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PREFERENCE MODELLING IN R: A TRIAL ON HOME BUYERS' WILLINGNESS TO PAY

Modelagem de preferência em R: um teste sobre a disposição de pagar dos compradores de casas

Ahmed Syahid[1], Mohammad Ali Tareq [1,2 *], Aizul Nahar [1]
[1]Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Jalan Semarak,
[2] International Joint Intellectual Property Laboratory (IJIPL), MJIIT, UTM, Jalan Semarak,
*Corresponding author: Mohammad Ali Tareq
E-mail: tareq@utm.my

ABSTRACT

Modelling stated preferences is an almost mystical science and as there is no data explaining how the sustainable feature in homes would effectively encourage homebuyers to invest in sustainable housing, it is important to investigate the buyers' willingness to pay (WTP) for sustainable housing. The study of stated preferences often requires the use of specialised software or proprietary programs, which can be difficult and/or expensive to use. This study proposes to re-purpose the 'support.CEs' package, a program written in the R programming language, from its agronomic roots to measure home buyer preferences for sustainable housing. These are demonstrated through a stated preference discrete choice experiment of choosing model houses with differing levels of energy savings, renewable energy generation, landscaping, soundproofing, ventilation, and price differences. A pilot study was performed using an online survey, constructed using the L^{MA} design tool provided in the 'support.CEs' package. The survey was also separated into six blocks of six questions each to reduce the cognitive burden on respondents. The survey was distributed through social media channels. Preliminary results with a limited sample of 20 respondents with mixed income, age, and occupational demographics, analysed using the package's c*logit* function, that performs conditional logit estimations, have shown that the results have a statistically reliable adjusted rho-squared value and that all coefficients show the expected signs. From this study, it can be concluded that the 'support.CEs' package can be used to model home buyer preferences and that adequate blocking allows for the measurement of a higher number of variables despite having smaller sample sizes.
Keywords: Home Buyer Preferences; Discrete Choice Experiments; Sustainable Housing.

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MODELAGEM DE PREFERÊNCIA EM R: UM TESTE SOBRE A DISPOSIÇÃO DE PAGAR DOS COMPRADORES DE CASAS

Preference modelling in R: a trial on home buyers' willingness to pay

Ahmed Syahid[1], Mohammad Ali Tareq [1,2 *], Aizul Nahar [1]
[1]Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Jalan Semarak,
[2] International Joint Intellectual Property Laboratory (IJIPL), MJIIT, UTM, Jalan Semarak,
*Corresponding author: Mohammad Ali Tareq
E-mail: tareq@utm.my

RESUMO

Modelar as preferências declaradas é uma ciência quase mística e como não há dados que expliquem como o recurso sustentável nas casas encorajaria efetivamente os compradores de casas a investirem em moradias sustentáveis, é importante investigar a disposição dos compradores de pagar (WTP) por moradias sustentáveis. O estudo das preferências declaradas freqüentemente requer o uso de software especializado ou programas proprietários, que podem ser difíceis e / ou caros de usar. Este estudo propõe a reformulação do pacote 'support.CEs', um programa escrito na linguagem de programação R, de suas raízes agronômicas para medir as preferências do comprador de imóvel residencial por habitação sustentável. Isso é demonstrado por meio de um experimento de escolha discreta de preferência declarada de escolher casas modelo com diferentes níveis de economia de energia, geração de energia renovável, paisagismo, isolamento acústico, ventilação e diferenças de preço. Um estudo piloto foi realizado usando uma pesquisa online, construída usando a ferramenta de design LMA fornecida no pacote 'support.CEs'. A pesquisa também foi dividida em seis blocos de seis perguntas cada para reduzir a carga cognitiva dos entrevistados. A pesquisa foi distribuída nas redes sociais. Resultados preliminares com uma amostra limitada de 20 respondentes com renda mista, idade e dados demográficos ocupacionais, analisados usando a função de entupimento do pacote, que realiza estimativas logit condicionais, mostraram que os resultados têm um valor rho-quadrado ajustado estatisticamente confiável e que todos os coeficientes mostrar os sinais esperados. A partir deste estudo, pode-se concluir que o pacote 'support.CEs' pode ser usado para modelar as preferências do comprador de imóvel residencial e que o bloqueio adequado permite a medição de um número maior de variáveis, apesar de ter tamanhos de amostra menores.

Palavras-chave: Preferências do comprador de casa; Experimentos de escolha discreta; Habitação sustentável.

INTRODUCTION

Sustainability of the built environment integrates energy-efficient buildings with an environment-friendly layout to reduce adverse environmental effects (Johar & Razak, 2015). It transforms the traditional buildings into sustainable buildings which provide significant benefits to residents such as health, wellbeing and productivity, reduced resources consumption, lesser maintenance expenses, and improved indoor environment (Balaban & Puppim de Oliveira, 2017; Darko & Chan, 2017), while developers can benefit from the improved corporate image and increased competitiveness (Isa et al., 2013). Sustainable building is referred to as building created through sustainable construction for the particular purpose of promoting health, enhancing resources efficiency and reducing the harmful influence of the built environment on the ecosystem (Kibert, 2004). The interrelationship between individuals, communities and organization surrounding the ecosystem is the most important thing for the sustainability in build environment (Hardi et al., 1999; Said et al., 2017).

The sustainable housing is the one that is well-available, cost-efficiency and considers environmental, social, economic and aesthetic aspects in design. The reformulation of some of the forgotten traditional values of architecture and design as well as the environmental, social and economic conditions are emphasized in defining sustainable housing (Maliene & Malys, 2009; Medineckienė et al., 2010; Mulliner & Maliene, 2011; Salama, 2007). The evaluation of cost-optimal solutions for sustainable housing design is also a major mission at present, because it will directly affect the developing effectiveness of sustainable housing (D'Agostino et al., 2017; Filer et al., 2020; Said et al., 2017). Said et al. (2017) defined the term cost-efficiency for sustainable housing as the optimal use of energy and water as well as efficient management of waste.

The impacts of climate change have aroused people's awareness of environmental protection as well as substantially affected people's perceptions of housing design (AlQahtany, 2020; P.-K. Wang et al., 2020). J. Liu et al. (2020) argued that energy saving awareness, carbon reduction goals, and the use of green materials are currently viewed as residents' social responsibilities.

Said et al. (2017) explored owners' perception toward sustainable housing affordability in Malaysia, particularly in the state of Sarawak and found that the areas where utilities are highly available are better aligned with the sustainable housing affordability, while areas where facilities are not well provided have poor performance in this regard. Wingate (2014) studied the influence of the environmental attitude in the integration of sustainable interior design features in residential settings, and examined the relationship between public perception and sustainable interior design practices in residential settings in Wisconsin, USA. Huong and Soebarto (2003) investigated the gaps in understanding sustainable housing in Adelaide, South Australia and Hanoi, Vietnam and compared the perceptions of various stakeholders in the housing (e.g. designers, developers, users), and highlighted the importance of the multiple dimensions of sustainability, namely, the environmental, social and economic dimensions to achieve sustainable housing.

Thus economic, environmental and social issues from sustainable housing design must be considered in order to achieve the long-term sustainable results equally (Qin et al., 2020). In other words, eco-friendliness is a critical element of housing design, and using green materials in interior spaces as well as designing or selecting facilities associated with the concepts of energy saving, sustainable energy, and energy recovery are critical for housing design (Dahlblom, 2020; Klumbyte et al., 2020). Therefore, it is urgent to obtain a better understanding of the way the adoption of sustainability initiatives at a local level can be adopted, regarding consumer decision-making in housing contexts (Judge et al., 2019). As there is no data explaining how the sustainable feature in homes would effectively encourage homebuyers to invest in sustainable housing (Zhang et al., 2016), it is important to investigate the buyers' willingness to pay (WTP) for sustainable housing (Syahid et al., 2016; Tareq et al., 2015). As there is no data explaining how the sustainable feature in homes would effectively encourage homebuyers to invest in sustainable housing (Zhang et al., 2016), it is important to investigate the buyers' willingness to pay (WTP) for sustainable housing (Syahid et al., 2016).

