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Homebuyers' Green Features Preferences and Willingness To Pay: Evidence From Penang, Malaysia

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Abstract

Purpose – This paper aims to determine the green features that homebuyers in Penang consider for their green building choice, as well as to investigate the price premium that prospective homebuyers are willing to pay for green buildings as compared with normal buildings.

Design/methodology/approach – This study used a quantitative approach. There are twelve green features identified and grouped under three independent variables namely energy efficiency, indoor environment quality and water efficiency. The survey was a cross-sectional study and a total of 120 valid responses were collected using a self-administered online survey questionnaire among Penangites in Malaysia. Multinomial logistic regressions were run using Stata 17.0 for the data analysis.

Findings – The result shows that indoor environment quality is the major factor that will influence the home buyers' willingness to pay for 11% to 29% green buildings' price premium. Those features are natural ventilation design, sufficient daylighting, low-toxicity finishes and furnishing, and sound insulation design.

Practical implication – The study provides insights for policymakers and developers to understand the needs for home buyers so that green buildings can be successfully launched and appreciated in the country.

Originality – The understanding of the homebuyers' green features and the range of willingness to pay for price premium may provide a guide to the developer in determining the design and price range for green building development.

Keywords Green building, Green features, Willingness to pay, Price premium, Penang, Environment

Introduction

Green Buildings (GBs) are referred to as those buildings that have a less negative impact on the environment. GBs can eliminate negative impacts on the natural environment through the practice of resource efficiency throughout a building's life cycle beginning from planning, design, construction, operation, and maintenance of the buildings. GBs become a significant sustainable development as they manage to preserve the natural resources and enhance the well-being of the occupants (Goh *et al.*, 2021; Zhang and Tu, 2021; Green Building Index, 2022; Guribie *et al.*, 2022). Traditional buildings consume more energy than is required and produce a variety of emissions and waste (Samer, 2013). The economic benefits associated with lower energy usage in green buildings are worth considering from a life cycle perspective (Dwaikat and Ali, 2018).

There are various GB rating systems created by different countries to assess the level of sustainability of green buildings. The Green Building Index (GBI) was first established in Malaysia in 2009 by the Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia aims to guide the built environment toward a more eco-friendly environment through the stakeholders such as developers, architects, engineers, and contractors. Even though Malaysia is very close to Singapore, the green building rating systems for both countries are different. In Malaysia, the GBI is composed of particularity for Malaysia’s tropical weather, environmental context, and cultural and social needs. The GBI tools evaluate the buildings’ environmental design and performance through the six main criteria namely energy efficiency, indoor environment quality, sustainable site planning and management, materials and resources, water efficiency, and innovation (Vyas and Jha, 2016; Green Building Index, 2022). This study selected energy efficiency (EE), indoor environmental quality (IEQ) and water efficiency (WE) as the three main green preferences because these are the major concerns for most individuals in Malaysia. Penangites as well as Malaysians are always trying to reduce their electrical bills to reduce their cost of living, emphasising on good indoor environmental quality when purchasing house as this indicates good feng shui, and Malaysians are always being reminded by the government to reduce the water usage especially, when water level is low in the reservoir.

In the past, various GB studies have examined the barriers to GB implementation in the global and specific country context (Darko & Chan, 2017; Guribie *et al.*, 2022; Lee *et al.*, 2020; Lop *et al.*, 2019; Samari *et al.*, 2013; Shen *et al.*, 2017; Wang *et al.*, 2021; Wong *et al.*, 2021). Darko & Chan (2017) summarised the barriers through a systematic review of the literature. The most-reported barriers include lack of information, cost, lack of incentives, lack of interest and demand, and lack of GB codes and regulations. According to Wang *et al.* (2021), the primary influencing elements for the growth of green buildings in China are the amount of science and technology input, the size of the industrial sector, and green financial assistance. Guribie *et al.* (2022) mentioned that the top six reasons for the low demand for GB in Ghana include inadequate GB advertising, the perceived cost of implementation, a lack of knowledge and technology, a lack of financial incentives, an uneducated construction industry, and investment risks and uncertainties. Shen *et al.* (2017) examined this topic from the views of building specialists in Thailand and concluded that the competence of the parties involved in the development of the GB is crucial for the success of the GB industry.

