list of green housing attributes. The third section explored the respondents' WTP extra for a property with one of the green housing attributes with the use of a dichotomous scale (1="willing" and 0="unwilling"). The last section concerned the particulars (i.e., socioeconomic characteristics) of the respondents.

### ***Green Housing Attributes Investigated***

While there are numberless types of green housing attributes in the market, it is impossible to investigate all of them in this study due to limited time and resources. With reference to the good practices and items credited in the local green building classification or rating systems such as the Building Environmental Assessment Method Plus (BEAM Plus) and Comprehensive Environmental Performance Assessment Scheme (CEPAS), six green housing attributes were chosen as the subjects of investigation in this study. These attributes were:

- 1) use of timber from sustainable sources for new construction, renovation or fitting-out;
- 2) use of prefabricated building elements;
- 3) use of LED lightings in the housing units;
- 4) installation of photovoltaic (PV) panels for generating energy for uses in common areas;
- 5) use of water-saving shower heads in bathrooms in the housing units; and
- 6) installation of a grey-water recycling system for uses in the common areas.

These six attributes were selected for their common applications in the housing sector. Otherwise, the respondents might have no prior experience or knowledge about the attributes so that their perceptions or WTP obtained from the survey were not credible. More importantly, the six selected attributes had different natures and scopes of application. For example, attributes (1) and (2) were related to the use of green materials or construction methods while attributes (3) and (4) dealt with the energy use in a building (e.g. energy efficiency and use of renewable energy). The remaining two attributes were associated with water consumption and reuse. Moreover, attributes (3) and (5) were confined to private housing space while common