1 STATED PREFERENCE MODELLING A BACKGROUND

Modelling stated preferences is an almost mystical science, turning something as anomalous as buyer choices into hard numbers, drawing from disciplines as disparate as marketing, psychology, economics, and statistics (Louviere et al., 2010) to conclude on the meaning behind buyers' choices. This multi-disciplinary combination of techniques equally allow preference modelling to go beyond the bounds of any one particular field, seeing applications in studies as diverse as marketing (Danaher, 1997; Moser & Raffaelli, 2014; Ogawa et al., 1993; Okechuku, 1994; Silayoi & Speece, 2007), real estate (Han, 2010; Marmolejo-Duarte & Ruiz-Lineros, 2013; Orzechowski et al., 2005), healthcare (Hall et al., 2004; Hoefman et al., 2015; Mangham et al., 2008), environmental (Davila et al., 2015; Gill et al., 2015; Johnson & Desvousges, 1997), agronomic (Aizaki et al., 2013; Aizaki & Sato, 2007; Font-i-Furnols & Guerrero, 2014), transport (Brownstone et al., 2000; Calfee et al., 2001), and manufacturing (Amarchinta & Grandhi, 2008) studies.

Many techniques exist for collecting and studying buyer preferences including the analytical hierarchy process (Zahedi, 1986), conjoint analysis (Green & Srinivasan, 1978), discrete choice experiments (DCE)[1] (Louviere et al., 2010), and contingent valuation (Carson & Hanemann, 2005). Each technique is only situationally superior, with its own sets of strengths and weaknesses. However, the main objective all of these techniques is to elicit the monetary value of a particular good or sets of goods.

While any of these techniques could technically be used to model homebuyer preferences, the unique nature of housing as a multi-dimensionally heterogeneous good (Galster, 1996) makes preference elicitation through contingent valuation tedious and analytically problematic, as this technique relies on respondents choices in response single attribute changes rather than multiattribute choice situations (Boxall et al., 1996), which is the typical trade-off situation when choosing homes.

The analytical hierarchy process, originating in operations research, has found use in many fields (Forman & Gass, 2001), as its primary objective of figuring out the importance of criteria and attributes, thus finding a home in fields as far apart as healthcare to architecture to finance (Zahedi, 1986). With respect to the home buying process, it has proven less useful except to paint broader strokes on home buyer preferences (Kauko, 2006) and is not naturally capable in providing hard numbers on the willingness to pay (WTP) for these preferences (Kallas et al., 2007).

To identify and analyse the profile of early homebuyers, there are two necessary insights; is an individual willing to change (WTC) followed by their willingness to pay an additional upfront price for sustainable housing (Khan et al., 2020). Willingness to change is a measure of the cognitive and emotional buy-in to the change. It is a process that transforms from cognitive to physical. It begins with understanding the reasons to change, followed by accepting those reasons. But this transition is not easy; individuals are known to deny in the beginning before accepting the change. But a mere acceptance is not enough. The willingness to change becomes physical with the desire to engage in change. The willingness to change is measured by the amount of effort an individual is willing to invest to realize the change (Metselaar, 1997). Willingness to pay depends upon the willingness to change because if an individual is not cognitively and emotionally convinced to change, it is highly unlikely that they would be willing to pay. Thus, the willingness to change and pay becomes critical from the standpoint of potential policy and product implications.

And since several socioeconomic factors are at the core of this critical decision-making (Glumac & Wissink Thomas, 2018; Y. Liu et al., 2018; Oerlemans et al., 2016), WTP might be context-sensitive. While constructing and promoting sustainable housing is up to the real estate developers, homebuyers, being the last link of this supply chain, significantly influence this market through their willingness to pay (Zhang et al., 2016). Research also suggests that recognizing early buyers and their characteristics promote the adoption of sustainable products in a market (Khan et al., 2020; Muzaffar, 2015; Winston, 2010).

[1] While conjoint analysis and DCEs are often used interchangeably, this is a misnomer as the two are dissimilar choice modelling techniques that are only superficially the same.

2 DISCRETE CHOICE EXPERIMENTS IN R

Based on the arguments that DCEs and analytical hierarchy process methods having similar predictive ability (Ijzerman et al., 2012; Scholl et al., 2005) and the objective of this study; to distil hard numbers on the WTP for sustainable homes, it would be more suitable to use DCEs to study home buyers' preferences. To this end, the authors propose the use of 'support.CEs' (Aizaki, 2012), a program written in R to formulate surveys eliciting buyer preferences and analyse the resultant responses. Other programs exist in the open source ecosystem that could be used to carry out DCEs or conjoint analyses (Bak & Bartlomowicz, 2012; Borghi, 2009), but methodological refinements have shown the 'support.CEs' program to be the best fit for this study.

Like other stated preference modelling techniques, DCEs rely on the assumptions of the random utility theory (Boxall et al., 1996) that buyers are both rational and choose alternatives that maximise their utility. However, it is different by offering a comprehensive set of characteristics with each alternatives, which more closely resembles a real-world decision (Mangham et al., 2008) than anything that could be feasibly conceived using either contingent valuation or analytical hierarchy process techniques.

This program was specifically chosen to model home buyer preferences due to both the advantages of the program itself and that of the DCE technique. The choice of an open-source program against other commercial software such as Sawtooth (Orme, 2001) or proprietary codes is advantageous in allowing the primary research to be carried out at minimal cost and transparently allowing any subsequent replication and validation by other researchers. The program itself is inherently flexible and allows for minute specifications to suit many methodologies and experimental designs.[2]

The origins of the 'support.CEs' programs lies in agronomics, initially used to model consumer preferences for different attributes of milk (Aizaki & Sato, 2007). This study only tested a small number of attributes: the presence of HACCP and Good Agricultural Practice labels against prices amongst Tokyo residents. In recent literature, the 'support.CEs' program has also been used in environmental economics to measure stakeholder preferences for multiple use offshore platforms designs (Davila et al., 2015) and in transport studies to model changes in mode of travel with differing parking options (Ng, 2014).

The flexibility of the program is shown in its use to estimate respondents choice of funding two medical programmes using the constant-sum paired comparison method (Skedgel & Regier, 2015), where respondent trade-off between two choices with a given budget constraint. It has also been combined with eye tracking technology to yield Uruguayan consumers preferences for yoghurt labels (Mawad et al., 2015).

3 RESEARCH METHODOLOGY

According to the CIBSE (2004), there are four main factors affecting building energy consumption. The general design of the building, including shape, size, materials, location and orientation. Second, the human factors, in other words, the interaction of people with the building such as comfort requirements, occupancy regimes and activity. Third, the building services, including fuels, type and size of systems and plant controls. Fourth, the climate as an external factor.

This is of particular interest as the climate condition is considered one of the main influences on adopting sustainable technologies in the built environment, especially in countries located in the world's hottest regions that consume huge amounts of energy to operate domestic building systems, which leads to high rates of carbon dioxide emissions. Therefore, providing comfortable, healthy and sustainable living spaces in addition to using natural resources and reducing energy consumption are the most important goals of designing a climatically responsive sustainable building (Behbood et al., 2010).