In the Malaysian context, Lop *et al.* (2019) utilised a survey questionnaire to collect the opinion of architects, and the results showed that the most important success criteria to boost GB implementation and participation are providing education and training to construction practitioners, increasing clients awareness, and government initiatives. Besides, Lee *et al.* (2020), Samari *et al.* (2013), and Wang *et al.* (2021) collected data from construction industry professionals and found that the lack of market demand for GB is one of the important barriers for GB industry. While various studies have been conducted to examine the barriers of the implementation of GB from the construction experts' perspective point of view, yet, limited study collected responses from the purchasers' point of view. This study attempts to bridge this gap because the demand for green building developments is primarily driven by market needs, therefore, understanding the end-user requirements should ultimately play a key part in deciding the GB success (Chau, Tse and Chung, 2010).

The Malaysian government including Penang has been providing a variety of incentives to developers that seek green building certification, particularly the GBI to promote greener building and construction practises. However, concerns about cost and market demand have inhibited growth (Green Buildings and Townships Working Group, 2020). Hence, this study examines whether these green features (i.e., energy efficiency, indoor environmental quality, and water efficiency) positively affect Penangites' willingness to pay (WTP) more for GB as compared with non-GB buildings.

Literature Review

Conceptual Framework

The multinomial logistic regression model was used in this study because the dependent variable (i.e., WTP for GB) is a nominal variable categorized as 0 (not WTP any), 1 (WTP additional 1% to 10%), 2 (WTP additional 11% to 29%), and 3 (WTP equal or more than 30%). Equation (1) shows the multinomial logistic regression model, which calculates the probability of being in a nominal variable's category versus the nominal variable's base category.

$$ln\left[\frac{\pi(Y=j|x_1,x_2,\dots\dots,x_p)}{\pi(Y=J|x_1,x_2,\dots\dots,x_p)}\right]=\alpha_j+\beta_{j1}X_1+\beta_{j2}X_2+\cdots+\beta_{jp}X_p$$

Equation (1)

Where

$j=1,2,\dots,J-1$

J = base category (which it can be any category, typically the highest one)

α_j = intercepts

$\beta_{j1},\beta_{j2},\dots,\beta_{jp}$ = logit coefficients for each comparison

The odds in a multinomial logistic model are the proportion of a category's probability to that of the base category, which is determined by the exponential of the logit coefficient β. It is written as follows and is interpreted as the change in probabilities for a one-unit change in a predictor variable while holding other predictor variables constant:

$$Odds\ (Y=j\ vs.Y=J)=\frac{p(Y=j)}{p(Y=J)} \qquad \text{Equation (2)}$$

The following Equation (3) is constructed as a multinomial logistic regression model for this study based on the predictor variables, control variables, and dependent variables.

$$ln\left[\frac{\pi(Y=j|x_1,x_2,\dots\dots,x_8)}{\pi(Y=J|x_1,x_2,\dots\dots,x_8)}\right]=\alpha_j+\beta_{j1}EE+\beta_{j2}IEQ+\beta_{j3}WE+\beta_{j4}i.AGE+\beta_{j5}i.G+\beta_{j6}i.EDU+\beta_{j7}i.CHILD+\beta_{j8}i.MHI \qquad \text{Equation (3)}$$

Where j refers to

$j=0\ indicates\ WTP\ is\ 0\%$

$j=1\ indicates\ WTP\ is\ 1\%\ to\ 10\%\ (low), base\ category$

$j=2\ indicates\ WTP\ is\ 11\%\ to\ 29\%\ (medium)$

$j=3\ indicates\ WTP\ is\ \geq 30\%\ (high)$

$EE=Energy\ efficiency;\quad IEQ=Indoor\ environment\ quality;\quad WE=$

$Water\ efficiency$; $AGE = Age\ group$; $G = Gender\ (Male\ or\ Female)$; $EDU = Education\ level$;
$CHILD = Having\ children\ or\ not$; $MHI = Monthly\ household\ income$