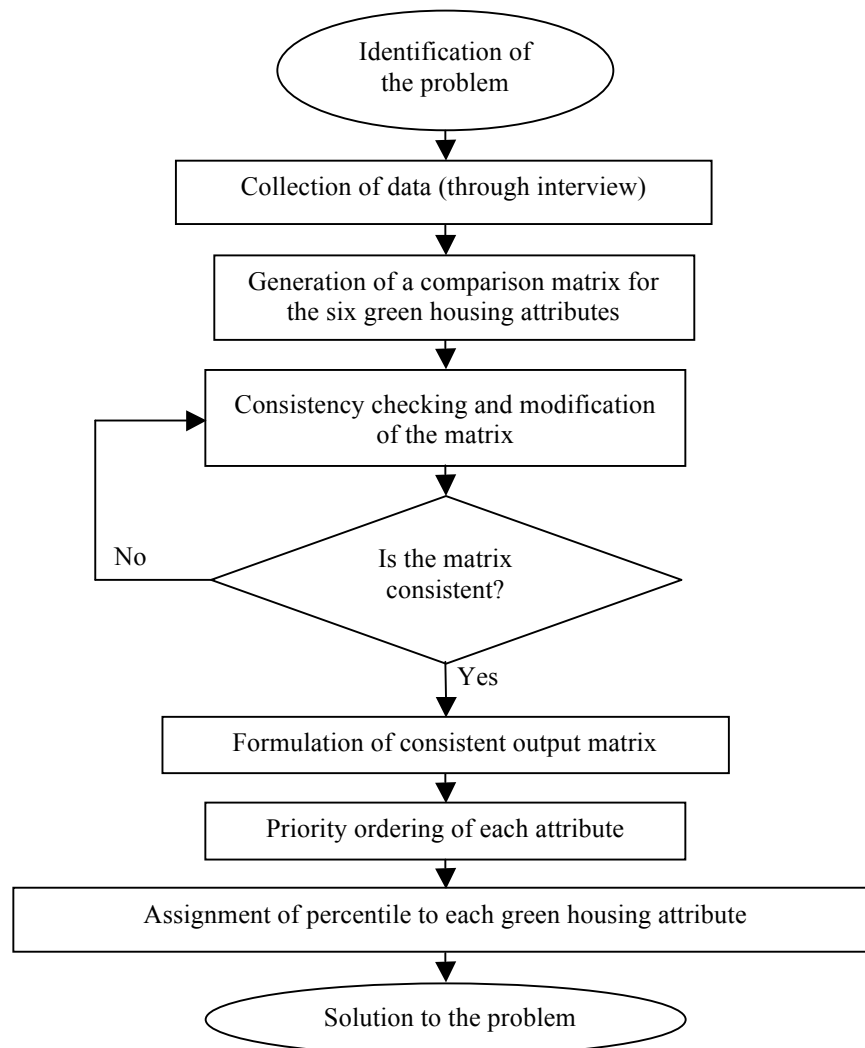


areas of buildings were foci for attributes (4) and (6). Attributes (1) and (2) involved both private and common areas of buildings. This great variety might help explain the differences in research findings with reference to different natures of the green housing attributes.

### Analysis Method

The respondents' preferences for different green housing attributes were compared using the non-structural fuzzy decision support system (NSFDSS). This technique has been widely adopted to determine factor weightings in multi-criteria decision making (Ho *et al.*, 2004; Yau and Chan, 2008), and it is applicable to the evaluation of relative preferences for different green housing attributes in this study. The workflow of the NSFDSS, as shown in Figure 1, was adapted from Tam *et al.* (2002) and Ho *et al.* (2004). In brief, each respondent was given 15 pairs of attributes (i.e.,  $6 \times (6-1) / 2$ ) as total number of attributes was six. In each pairwise comparison, the respondent had to state which attribute he or she preferred over the other or state his or her indifference. A comparison matrix was then resulted for the respondent, and internal

**FIGURE 1.** Work flow of the NSFDSS.



**TABLE 1.** An example of input matrix for pairwise comparison

Attribute	Input Value					
	(1)	(2)	(3)	(4)	(5)	(6)
(1)	0.5	1	1	1	1	1
(2)	—	0.5	1	0	0	1
(3)	—	—	0.5	0	0	0.5
(4)	—	—	—	0.5	1	1
(5)	—	—	—	—	0.5	1
(6)	—	—	—	—	—	0.5

consistency of the inputs could be checked. These exercises were aided with the input matrix in Table 1. The respondents could choose one out of the three output values, namely 0, 0.5 and 1, for each pairwise comparison. For example, an output value of 1 is assigned when attribute (1) (i.e., the attribute in the column) is more preferred than attribute (2) (i.e., the attribute in the row). A value of 0 is used when attribute (2) category is less preferred than attribute (4). A value of 0.5 is allotted when the preferences to attributes (3) and (6) are of the same level.

With the completed input matrix, the internal consistency of a respondent's inputs could be checked. In our case, the number of housing attributes to be considered is six so the matrix of pairwise comparison is

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{42} & a_{43} & a_{44} & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{bmatrix} = (a_{mn}) \quad \text{for} \quad \begin{matrix} m = 1,2,3,4,5,6 \\ n = 1,2,3,4,5,6 \end{matrix} \quad (1)$$

where  $a_{mn}$  is the logical indicator of pairwise comparison with housing attributes  $m$  and  $n$ . The matrix of pairwise comparison, which is a square matrix, can be completed using the input matrix although the latter comprises only the upper triangle. The lower triangle was obtained by subtracting the transposed upper triangle from one. The checking of internal consistency was done by identifying the case of intransitivity (e.g.  $a_{12} > a_{13}$  but  $a_{34} < a_{24}$ ). If intransitivity was spotted, the respondent would be asked to revise his or her input values.

What comes next was to prioritize the green housing attributes according to the results of pairwise comparisons. As illustrated in Table 2, the values in each row were summed up. A housing attribute with a larger sum means it is more preferred by the respondent. The attributes were then rearranged in a descending order of the sum. Based on the priority order, a percentile was assigned to each attribute. The most preferred attribute was assigned with 100%. The remaining attributes were compared to it one by one, and they were assigned with a percentile not greater than 100%. The general rule was that a higher percentile was given for an attribute with a higher priority. Each percentile was assigned a semantic score  $s_x$  in the range of [1, 0.5], with 1 meaning 'same preference' and 0.5 meaning 'not preferred', as shown