[2] The authors have tested this and found incompatibilities with certain unworkable combinations, such as excessive blocking or attribute levels not found within normal DCE experimental design.

Housing has a great capability to contribute to sustainability, and it is one of the most significant public strategies affecting urban development. Various aspects of housing can have significant impacts on the environment, the way it is constructed, designed, used and demolished (Pullen et al., 2010; Winston & Pareja Eastaway, 2008) have proposed a set of nine key elements and sub-elements for sustainable housing, and these elements have been referred to in a number of studies (Al Surf, 2014; Aldossary et al., 2016; J. Liu et al., 2020; Safronova et al., 2017; Said et al., 2017):

a. efficiency (water, energy);
b. construction (methods, materials);
c. affordability (rent or purchase);
d. dwelling sizes;
e. desirability;
f. adaptability;
g. social acceptability;
h. appropriate density (low, medium, high); and
i. procurement (government, private, public–private partnership).

These elements can be classified into three main themes, according to the dimensions of sustainability (AlQahtany, 2020), as follows:

Environmental sustainability: the theme stresses the importance of designing housing in a way that saves energy (e.g., using alternative energy systems such as solar panels, wind turbines, solar water heating) and water (e.g., using rainwater collectors, greywater systems), reduces greenhouse gas emissions and reduces waste throughout construction and during the home's lifetime. The passive house is one of the most environmentally friendly designs that combines several technologies that help to achieve ultra-low energy use.

Social sustainability: this theme underlines the significance of designing housing in a way that provides comfort and flexibility for occupants with different abilities and at different stages of life, including children and people with limited mobility. It also highlights the use of built-in safety elements to avoid injuries and security features that enhance the residents' sense of security and reduce crime.

Economic sustainability: the theme highlights the importance of designing housing in a way that saves money throughout construction and during the home's lifetime. It also stresses the importance of careful planning to avoid the need for major future refurbishment work and reduces costs associated with water use, energy use and maintenance.

The preference of the home buyer may well be influenced by the above-mentioned elements and sub-elements. As such, whether stated or implicit, these elements should be considered while designing the WTP for the home buyers.

5 EXPERIMENTAL DESIGN

As with all attribute-based methods for eliciting stated preferences, the one first steps in eliciting home buyer preferences for sustainable features in homes is to identify and describe the attributes that define the choices given to respondents (Holmes & Adamowicz, 2003). For this purpose, the authors have resorted to the definitions for sustainable housing used in sustainable building standards, namely the Green Building Index (GBI) to suit the Malaysian home buying public (GBI, 2011). The authors reasoned that using established standards provides a ready baseline to define sustainability in real estate and enhance the applicability of this study's results.

The award of certification and sustainability levels in the GBI is through the tally of points given for incorporating certain features in a building that enhance sustainability (GBI, 2011). These features are discretely separated into levels, which can then be directly translated into attribute levels demarcating sustainability. The choices of sustainable features were made based on its significance on resident's quality of life and could be practically addressed through building design (Chau et al., 2006).

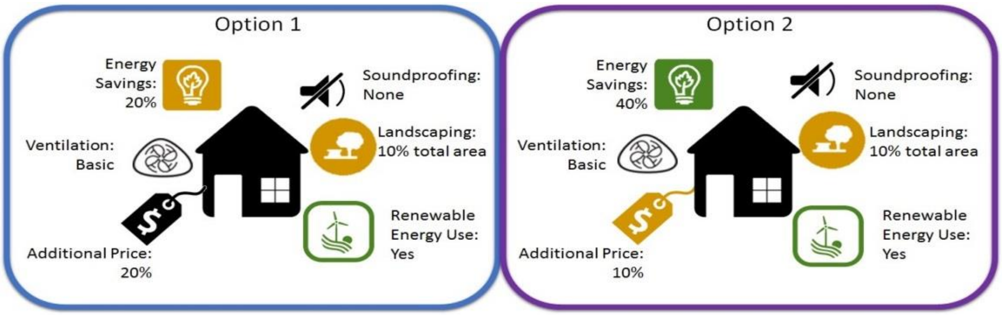
The issue of choice, or lack thereof, is a major field of study amongst stated preference practitioners. The excessive choice effect has been shown to decrease the probability of choosing an option as the number of options increases (Iyengar & Lepper, 2000) due to the increased search costs from having more options (Norwood, 2006). The Irons and Hepburn model for optimal searching behaviour stipulates that searching stops when the cost of searching one more option is greater than the expected value of the payoff from greater searching plus the reduction in regret that greater searching delivers (Irons & Hepburn, 2007), which is consistent with a satisficing model of buyer behaviour (Schwartz et al., 2002). However, because of the need to value attributes relative to every other attribute, it is necessary to have at least two options with differing attribute levels within each choice set (Holmes & Adamowicz, 2003).

Other factors that influence complexity of DCEs include the number of attributes, levels of attributes, and the number of choice sets (questions), all of which either increase or decrease the calculated WTP but almost invariably increase error variance (Burton & Rigby, 2012).

The experimental design of the overall survey is based on the L^{MA}[3] design generated internally from the 'support.CEs' program (Aizaki, 2012), where the experimental design is directly from the orthogonal main effects plan (Aizaki et al., 2014). This experimental design is generally larger than most orthogonal main effects plan for DCEs (Street et al., 2005), which the authors mitigate through effective separation of the choice sets into multiple blocks; subsets of choice sets. It has also been argued that the L^{MA} design, while orthogonal is not the most statistically efficient (Street et al., 2005) and possibly suffers from balance, overlap, and dominated pairs. Additionally, the L^{MA} design cannot be used to determine higher order interaction effects (Aizaki et al., 2014). The latter is ignored because the authors believe further interaction effects are unnecessary for this study while the former will be offset by better internal and cross-validity indicators compared to other experimental designs (Viney et al., 2005).

Based on previous evidence, the authors have decided to construct the survey based on six choice sets of two options each containing six attributes of three or two levels, separated into six blocks [an example of the choice sets is presented in Figure 1]. The following is a sample of a question in the survey, where respondents choose options 1, 2, or neither options to indicate their preference in sustainable housing:

Figure 1: Question 1, Block 1



The authors have decided to incorporate pictorials and colour coding to allow the surveys attribute and attribute levels to be more easily understood. This follows the effects of traffic light system which enhances the visibility of pertinent information (Mawad et al., 2015). Also, having a more game-like survey technique, which include more visual rather than textual information, leads to a more enjoyable experience for respondents (Ogawa et al., 1993).

[3] L^{MA} design is an experimental design, where L is the number of levels, M is the number of alternatives in each choice set, and A is the number of attributes for each alternative.