The Development of Green Building in Malaysia and Penang

The Construction Industry Transformation Programme (CITP) 2016-2020 was created by the Malaysian government's Ministry of Works to facilitate sector-wide transformation, ensuring the industry's productivity, resilience, and sustainability. The CITP was designed to produce strategic planning and has been established to improve the performance of the Malaysian construction industry with sustainable elements. However, the majority of stakeholders in the construction industry are not involved in this change, therefore slowing down development (Lee, Azmi and Lee, 2020). The incentives for the development of GB such as tax exemption and stamp duty implemented by the Malaysian government are unable to attract the construction firms to enter GB development because of the high upfront cost of GB is not able to recoup the financial incentives introduced by the government (Samari *et al.*, 2013).

As of the year 2020, Kuala Lumpur, Selangor, and Penang were the states in Malaysia with the most GBI-certified buildings (Green Buildings and Townships Working Group, 2020). Penang announced the Batu Kawan Eco-City programme in 2011 with the goal of fostering sustainable growth for the new city. The 2,600 hectare development includes commercial and residential all to be GBI certified, according to the Batu Kawan Eco-City regulations (Phee, 2018). Unfortunately, the adoption of green design and innovation in buildings has been low due to higher cost that has discouraged the development of GB (Green Buildings and Townships Working Group, 2020).

The Penang government has strongly encouraged GB development due to its long term cost benefits. Kats *et al.* (2003) mentioned that green design would result in life cycle savings of 20% of total construction expenses, with just a modest increase in upfront expenditures of roughly 2%. In a Leadership in Energy and Environmental Design (LEED) building, the financial benefits of green design are between US$50 and US$70 per square foot for a 20-year net benefit (Kats *et al.*, 2003; Kats, 2003). Besides, Paul von (2003) revealed a significant cost saving for LEED-certified buildings compared with traditional buildings over the 40-year life cycle. The benefits of GBs provide numerous economic advantages incorporating lower energy usage, increased occupant productivity and decreased health liability risks via improved indoor air quality (Paul von, 2003). It is also believed that cost savings through the benefit of GB may improve a customer's willingness to purchase and pay more in the near future (Samari *et al.*, 2013).

Related Literature on Willingness to Pay (WTP) for Green Building (GB)

Lee *et al.* (2020) mentioned that 71.1% of developers companies based in Kuching, Sarawak, stated that market demand is one of the factors motivating construction industry players to implement GB. This is further supported by Wong *et al.* (2021) where various stakeholders in the Malaysian construction industry highlighted that low market demand for GB is among the most important barriers in the GB implementation. Based on the inputs from the perspective of industry players, improving consumers' awareness and knowing their green features preference will lead to the demand for the GB, hence supporting the GB development (Samari *et al.,* 2013). Thus, consumers' WTP for GB becomes an interest for practitioners, academics and the government.

Zhang *et al.* (2018) summarised the previous researchers' studies on the residents' WTP for particular green attributes. Although the amounts of WTP vary widely, almost all of them indicate that residents are willing to pay significant price premiums for green attributes. Among the studies, Banfi *et al.* (2008), Kwak *et al.* (2010) and Park *et al.* (2013) stated that consumers in Switzerland and Korea value the benefits of energy-saving measures in residential buildings in their respective countries. Park *et al.* (2013) also noticed that information technology facilities are the least preferred in GB preferences, whereas Hu et al. (2014) found that China consumers are willing to pay for an unpolluted environment and for non-toxic construction materials used in their buildings. Nevertheless, studies such as Chau et al. (2010) revealed no significant difference in the consumer preferences in Hong Kong between green and conventional residents for energy conservation, indoor air quality improvement, indoor noise reduction or water conservation. Therefore, it is vital to understand consumers' green attributes' preferences to help the government and developer to build GB according to the needs of consumers.