**TABLE 2.** An example of priority ordering.

Attribute	Input Value						Row Sum
	(1)	(2)	(3)	(4)	(5)	(6)	
(1)	0.5	1	1	1	1	1	5.5
(2)	0	0.5	1	0	0	1	1.5
(3)	0	0	0.5	0	0	0.5	1.0
(4)	0	1	1	0.5	1	1	4.5
(5)	0	1	1	0	0.5	1	3.5
(6)	0	0	0.5	0	0	0.5	1.0

**TABLE 3.** Table for conversion between percentile, semantic score and priority score.

Percentile (%)	Semantic Score, $s_x$	Priority Score, $r_x$
100	0.500	1.000
95	0.525	0.905
90	0.550	0.828
85	0.575	0.739
80	0.600	0.667
75	0.625	0.600
70	0.650	0.538
65	0.675	0.491
60	0.700	0.429
55	0.725	0.379
50	0.750	0.333
45	0.775	0.290
40	0.800	0.250
35	0.825	0.212
30	0.850	0.176
25	0.875	0.143
20	0.900	0.111
15	0.925	0.081
10	0.950	0.053
5	0.975	0.026
0	1.000	0.000

in Table 3. Afterwards, the semantic score was converted into a priority score  $r_x$  in the range of [1,0] by applying fuzzy set theory through the following equation:

$$r_x = \frac{1 - s_x}{s_x} \quad , \quad 0.5 \leq s_x \leq 1 \quad (2)$$

The priority score indicated the relative preference of each attribute. The aggregate priority score for a particular attribute was taken as the arithmetic mean of the all the priority scores of individual respondents. For easy interpretation, the aggregate priority scores of the six housing attributes were rescaled so that the aggregate priority score of the most preferred attribute



would be unity (or 100%). The advantage of using the NSFDSS was significant because direct prioritization of the six attributes with reference to the preference level in one go could result in unstable and inconsistent ranking due to cognitive incapacity of the respondents. Besides, the NSFDSS, which is theoretically sound, allowed meaningful of the preference levels among the attributes.

As for the determinants of WTP for the green housing attributes, they were identified by means of logistic regression. For each attribute, a logistic regression model was developed with the objective of predicting the probability of the respondents' WTP for the attribute. With its freedom from restrictions, logistic modelling could be used for prediction of discrete outcomes (e.g. 'willing to pay' vs. 'unwilling to pay') from a set of variables that could be continuous, discrete, dichotomous or a combination thereof (Tabachnick and Fidell, 2007). In this study, socio-demographic variables and environmental attitude were used as independent variables in the models. The logistic modelling technique had at least two essential merits. Firstly, it helped identification of the explanatory variables that affected the respondents' choices while controlling the effects of possible confounding variables. Secondly, it allowed comparison in the strength and importance of the explanatory variables, given that the scales of all independent variables were standardized.

Based on the literature on the determinants of WTP for a green project, the logistic models of this study were specified as follows:

$$WILL(i) = f(MALE, AGE, EDU, HINC, ATT) \quad (3)$$

where  $WILL(i)$ , for  $i=1,2,\dots,6$ , denotes an individual respondent's WTP more for a property equipped with one of the green housing attributes numbered above;  $MALE$  is a dummy variable which equals one if the respondent is a male, and zero if otherwise;  $AGE$ ,  $EDU$  and  $HINC$  represent the respondent's age, education level and household income, respectively; and  $ATT$  denotes the environmental attitude of the respondent.