Theoretical Background

The basis of many attribute-based methods such as DCEs is the assumption that agents would choose alternatives yielding the highest utility, also known as the Random Utility Theory[4] (McFadden, 1974). Assuming respondent i selects alternative j to maximise his/her utility. The utility from making the choice, U_{ij} can be decomposed into:

$$U_{ij} = V_{ij} + e_{ij} \qquad \text{----------} \qquad (1)$$

where V_{ij} is the systematic component of the utility of respondent i from selecting alternative j, and e_{ij} is the stochastic component of the utility (Aizaki et al., 2013). The systematic component of the utility is assumed to be as follows:

$$V_{ij} = ASC + b_1\, EN_{ij} + b_2\, SD_{ij} + b_3\, VN_{ij} + b_4\, LD_{ij} + b_5\, R_{ij} + b_6\, PR_{ij} \qquad \text{----------} \ (2)$$

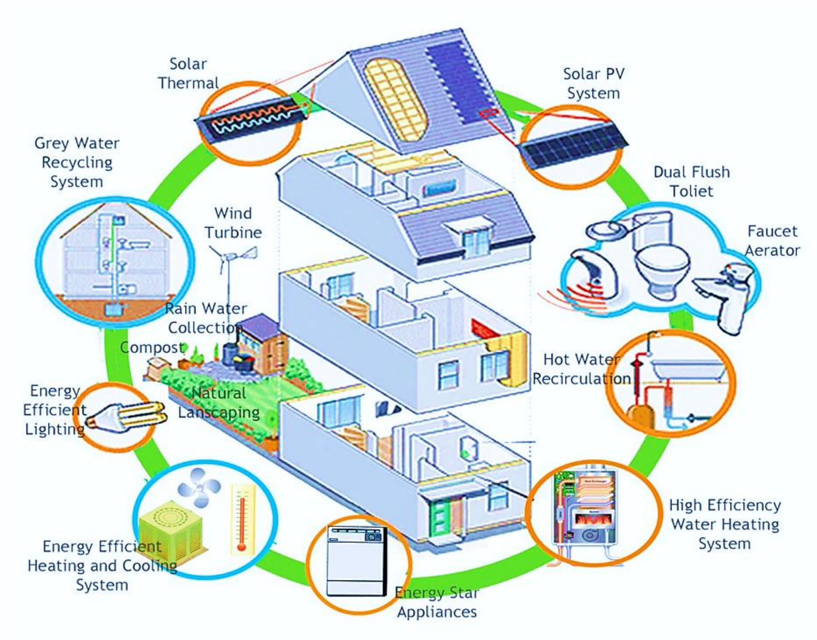
where, *ASC* denotes an alternative specific constant for housing choices relative to the neither option, where the systematic component of the utility for the option is normalised to zero. The definitions for other variables are tabulated in Table 1:

Table 1: Variable Definition

Coef.	IV	Type	Definition
b_1	EN_{ij}	Continuous	Percentage of energy saved from the respondent's energy consumption
b_2	SD_{ij}	Dummy	Enhancement of interior soundproofing
b_3	VN_{ij}	Dummy	Enhancement of indoor ventilation
b_4	LD_{ij}	Continuous	Percentage of development area set aside for landscaping and recreational uses
b_5	R_{ij}	Dummy	Production of renewable energy within the development area and usage of renewable energy in common areas
b_6	PR_{ij}	Continuous	Increase in price as a function of the respondent's perception of house price

4 A further exposition of this theory and its applications to DCEs can be found in Alberini et al. [51]

Figure 2: Illustrated list of sustainable features in homes



Survey Methodology

This survey was carried out online using Google Forms as its basis, which allowed for branching questionnaires that enabled effective separation of the choice sets into blocks that reduce the number of choice sets faced by respondents, which significantly reduce complexity (Hensher, 2004) and lessens respondents cognitive burden (Rolfe & Bennett, 2009).

The preliminary sections of the survey include basic demographic information; age, income, education, and employment which allows the authors to separate the WTP for sustainable features against different demographic groups. Previous studies have shown that demographics affect WTP for sustainable housing features (Marmolejo-Duarte & Ruiz-Lineros, 2013; Park et al., 2013), which the authors believe is also the case amongst Malaysian homebuyers.

The following section looks at the respondents current housing situation, including home ownership, current type of house, and future housing purchase decisions. The most pertinent of these questions is whether future house purchases is for investment or own use, which has been shown to affect WTP for sustainable housing (Heinzle et al., 2013).

This survey also includes a set of primer questions that is meant to shift respondents' thoughts towards sustainability and sustainable behaviour. The survey provides respondents with a list of sustainable features and sustainable behaviours (Poortinga et al., 2003) for them to acknowledge either knowing or performing. While this section of the survey is not analysed further, the authors believe it is useful to get respondents who would not have otherwise thought of sustainability and sustainable features in homes to consider the breadth of possibilities in sustainable housing.

Following these questions, respondents are given a preamble on the main part of the survey and a choice of selecting one of six blocks prepared for this DCE. Each block consists of six questions each with two options and a null option.

Results

A test run of the DCE was distributed through social media channels and received 20 responses. The table 2 shows a summary of respondents' demographics:

Table 2: Summary of respondents' demographics (n=20)

Category	n	%
Age		
18-25	1	5%
26-35	11	55%
36-45	6	30%
46-55	2	10%
Education		
Postgraduate Degree or higher	16	80%
Undergraduate Degree	4	20%
Annual Income		
less than RM 10,000	4	20%
RM 10,000 - RM 35,000	2	10%
RM 35,000 - RM 70,000	7	35%
more than RM 70,000	6	30%
Prefer not to say	1	5%
Employment		
Student	3	15%
White collar	17	85%

From the survey preliminaries, we can see that this sample consists of a good mix of first-time, long-term, and non-homeowners, summarised in Table 3. It is known that first-time homeowners, whether they have taken the property plunge or otherwise, have different priorities in their home buying decisions (Reed & Mills, 2007; Tan, 2012).

Table 3: Summary of respondents' home ownership

Home Ownership	n	%
Do not own current home	8	40%
Yes, for less than 2 years	4	20%
Yes, for 2 - 5 years	2	10%
Yes, for more than 5 years	6	30%

Table 4 represents the estimations of respondents' WTP for sustainable features in homes. The results are outputted as the results of conditional logit estimations (Hosmer Jr. et al., 2013), where columns $coef$, $\exp(coef)$, $\mathrm{se}(coef)$, z and p respectively showing the estimated coefficient, exponential function of the estimated coefficient, standard error of the estimated coefficient, z-value, and p-value under the null hypothesis that the estimated coefficient is equal to zero (Aizaki et al., 2014). Because the dependent variable; price was presented to respondents in percentages, all the coefficients here should be interpreted as a percentage increase or decrease in prices.

Table 4: WTP estimation results

	$coef$	$\exp(coef)$	$se(coef)$	z	p
ASC	0.44	1.55	0.62	0.70	4.80e-1
No Renewables	-0.85	0.43	0.34	-2.5	1.20e-2
Soundproofing	0.64	1.89	0.35	1.81	7.10e-2
Ventilation	0.44	1.55	0.32	1.36	1.70e-1
Energy Savings %	0.06	1.06	0.01	4.47	7.70e-6
Landscaping %	0.04	1.04	0.02	1.76	7.80e-2
Price %	-0.03	0.97	0.02	-1.58	1.10e-1

Likelihood ratio test=93.9 on 7 df, p=0 n= 360, number of events= 120

Using the gofm function in 'support.CEs' (Aizaki, 2012) produced the following output, which indicates the goodness of fit of the estimations above:

Rho-squared	0.356
Adjusted rho-squared	0.302
Akaike information criterion (AIC)	183.794
Bayesian information criterion (BIC)	203.306
Number of coefficients	7
Log likelihood at start	-131.833

The estimated model above is shown to be a good fit as its rho-squared and adjusted rho-squared value falls within the values of 0.2 and 0.4 (Street et al., 2005). The Akaike and Bayesian Information Criteria are criteria used to measure the statistical quality of a model that penalises a model for both deviance and complexity (Swait, 2007), where lower values are preferred over larger ones (Louviere et al., 2010). However, without competing models, it is not possible to perform any comparative analysis between models. However, the functionality of such statistical information would be greatly appreciated for researchers comparing between different groups of respondents (Osland, 2010).