Hypothesis Development

Several researchers have carried out studies on the residents' WTP for particular green attributes (Banfi *et al.*, 2008; Chau, Tse and Chung, 2010; Kwak, Yoo and Kwak, 2010; Park *et al.*, 2013; Hu, Geertman and Hooimeijer, 2014). Consumers place a high value on the advantages of energy-saving features. The WTP for the green attributes under energy efficiency range from 0.09% to 14.8% (Banfi *et al.*, 2008; Chau, Tse and Chung, 2010; Kwak, Yoo and Kwak, 2010; Park *et al.*, 2013). Chau *et al.* (2010) mentioned that reducing noise level and improving air quality from an unacceptable to acceptable level contributes to the WTP for green attributes ranging from 4.7% to 7.8%. Moreover, Hu *et al.* (2014) and Park *et al.* (2013) mentioned that improved indoor environment quality through a reduction in VOC emission and the use of non-toxic construction material would result in WTP for these green attributes ranging from 0.05% to 5.8%. Furthermore, the saving in water consumption provides the homebuyers' WTP for these green attributes under water efficiency ranges from 4.3% to 4.7% (Chau, Tse and Chung, 2010). Although the amounts of WTP vary widely, almost all of them indicate that residents were willing to pay significant price premiums for green attributes. Therefore, based on the past studies, and limited study has been found to examine this area among Penangites, the hypothesis for this study includes the following assumption:

H1: Energy efficiency in green buildings has a positive effect on the WTP for a price premium.

H2: Indoor environment quality in green buildings has a positive effect on the WTP for a price premium.

H3: Water efficiency in green buildings has a positive effect on the WTP for a price premium.

Figure 1 illustrates the conceptual framework of this study.

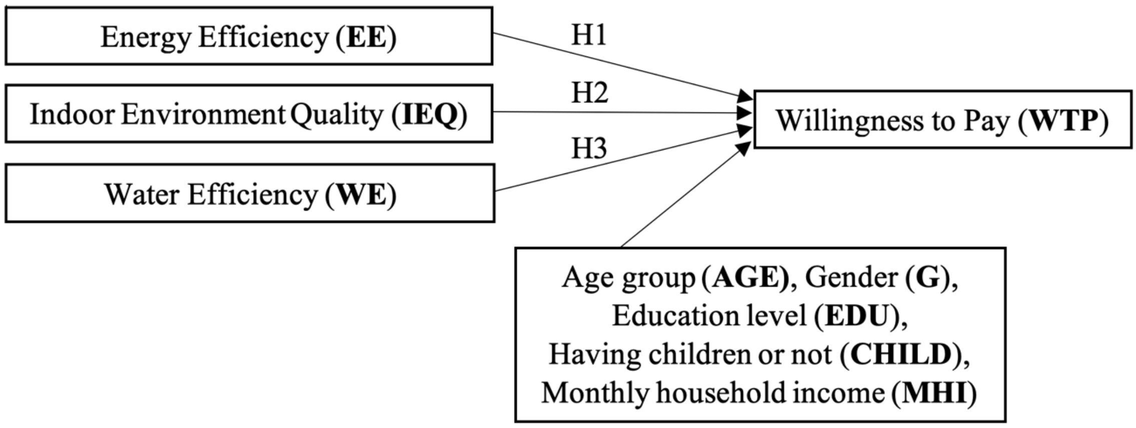

Figure 1. Conceptual framework of the study

Methodology

Research Sample

This research targeted the Penang population. Penang was chosen because it is the second largest property market in Malaysia after Kuala Lumpur (Department of Statistics Malaysia, 2021). To ensure the reliability of the study, we have set three inclusive criteria for our respondents. First, respondents need to be above 18 years old, second, respondents are currently staying in Penang, and lastly, they have the intention to purchase a green home. Based on the above, the study adopted a non-probability purposive sampling method. To decide the appropriate sample size for this study, G*Power software has been used to calculate the sample size with a medium effect size. The minimum sample size of 119 respondents was required for this study.

Research Design

This study used a quantitative approach through an internet survey to determine the green features preference of the homebuyers of GBs and to find out the willingness of homebuyers to pay for the GB price premium. The survey was a cross-sectional study in which data were collected over a period of 2 months in August-September 2022, using emails and social media. The data were collected using a self-administered online survey questionnaire form.