## RESEARCH FINDINGS, ANALYSES AND DISCUSSION

### *Findings from the Survey and Analyses*

In total, 300 residents in Tai Kok Tsui were randomly sampled, and 231 valid questionnaires were completed between May and August 2011. Table 4 summarizes the socio-demographic characteristics of the respondents. The self-reported environmental attitude of the respondents had a mean of 3.85 and a standard deviation of 1.12. Given the significant difference of the mean score from three (at the 1% level), the respondents generally regarded environmental protection important. As shown in Table 5, among the six housing attributes, the use of water-saving shower was regarded as most important to the achievement of sustainability ( $\mu=4.09$ ), followed by the uses of LED lighting ( $\mu=4.06$ ) and timber from sustainable sources ( $\mu=3.97$ ). With a mean score of 3.09, the use of prefabricated building elements was regarded as least important to the achievement of sustainability. A similar set of results were obtained for the relative preference of the six green housing attributes, which are presented in Figure 2. The use of water-saving showers was the most preferred attribute, followed by the uses of LED lighting and PV panels. Yet, the difference in the levels of preference between water-saving showers and LED lighting was not statistically significant even at the 10% level. On the other hand, prefabricated building elements were regarded as the least preferred one. The magnitude of preference of this housing attribute was only 43.5% of that of water-saving showers.

**TABLE 4.** Socio-demographic profiles of the respondents ( $n=231$ ).

Characteristic		Frequency	Percentage*
Gender	(1) Male	126	54.5%
	(2) Female	105	45.5%
Age	(1) 18-24 years old	11	4.8%
	(2) 25-34 years old	34	14.7%
	(3) 35-44 years old	71	30.7%
	(4) 45-54 years old	71	30.7%
	(5) 55-64 years old	31	13.4%
	(6) 65 years old or above	13	5.6%
Education	(1) Primary school or below	33	14.3%
	(2) Lower secondary school	10	4.3%
	(3) Upper secondary school	43	18.6%
	(4) Matriculation	27	11.7%
	(5) Sub-degree post-secondary education	50	21.6%
	(6) Bachelor degree or above	68	29.4%
Household Income	(1) HK\$9,999 or below	30	13.0%
	(2) HK\$10,000 – 14,999	58	25.1%
	(3) HK\$15,000 – 19,999	61	26.4%
	(4) HK\$20,000 – 24,999	57	24.7%
	(5) HK\$25,000 – 29,999	17	7.4%
	(6) HK\$30,000 or above	8	3.5%

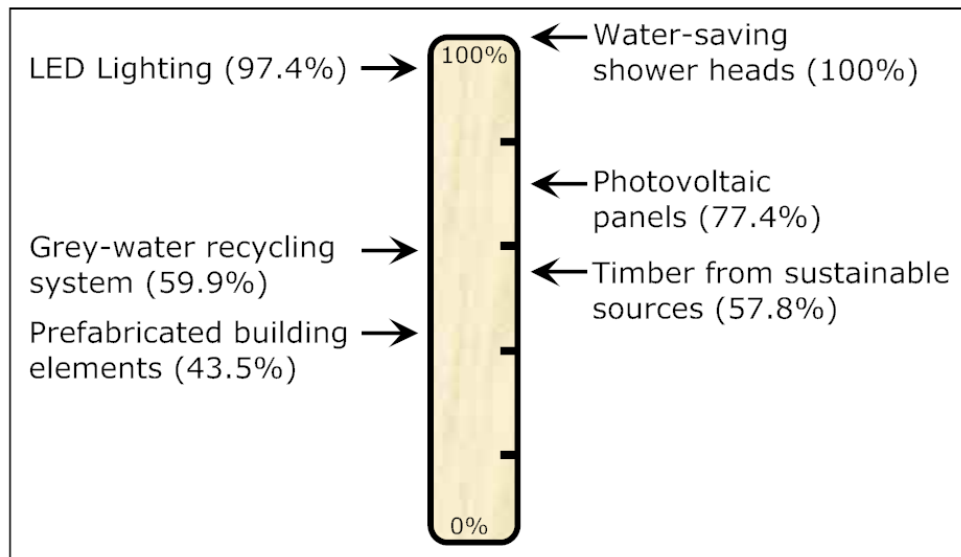
Note: \* Percentages may not add to 100% due to rounding.