Using the mwtp function in the 'support.CEs' package (Aizaki, 2012), it is possible to calculate the marginal willingness to pay (MWTP) for each sustainable feature. MWTP is defined as the economic value of a small change in a non-monetary variable (Aizaki et al., 2014). The MWTP of non-monetary goods in 'support.CEs' calculated by first defining the monetary good and using it as a baseline to calculate the economic value of all other goods defined in the DCE, using equation 3 (Aizaki et al., 2014):

$$MWTP = \frac{\delta V/\delta X_N}{\delta V/\delta X_M} = \frac{\beta_N}{\beta_M} \qquad \text{----------} \ (3)$$

The results from the MWTP estimations are presented in table 5. These results show the correct signs; the absence of renewable energy generation efforts are likely to reduce house prices by 27.8%, the enhancement of soundproofing increasing prices by 20.9%, ventilation enhancements increasing prices by 14.3%, and every percentage increase of energy savings above a baseline and landscaped area within a development increasing prices by 1.83% and 1.15% respectively.

Table 5: WTP estimation results

	MWTP	2.50%	97.50%
No Renewables	-27.802	-234.293	155.671
Soundproofing	20.909	-94.779	166.089
Ventilation	14.352	-93.299	154.339
Energy Saving %	1.829	-9.82	14.629
Landscaping %	1.152	-6.594	11.176

method = Krinsky and Robb

An earlier review of determinants of sustainable housing demand (Tareq et al., 2015) has shown that previous studies indicate positive WTP for ventilation (Chau et al., 2010; Hu et al., 2014; Kwak et al., 2010; Park et al., 2013), soundproofing (Chau et al., 2010; Hu et al., 2014), energy savings (Chau et al., 2010; Hu et al., 2014; Park et al., 2013), and landscaping (Cervero & Kang, 2011; Huang & Yin, 2015; Kong et al., 2007; A. M. Wang, 2005). However, because the current study is centred on the Malaysian home buyer, it is not possible to compare the results from this study with previous literature due to differences in sustainable development policy, purchasing power, and environmental awareness, amongst other factors.

A house's renewable energy generation capacity is positively valued in Japan (Yokoi & Ishizuka, 2013), Australia (Ma et al., 2015), and the UK (Scarpa & Willis, 2010). The positive valuation shown in this study could be attributed to Malaysia's newly introduced renewable energy policy that includes feed-in tariffs for household renewable energy generation (Ahmad et al., 2011; Sovacool & Drupady, 2011), incentivising households to install solar PV panels to generate positive cash flow. It could be possible that this positive MWTP is a manifestation of the present value of expected cash flows from this feed-in tariff (Yoshida & Sugiura, 2015). However, it is still not possible to benchmark Malaysian home buyers' WTP for renewable energy generation with those from other countries due to policy and demographic differences highlighted earlier.

CONCLUSION

This study has proven that the 'support.CEs' program (Aizaki, 2012) can be re-purposed to measure the WTP of home buyers for housing features, especially those related to sustainable development. Programming in R is a useful tool for quantitative researchers, as evidenced by this and other freely available programming packages. This study has shown that, with sufficient separation of questions into blocks, it is possible to conduct this DCE with a small sample yet still achieve statistically reliable estimates. The results from this study show the expected signs but cannot currently be compared to those from previous studies. The results here will be used as the stepping stone towards a larger study of Malaysian home buyer preferences, now that the research tool have been proven to be suitable and effective in quantifying home buyer preferences.

REFERENCES

AHMAD, S.; KADIR, M. Z. A. A.; SHAFIE, S. Current perspective of the renewable energy development in Malaysia. Renewable and Sustainable Energy Reviews, 2011 15(2), 897-904. doi:https://doi.org/10.1016/j.rser.2010.11.009

AIZAKI, H. Basic Functions for Supporting an Implementation of Choice Experiments in R. 2012, 50(Code Snippet 2), 24. doi:10.18637/jss.v050.c02

AIZAKI, H.; NAKATANI, T.; SATO, K. Stated Preference Methods Using R (1st ed. 2014). New York: Chapman and Hall/CRC.

AIZAKI, H.; NANSEKI, T.; ZHOU, H. Japanese consumer preferences for milk certified as good agricultural practice. Animal Science Journal, 2013 84(1), 82-89. doi:https://doi.org/10.1111/j.1740-0929.2012.01043.x

AIZAKI, H.; SATO, N. Consumers' Valuation of Good Agricultural Practice by Using Contingent Valuation and Contingent Ranking Methods: A Case Study of Miyagi Prefecture, Japan. Agricultural Information Research, 2007 16(3), 150-157. doi:10.3173/air.16.150

AL SURF, M. S. Challenges facing the application of sustainability to housing in Saudi Arabia. (PhD QUT Thesis (PhD)), Queensland University of Technology, Queensland, 2014.

ALDOSSARY, N. A.; REZGUI, Y.; KWAN, A. Public perception of sustainable, low energy homes in a subsidized developing country: Saudi Arabia as case study. Paper presented at the The 2016 International Academic Research Conference, 2016, London.

ALQAHTANY, A. People's perceptions of sustainable housing in developing countries: the case of Riyadh, Saudi Arabia. Housing, Care and Support, 2020 23(3/4), 93-109. doi:10.1108/HCS-05-2020-0008

AMARCHINTA, H. K.; GRANDHI, R. V. Multi-Attribute Structural Optimization Based on Conjoint Analysis. AIAA Journal, 2008 46(4), 884-893. doi:10.2514/1.30530

BAK, A.; BARTLOMOWICZ, T. Conjoint analysis method and its implementation in conjoint R package. In J. Pociecha & R. Decker (Eds.), Data analysis methods and its applications, (Pociecha J., Decker R. (Eds.) ed., 2012 pp. 239-248). Bielefeld University, Germany: Bielefeld University, Germany.

BALABAN, O.; PUPPIM DE OLIVEIRA, J. A. Sustainable buildings for healthier cities: assessing the co-benefits of green buildings in Japan. Journal of Cleaner Production, 2017 163, S68-S78. doi:https://doi.org/10.1016/j.jclepro.2016.01.086

BEHBOOD, K. T.; TALEGHANI, M.; HEIDARI, S. Energy efficient architectural design strategies in hot-dry area of Iran: Kashan. Emirates Journal for Engineering Research, 2010 15(2), 85-91.

BORGHI, C. Discrete choice models for marketing: New methodologies for optional features and bundles. (Master Master thesis), Mathematisch Instituut, Universiteit Leiden, Leiden 2009. Retrieved from https://www.universiteitleiden.nl/binaries/content/assets/science/mi/scripties/borghimaster.pdf

BOXALL, P. C.; ADAMOWICZ, W. L.; SWAIT, J.; WILLIAMS, M.; LOUVIERE, J. A comparison of stated preference methods for environmental valuation. Ecological Economics, 1996 18(3), 243-253. doi:https://doi.org/10.1016/0921-8009(96)00039-0

BROWNSTONE, D.; BUNCH, D. S.; TRAIN, K. Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. Transportation Research Part B: Methodological, 2000 34(5), 315-338. doi:https://doi.org/10.1016/S0191-2615 (99)00031-4

BURTON, M.; RIGBY, D. The Self Selection of Complexity in Choice Experiments. American Journal of Agricultural Economics, 2012 94(3), 786-800. doi:https://doi.org/10.1093/ajae/aas015

CALFEE, J.; WINSTON, C.; STEMPSKI, R. Econometric Issues in Estimating Consumer Preferences from Stated Preference Data: A Case Study of the Value of Automobile Travel Time. The Review of Economics and Statistics, 2001 83(4), 699-707. doi:10.1162/003465301753237777

CARSON, R. T.; HANEMANN, W. M. Chapter 17 Contingent Valuation. In K.-G. Mler & J. R. Vincent (Eds.), Handbook of Environmental Economics 2005 Vol. 2, pp. 821-936. Elsevier.

CERVERO, R. ; KANG, C. D. Bus rapid transit impacts on land uses and land values in Seoul, Korea. Transport Policy, 2011 18(1), 102-116. doi:https://doi.org/10.1016/j.tranpol.2010.06.005

CHAU, C. K.; TSE, M. S.; CHUNG, K. Y. A choice experiment to estimate the effect of green experience on preferences and willingness-to-pay for green building attributes. Building and Environment, 2010 45(11), 2553-2561. doi:https://doi.org/10.1016/j.buildenv.2010.05.017

CHAU, C. K.; YUNG, H. K.; LEUNG, T. M.; LAW, M. Y. Evaluation of relative importance of environmental issues associated with a residential estate in Hong Kong. Landscape and Urban Planning, 2006 77(1), 67-79. doi:https://doi.org/10.1016/j.landurbplan.2005.01.006

D'AGOSTINO, D.; ZACÀ, I.; BAGLIVO, C.; CONGEDO, P. M. Economic and Thermal Evaluation of Different Uses of an Existing Structure in a Warm Climate. Energies, 2017 10(5), 658.

DAHLBLOM, M. Towards sustainability with building services systems:–by focusing on material choices, energy use and thermal indoor climates in residential buildings. Tor, 2020 Uppsala University, Sweden.

DANAHER, P. J. Using conjoint analysis to determine the relative importance of service attributes measured in customer satisfaction surveys. Journal of Retailing, 1997 73(2), 235-260. doi:https://doi.org/10.1016/S0022-4359(97)90005-1

DARKO, A.; CHAN, A. P. C. Review of Barriers to Green Building Adoption. Sustainable Development, 2017 25(3), 167-179. doi:https://doi.org/10.1002/sd.1651

DAVILA, O. G.; KOUNDOURI, P.; SOULIOTIS, I.; KOTRONI, E.; CHEN, W.; HAGGETT, C.; RUDOLPH, D. Supporting BLUE Growth: Eliciting Stakeholders' preferences for Multiple-Use Offshore Platforms. DEOS Working Papers, 2015. Athens University of Economics and Business.

FILER, J. E.; DELORIT, J. D.; HOISINGTON, A. J.; SCHULDT, S. J. Optimizing the Environmental and Economic Sustainability of Remote Community Infrastructure. Sustainability, 2020 12(6), 2208.

FONT-I-FURNOLS, M.; GUERRERO, L. Consumer preference, behavior and perception about meat and meat products: An overview. Meat Science, 2014 98(3), 361-371. doi:https://doi.org/10.1016/j.meatsci.2014.06.025

FORMAN, E. H.; GASS, S. I. The Analytic Hierarchy Process—An Exposition. Operations Research, 2001 49(4), 469-486. doi:10.1287/opre.49.4.469.11231

GALSTER, G. William Grigsby and the Analysis of Housing Sub-markets and Filtering. Urban Studies, 1996 33(10), 1797-1805. doi:10.1080/0042098966376

GBI. Assessment Criteria for Residential New Construction RNC (2014). Avaliable in: https://www.greenbuildingindex.org/Files/Resources/GBI%20Tools/RNC%20Reference%20Guide%20V3.1.pdf

GILL, D. A.; SCHUHMANN, P. W.; Oxenford, H. A. Recreational diver preferences for reef fish attributes: Economic implications of future change. Ecological Economics, 2015 111, 48-57. doi:https://doi.org/10.1016/j.ecolecon.2015.01.004

GLUMAC, B.; WISSINK T. P. Homebuyers' preferences concerning installed photovoltaic systems: A discrete choice experiment. Journal of European Real Estate Research, 2018 11(1), 102-124. doi:10.1108/JERER-12-2016-0044

GREEN, P. E.; SRINIVASAN, V. Conjoint Analysis in Consumer Research: Issues and Outlook. Journal of Consumer Research, 1978 5(2), 103-123. doi:10.1086/208721

HALL, J.; VINEY, R.; HAAS, M.; LOUVIERE, J. Using stated preference discrete choice modeling to evaluate health care programs. Journal of Business Research, 2004 57(9), 1026-1032. doi:https://doi.org/10.1016/S0148-2963(02)00352-1

HAN, X. Housing demand in Shanghai: A discrete choice approach. China Economic Review, 2010 21(2), 355-376. doi:https://doi.org/10.1016/j.chieco.2010.02.006

HARDI, P.; ZDAN, T.; SMITH, G. Assessing sustainable development: principles in practice. In G. Smith (Ed.), (Smith, G. (Ed.). ed 1999.).

HEINZLE, S. L.; BOEY Y. Y.; A.; LOW Y. X. M. The Influence of Green Building Certification Schemes on Real Estate Investor Behaviour: Evidence from Singapore. Urban Studies, 2013 50(10), 1970-1987. doi:10.1177/0042098013477693

HENSHER, D. A. Identifying the Influence of Stated Choice Design Dimensionality on Willingness to Pay for Travel Time Savings. Journal of Transport Economics and Policy, 2004 38(3), 425-446.

HOEFMAN, R.; AL-JANABI, H.; MCCAFFREY, N.; CURROW, D.; RATCLIFFE, J. Measuring caregiver outcomes in palliative care: a construct validation study of two instruments for use in economic evaluations. Quality of Life Research, 2015 24(5), 1255-1273. doi:10.1007/s11136-014-0848-8

HOLMES, T. P.; ADAMOWICZ, W. L.Attribute-Based Methods. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), A Primer on Nonmarket Valuation (2003 pp. 171-219). Dordrecht: Springer Netherlands.

HOSMER JR. D. W.; LEMESHOW, S.; STURDIVANT, R. X. Applied Logistic Regression (r. Edition Ed.). NJ: John Wiley & Sons, 2013 Hoboken.

HU, H.; GEERTMAN, S; HOOIMEIJER, P. The willingness to pay for green apartments: The case of Nanjing, China. Urban Studies, 2014 51(16), 3459-3478. doi:10.1177/0042098013516686

HUANG, H.; YIN, L. Creating sustainable urban built environments: An application of hedonic house price models in Wuhan, China. Journal of Housing and the Built Environment, 2015 30(2), 219-235. doi:10.1007/s10901-014-9403-8

HUONG, N. V.; SOEBARTO, V. Gaps in Understanding Sustainable Housing: Case study in Adelaide and Hanoi. Architectural Science Review, 2003 46(4), 369-374. doi:10.1080/00038628.2003.9697008

IJZERMAN, M. J.; VAN TIL, J. A.; BRIDGES, J. F. P. A Comparison of Analytic Hierarchy Process and Conjoint Analysis Methods in Assessing Treatment Alternatives for Stroke Rehabilitation. The Patient - Patient-Centered Outcomes Research, 2012 5(1), 45-56. doi:10.2165/11587140-000000000-00000

IRONS, B.; HEPBURN, C. Regret Theory and the Tyranny of Choice*. Economic Record, 2007 83(261), 191-203. doi:https://doi.org/10.1111/j.1475-4932.2007.00393.x

ISA, M.; RAHMAN, M. M. G. M. A.; SIPAN, I.; HWA, T. K. Factors Affecting Green Office Building Investment in Malaysia. Procedia - Social and Behavioral Sciences, 2013 105, 138-148. doi:https://doi.org/10.1016/j.sbspro.2013.11.015

IYENGAR, S. S.; LEPPER, M. R. When choice is demotivating: Can one desire too much of a good thing? Journal of Personality and Social Psychology, 2000 79(6), 995-1006. doi:10.1037/0022-3514.79.6.995