**TABLE 5.** Survey findings on perception and willingness to pay ( $n=231$ ).

Green housing attribute	Perceived importance		No. of respondents willing to pay (percentage)	
	Mean	$\sigma$	Yes	No
Use of water-saving shower heads	4.09	0.98	166 (71.9%)	65 (28.1%)
Use of LED lighting	4.06	1.10	162 (70.1%)	69 (29.9%)
Use of timber from sustainable sources	3.97	1.08	89 (38.5%)	142 (61.5%)
Installation of photovoltaic panels	3.49	1.15	99 (42.9%)	132 (57.1%)
Installation of a grey-water recycling system	3.30	1.09	97 (42.0%)	134 (58.0%)
Use of prefabricated building elements	3.09	1.35	59 (25.5%)	172 (74.5%)

As the same time, the uses of water-saving shower ( $n=166$  or 71.9%) and LED lighting ( $n=162$  or 70.1%) attracted the WTP from the highest numbers of respondents. 99 (42.9%) and 97 (42.0%) respondents were willing to pay more for a property equipped with PV panels and a grey-water recycling system, respectively, with 89 (38.5%) for the use of timber from

**FIGURE 2.** Relative preference of the six green housing attributes.



**TABLE 6.** Mean responses before rescaling ( $n = 231$ ).

Variable	Range	Mean	$\sigma$
WTP(1)	0=unwilling; 1=willing	0.39	0.49
WTP(2)	0=unwilling; 1=willing	0.26	0.44
WTP(3)	0=unwilling; 1=willing	0.70	0.46
WTP(4)	0=unwilling; 1=willing	0.43	0.50
WTP(5)	0=unwilling; 1=willing	0.72	0.45
WTP(6)	0=unwilling; 1=willing	0.42	0.49
MALE	0=female; 1=male	0.55	0.50
AGE	0=18-24 years old <> 6=65 years old or above	3.50	1.20
EDU	1=primary school or below <> 6=degree or above	4.10	1.74
HINC	1=HK\$9,999 or below <> 6=HK\$30,000 or above	2.99	1.28
ATT	1=not important at all <> 5=very important	3.85	1.12

sustainable sources. Only 59 respondents (24.2%) were willing to pay extra for the use of prefabricated building elements in the construction process. Table 6 summarizes the mean responses from the surveyed respondents before rescaling. After rescaling all variables to [0,1], logistic regressions were run on the dependent variable  $WTP(i)$ . The results are tabulated in Table 7. As the estimation results of all the six models show, WTP had a significant positive relationship with household income and environmental attitude. Education imposed a positive impact on WTP for prefabricated building elements but a negative one for LED lighting, keeping other factors constant. Younger respondents were more willing to pay extra for LED lighting, PV panels and water-saving shower heads. Female respondents tended to have a stronger WTP for timber from sustainable sources and water-saving shower heads, compared with the male counterparts.

**TABLE 7.** Results of the logistic regressions ( $n=231$ ).

Model	WTP(1)		WTP(2)		WTP(3)		WTP(4)		WTP(5)		WTP(6)	
	$\beta$	Standard Error	$\beta$	Standard Error	$\beta$	Standard Error	$\beta$	Standard Error	$\beta$	Standard Error	$\beta$	Standard Error
Constant	-2.84	0.73 ***	-5.77	1.13 ***	1.29	0.74 *	-1.60	0.73 **	0.11	0.75	-2.11	0.74 ***
MALE	-1.31	0.32 ***	-0.13	0.35	0.06	0.32	-0.32	0.30	-0.65	0.34 *	-0.23	0.29
AGE	-0.38	0.76	-1.40	1.06	-3.94	0.98 ***	-2.60	0.82 ***	-1.47	0.78 *	-1.02	0.72
EDU	-0.31	0.53	1.19	0.57 **	-1.03	0.54 *	-0.64	0.49	-0.06	0.50	0.57	0.50
HINC	3.23	0.77 ***	3.39	1.03 ***	3.28	0.90 ***	3.02	0.69 ***	3.60	0.79 ***	1.15	0.64 *
ATT	2.79	0.66 ***	4.01	1.12 ***	1.39	0.61 **	2.62	0.60 ***	0.97	0.58 *	2.13	0.61 ***
LR statistic	67.5 ***		63.7 ***		42.3 ***		49.6 ***		36.4 ***		26.5 ***	
McFadden $R^2$	0.219		0.242		0.150		0.157		0.132		0.084	

Notes: (\*\*\*), (\*\*), (\*) denote the estimated coefficients to be significant at the 1%, 5% and 10% levels, respectively.