JOHAR, F.; RAZAK, M. R. The Right Attitude to Sustain the Green Neighbourhoods. Procedia - Social and Behavioral Sciences, 2015 202, 135-143. doi:https://doi.org/10.1016/j.sbspro.2015.08.216

JOHNSON, F. R. ; DESVOUSGES, W. H. Estimating Stated Preferences with Rated-Pair Data: Environmental, Health, and Employment Effects of Energy Programs. Journal of Environmental Economics and Management, 1997 34(1), 79-99. doi:https://doi.org/10.1006/jeem.1997.1002

JUDGE, M.; WARREN-MYERS, G.; PALADINO, A. Using the theory of planned behaviour to predict intentions to purchase sustainable housing. Journal of Cleaner Production, 2019 215, 259-267. doi:https://doi.org/10.1016/j.jclepro.2019.01.029

KALLAS, Z; GÓMEZ-LIMÓN, J. A.; HURLÉ, J. B. Decomposing the Value of Agricultural Multifunctionality: Combining Contingent Valuation and the Analytical Hierarchy Process. Journal of Agricultural Economics, 2007 58(2), 218-241. doi:https://doi.org/10.1111/j.1477-9552.2007.00085.x

KAUKO, T. What makes a location attractive for the housing consumer? Preliminary findings from metropolitan Helsinki and Randstad Holland using the analytical hierarchy process. Journal of Housing and the Built Environment, 2006 21(2), 159-176. doi:10.1007/s10901-006-9040-y

KHAN, R. A. J.; THAHEEM, M. J.; ALI, T. H. Are Pakistani homebuyers ready to adopt sustainable housing? An insight into their willingness to pay. Energy Policy, 2020 143, 111598. doi:https://doi.org/10.1016/j.enpol.2020.111598

KIBERT, C. J. Green buildings: an overview of progress. Journal of Land Use & Environmental Law (Proceedings of the 10th anniversary public interest environmental conference: 'shaping Florida's future: a decade of protecting an eternity), 2004 19(2), 502.

KLUMBYTE, E.; BLIUDZIUS, R.; FOIKADES, P. A SIPOC based model for the sustainable management of facilities in social housing. IOP Conference Series: Earth and Environmental Science, 2020 410, 012081. doi:10.1088/1755-1315/410/1/012081

KONG, F.; YIN, H.; NAKAGOSHI, N.Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China. Landscape and Urban Planning, 2007 79(3), 240-252. doi:https://doi.org/10.1016/j.landurbplan.2006.02.013

KWAK, S.-Y.; YOO, S.-H.; KWAK, S.-J. Valuing energy-saving measures in residential buildings: A choice experiment study. Energy Policy, 2010 38(1), 673-677. doi:https://doi.org/10.1016/j.enpol.2009.09.022

LIU, J.; BENGTSSON, B.; BOHMAN, H.; STAFFANSSON PAULI, K. A System Model and An Innovation Approach toward Sustainable Housing Renovation. Sustainability, 2020 12(3), 1130.

LIU, Y.; HONG, Z.; ZHU, J.; YAN, J.; QI, J; LIU, P. Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter. Energy Policy, 2018 112, 152-161. doi:https://doi.org/10.1016/j.enpol.2017.10.020

LOUVIERE, J. J.; FLYNN, T. N.; CARSON, R. T. Discrete Choice Experiments Are Not Conjoint Analysis. Journal of Choice Modelling, 2010 3(3), 57-72. doi:https://doi.org/10.1016/S1755-5345 (13)70014-9

MA, C.; POLYAKOV, M.; PANDIT, R. Solar Capitalization in Western Australian Property Market. School of Agricultural and Resource Economics. University of Western Australia. Australia, 2015. Retrieved from https://ideas.repec.org/p/ags/uwauwp/199230.html

MALIENE, V.; MALYS, N.. High-quality housing—A key issue in delivering sustainable communities. Building and Environment, 2009 44(2), 426-430. doi:https://doi.org/10.1016/j.buildenv.2008.04.004

MANGHAM, L. J. ; HANSON, K. ; MCPAKE, B. How to do (or not to do). Designing a discrete choice experiment for application in a low-income country. Health Policy and Planning, 2008 24(2), 151-158. doi:10.1093/heapol/czn047

MARMOLEJO-DUARTE, C.; RUIZ-LINEROS, M. Using choice-based-experiments to support real estate design decisions. Journal of European Real Estate Research, 2013 6(1), 63-89. doi:10.1108/17539261311312979

MAWAD, F.; TRÍAS, M.; GIMÉNEZ, A.; MAICHE, A; ARES, G. Influence of cognitive style on information processing and selection of yogurt labels: Insights from an eye-tracking study. Food Research International, 2015 74, 1-9. doi:https://doi.org/10.1016/j.foodres.2015.04.023

MCFADDEN, D. Conditional logit analysis of qualitative choice behavior. New York: Academic Press, 1974.

MEDINECKIENĖ, M., TURSKIS, Z., & ZAVADSKAS, E. K. Sustainable construction taking into account the building impact on the environment. Journal of Environmental Engineering and Landscape Management, 2010 18(2), 118-127. doi:https://doi.org/10.3846/jeelm.2010.14

METSELAAR, E. E. Assessing the willingness to change: Construction and validation of the DINAMO. (PhD Thesis), Vrije Universiteit Amsterdam, Amsterdam, 1997.

MOSER, R.; RAFFAELLI, R. Does attribute cut-off elicitation affect choice consistency? Contrasting hypothetical and real-money choice experiments. Journal of Choice Modelling, 2014 11, 16-29. doi:https://doi.org/10.1016/j.jocm.2014.02.003

MULLINER, E.; MALIENE, V. Criteria for sustainable housing affordability. Journal of Environmental Engineering and Landscape Management, 2011 3, 966-973.

MUZAFFAR, N. Developing an extended model of Theory of Planned behaviour to explore green purchase behavior of Pakistani consumers. American Journal of Business and Management, 2015 4(2), 85–101. doi:https://doi.org/10.11634/216796061504654

NG, W. Assessing the Impact of Parking Pricing on Transportation Mode Choice and Behaviour. (PhD Doctor of Philosophy), University of California, Berkeley, USA. Retrieved from https://escholarship.org/uc/item/56f3v4wg Available from UC Berkeley UC Berkeley Electronic Theses and Dissertations database. 2014 (Ng_berkeley_0028E_14710)

NORWOOD, F. B. Less Choice is Better, Sometimes. Journal of Agricultural & Food Industrial Organization, 2006 4(1). doi:doi:10.2202/1542-0485.1130

OERLEMANS, L. A. G.; CHAN, K.-Y.; VOLSCHENK, J. Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. Renewable and Sustainable Energy Reviews, 2016 2016 66, 875-885. doi:https://doi.org/10.1016/j.rser.2016.08.054

OGAWA, K.; HATTORI, S.; FUKUSHIMA, T. A Comparative Study of Data Gathering Procedures in Conjoint Measurement. グノーシス：法政大学産業情報センター紀要＝Γνωσις(2), 1993 18-33. doi:info:doi/10.15002/00020855

OKECHUKU, C. The Importance of Product Country of Origin: A Conjoint Analysis of the United States, Canada, Germany and The Netherlands. European Journal of Marketing, 1994 28(4), 5-19. doi:10.1108/03090569410061150

ORME, B. (2001). Which Conjoint Method Should I Use? Semantic Scholar 2001. Available in: https://business.nmsu.edu/~mhyman/M310_Articles/Which_CA_Method_to_Use.pdf

ORZECHOWSKI, M. A.; ARENTZE, T. A.; BORGERS, A. W. J.; TIMMERMANS, H. J. P. Alternate methods of conjoint analysis for estimating housing preference functions: Effects of presentation style. Journal of Housing and the Built Environment, 2005 20(4), 349-362. doi:10.1007/s10901-005-9019-0

OSLAND, L. An Application of Spatial Econometrics in Relation to Hedonic House Price Modeling. Journal of Real Estate Research, 2010 32(3), 289-320. doi:10.1080/10835547.2010.12091282

PARK, M.; HAGISHIMA, A.; TANIMOTO, J.; CHUN, C. Willingness to pay for improvements in environmental performance of residential buildings. Building and Environment, 2013 60, 225-233. doi:https://doi.org/10.1016/j.buildenv.2012.10.017

POORTINGA, W.; STEG, L.; VLEK, C.; WIERSMA, G. Household preferences for energy-saving measures: A conjoint analysis. Journal of Economic Psychology, 2003 24(1), 49-64. doi:https://doi.org/10.1016/S0167-4870(02)00154-X

PULLEN, S.; MICHAEL, A; GEORGE, Z.; JIAN, Z.; NICHOLAS, C.; LOU, W. Developing an assessment framework for affordable and sustainable housing. Construction Economics and Building, 2010 10(1), 48-64. doi:https://doi.org/10.5130/AJCEB.v10i1-2.1587

QIN, H. T. Y.; IM, L. P.; ABDULLATEEF, O. Sustainability of affordable housing: A review of assessment tools. International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 2020 11(8). doi:DOI: 10.14456/ITJEMAST.2020.157

REED, R.; MILLS, A. Identifying the drivers behind housing preferences of first-time owners. Property Management, 2007 25(3), 225-241. doi:10.1108/02637470710753611

ROLFE, J.; BENNETT, J. The impact of offering two versus three alternatives in choice modelling experiments. Ecological Economics, 2009 68(4), 1140-1148. doi:https://doi.org/10.1016/j.ecolecon.2008.08.007

SAFRONOVA, N.; NEZHNIKOVA, E.; KOLHIDOV, A. Sustainable housing development in conditions of changing living environment. Paper presented at the MATECWeb of Conferences, 2017.

SAID, R.; DAUD, M. N.; ESHA, Z.; AB. MAJID, R; NAJIB, M. Owners' Perception towards Sustainable Housing Affordability in Kuching, Sarawak. Journal of Design and Built Environment, 2017 194-206%@ 2232-1500. doi:10.22452/jdbe.sp2017no1.16

SALAMA, A. Sustainability/Trans-Disciplinarity: A Concern for People and Environments between Confusing Terminology and Outdated Approaches, 2007. Retrieved from https://pureportal.strath.ac.uk/en/publications/sustainability-trans-disciplinarity-a-concern-for-people-and-envi

SCARPA, R.; WILLIS, K. Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. Energy Economics, 2010 32(1), 129-136. doi:https://doi.org/10.1016/j.eneco.2009.06.004

SCHOLL, A.; MANTHEY, L.; HELM, R.; STEINER, M. Solving multiattribute design problems with analytic hierarchy process and conjoint analysis: An empirical comparison. European Journal of Operational Research, 2005 164(3), 760-777. doi:https://doi.org/10.1016/j.ejor.2004.01.026

SCHWARTZ, B.; WARD, A.; Monterosso, J.; Lyubomirsky, S.; White, K.; Lehman, D. R. Maximizing versus satisficing: Happiness is a matter of choice. Journal of Personality and Social Psychology, 2002 83(5), 1178-1197. doi:10.1037/0022-3514.83.5.1178

SILAYOI, P; SPEECE, M. The importance of packaging attributes: a conjoint analysis approach. European Journal of Marketing, 2007 41(11/12), 1495-1517. doi:10.1108/03090560710821279

SKEDGEL, C.; REGIER, D. A. Constant-Sum Paired Comparisons for Eliciting Stated Preferences: A Tutorial. The Patient - Patient-Centered Outcomes Research, 2015 8(2), 155-163. doi:10.1007/s40271-014-0077-9

SOVACOOL, B. K.; DRUPADY, I. M. Examining the Small Renewable Energy Power (SREP) Program in Malaysia. Energy Policy, 2011 39(11), 7244-7256. doi:https://doi.org/10.1016/j.enpol.2011.08.045

STREET, D. J.; BURGESS, L.; LOUVIERE, J. J. Quick and easy choice sets: Constructing optimal and nearly optimal stated choice experiments. International Journal of Research in Marketing, 2005 22(4), 459-470. doi:https://doi.org/10.1016/j.ijresmar.2005.09.003

SWAIT, J. Advanced Choice Models. In B. J. Kanninen (Ed.), Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice (Kanninen, Barbara J. (Ed.) 2007 ed., pp. 229-293). Netherlands, Dordrecht: Springer Netherlands, Dordrecht.

SYAHID, A.; TAREQ, M. A.; ZAKI, S. A. Sustainability or Bust: Malaysian Home Buyers' Stated Preferences for Sustainable Housing. Paper presented at the 2016 The 3rd International Conference on Industrial Engineering and Applications (ICIEA 2016).

TAN, T.-H. Meeting first-time buyers' housing needs and preferences in greater Kuala Lumpur. Cities, 2012 29(6), 389-396. doi:https://doi.org/10.1016/j.cities.2011.11.016

TAREQ, M. A.; SYAHID, A.; KHAN, O. S. M.; ZAKI, S. A. Housing Demand Factors and its Implications on Sustainable Housing in Asia: A Retrospective. SSRN, 2015. Available in: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3848780

VINEY, R.; SAVAGE, E; LOUVIERE, J. Empirical investigation of experimental design properties of discrete choice experiments in health care. Health Economics, 14(4), 2005 349-362. doi:https://doi.org/10.1002/hec.981

WANG, A. M. Measuring the benefits of urban green areas: A spatial hedonic approach. Paper presented at the The 10th Asian Real Estate Society (AsRES) International Conference, Sydney, Australia, 2005.

WANG, P.-K.; SHIH, S.-G.; PERNG, Y.-H. Competitive Advantage Evaluation Model of Sustainable Housing Design. Sustainability, 2020 12(15), 6020.

WINGATE, S. Public perception of sustainable interior design practices in residential settings. (Master Graduate Theses and Dissertations), Iowa State University, Ames, Iowa, 2014. Retrieved from https://lib.dr.iastate.edu/etd/14257 (14257)

WINSTON, N. Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. Sustainable Development, 2010 18(6), 319-330. doi:https://doi.org/10.1002/sd.399

WINSTON, N.; PAREJA EASTAWAY, M. Sustainable Housing in the Urban Context: International Sustainable Development Indicator Sets and Housing. Social Indicators Research, 2008 87(2), 211-221. doi:10.1007/s11205-007-9165-8

YOKOI, T.; ISHIZUKA, H. Two-stage spatial hedonic model on newly built condominiums in the Tokyo housing market. Paper presented at the AsRES 19th International Conference, Asian Real Estate Society, Sydney, 2013.

YOSHIDA, J.; SUGIURA, A. The Effects of Multiple Green Factors on Condominium Prices. The Journal of Real Estate Finance and Economics, 2015 50(3), 412-437. doi:10.1007/s11146-014-9462-3

ZAHEDI, F. The Analytic Hierarchy Process—A Survey of the Method and its Applications. INFORMS Journal on Applied Analytics, 1986 16(4), 96-108. doi:10.1287/inte.16.4.96

ZHANG, L.; SUN, C.; LIU, H.; ZHENG, S. The role of public information in increasing homebuyers' willingness-to-pay for green housing: Evidence from Beijing. Ecological Economics, 2016 129, 40-49. doi:https://doi.org/10.1016/j.ecolecon.2016.05.010