## Discussion

The analysis results showed that the determinants of WTP varied with the green housing attributes concerned. Household income and environmental attitude were strong predictors of WTP for all the six green housing attributes under investigation. These findings confirm that while people's WTP for a green attribute is sensitive to the nature of the attribute, wealth factor has a rather consistent positive impact on WTP. This association is rather straightforward because demand for greenness is in most cases subject to wealth constraints (Kotchen, 2006). Moreover, the findings of this study confirmed Chyong *et al.* (2006) and Hansla *et al.* (2008) that environmental attitude played an important role in determining an individual's WTP for green products. People tend to channel their pro-environmental attitudes into environmentally-conscious consumption behaviour. In this light, if the local government wants a certain green attribute to be self-provided in the private housing market, enhancement of the environmental attitude among the homebuyers and renters is likely to be a prerequisite.

The survey results also suggested that, for the green housing attributes being studied, the level of preference coincided with the number of willing payers. The correlation coefficient between the two factors was 0.97 which was significant at the 1% level. Furthermore, the number of willing payers co-moved with the perceived importance of the green attribute, with a correlation coefficient of 0.80 which was significant at the 10% level. These high correlations helped validate the WTP self-reported by the respondents. From the results on perceived importance and WTP, it is seemingly that more weights were given to green housing attributes which could provide direct economic benefits to the respondents. For example, LED lighting and water-saving shower heads can reduce the uses of electricity and water, helping the residents to pay less for their bills for utilities. At the other extreme, although the use of prefabrication in construction can reduce wastage and save resources, its economic benefits to homebuyers are not so direct or explicit. Fewer respondents were thus willing to pay more for this attribute. PV panels and grey-water recycling system attracted less WTP than LED lighting and water-saving shower heads for two possible reasons. First, the investments in the former two systems usually incur high initial costs. Market players may expect a longer payback periods for these investments. Second, these two facilities are used in common areas so individual residents may not perceive economic benefits that are significantly large enough to influence their decision even if these facilities can actually conserve energy and water.

As a whole, the survey findings of this study put forward that people's WTP for green housing attributes was motivated by economic incentives in addition to moral or altruistic reasons. They offer valuable insights for the local government into the types of green building attributes local people are willing to pay extra for. Given that the costs of some provisions, such as LED lighting and water-saving shower heads, can be likely paid back by the market, the developers should not be subsidized for providing these attributes. The government should rationalize the subsidies and allocate the limited resources to the areas not valued by the end-users. In this sense, this study justifies the Hong Kong Government's initiative to grant real estate developers bonus floor area for their uses of prefabricated facades for their new developments. On the other hand, profit-driven developers should be strongly advised to apply the concept of green marketing for their new developments, making reference to the selective preferences and green consumption behaviour of the housing consumers.

## CONCLUDING REMARKS

The awareness of the ‘green housing’ concept has been growing in Hong Kong’s community. This study explores the perceptions of 231 residents in the city to the importance of six selected green housing attributes to sustainable development, and their preferences of and WTP for the attributes. The research findings suggested that WTP for these attributes varied with the attribute nature, and was contingent on different sets of socio-demographic factors. Yet, environmental attitude was found a strong determinant of the WTP, regardless of the attributes. Admittedly, a limited understanding of the benefits of green housing attributes can be a key inhibitor to the achievement of sustainable built environment in a city. From a policy point of view, governments should try their best to remove information barriers, improving the communication and information sharing among decision makers such as consumers, investors and developers. Otherwise, erroneous perception about the high cost and low benefit of building green prevails, and higher environmental performance goals are often dismissed by the players in the house-building sector. Moreover, due to limited resources, only six green housing attributes were investigated in this study. Further research on the WTP for other green or eco-friendly housing attributes (e.g. green-roofs and better thermal insulation) should be recommended.

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