Measurement of Variables

The survey questionnaire consisted of three sections. Section A consisted of several questions regarding the respondents' demographic backgrounds. Section B of the questionnaire is to identify the green features preference of the homebuyers of GBs. There were a total of 3 independent variables with 12 dimension questions included in this section. Respondents were asked to rate the extent to which the green features may affect their willingness to purchase a house or an apartment rated as a green building, instead of purchasing a similar conventional house or apartment. Respondents answered the question in a ten-point Likert scale ranging from "will not affect at all" (1) to "will strongly affect" (10). Section C of the survey examined the price premium that potential homebuyers are willing to pay for a GB apartment or house as opposed to a standard apartment or house of the same size and location. A continuous premium scale, ranging from zero (i.e., refusal to pay any extra price) to 30% was presented to the respondents. The continuous premium scale used in this research was limited to 30% to minimise overestimation of stated WTP. The independent variables in this study had the following definitions and measures.

Energy Efficiency (EE)
Energy efficiency is a key component that contributes to building energy savings (Abu Bakar *et al.*, 2015). EE can be defined as "using less energy without compromising the performance of the building" (Wang *et al.*, 2012). This means that while using less energy, the building will nevertheless provide the same level of energy performance. The primary goal of EE is to minimise a building's energy usage and, as a result, its overall GHG emissions. The measurement of EE includes six items (Goh *et al.*, 2021): (1) solar photovoltaic (i.e., solar panel); (2) solar shading devices (i.e., awnings or blinds) ; (3) wall insulation materials to reduce heat or sunlight penetration; (4) high-performance glazing (i.e., tinted window) (5) green roof; and (6) lighting with motion sensor.

Indoor Environment Quality (IEQ)
Indoor environment quality refers to the condition inside a building and is determined by many factors encompasses air quality, lighting, temperature conditions, damp conditions, acoustic conditions, and other factors (USGBC, 2014). A good IEQ can improve the health of the occupants by decreasing the occurrence of sick building syndrome and building related illness (Designing Buildings, 2022). Thus, the measurement of IEQ includes four items (Goh *et al.*, 2021): (1) low-toxicity finishes and furnishing; (2) natural ventilation design; (3) sufficient daylighting; and (4) sound insulation design.

Water Efficiency (WE)
Water efficiency refers to preserving fresh water and minimising total water use. Additionally, it emphasises the use of advanced techniques and technologies that consume less water while still offering equivalent or greater quality of life (Sheth, 2017). The measurement of WE includes two items (Goh *et al.*, 2021): (1) water-efficient fittings; and (2) rainwater harvesting system.

Data Analysis Method
The collected data was analysed using Stata 17.0. First, descriptive statistics were calculated to assess the mean and standard deviation of homebuyers' green features preferences. Second, Cronbach's alpha was used to measure the internal consistency and calculate the reliability of the questions which developed via multiple-question Likert scale surveys (Boermans and Kattenberg, 2012). Third, a multinomial logistic regression analysis was applied to ascertain if homebuyers' preferences for green features are significantly correlated with the amount of price premium that prospective homebuyers are ready to pay.
To perform the multinomial logistic regression analysis, the WTP is categorized into: 0 (WTP_0) = respondent is not willing to pay anything; 1 (WTP_low) = respondent is willing to pay additional 1% to 10%; 2 (WTP_medium) = respondent is willing to pay additional 11% to 29%, and 3 (WTP_high) = respondent is willing to pay equal or more than 30%.

Results
Demographic Analysis
The survey collected a total of 145 respondents within the month of August to September in 2022. However, after filtering, only 120 usable data for final data analysis. Table I presents

the findings of the respondents' demographic information. Based on Table I, there are 48 males and 72 females and the majority of respondents aged between 31 to 40 (i.e., 55%). In terms of respondents' education level, more than 80% obtained undergraduate degree, postgraduate degree or above. In the aspects of marital status, 43.3% respondents are single, and 54.2% respondents are married. Among the 120 respondents, 47.5% of respondents are having children. For the respondent's monthly household income, 32.5% of the respondents are under B40 group of income (income ≤ RM4,850), 38.3% of the respondents are under M40 group of income (RM4,851 ≤ income ≤ RM10,970) and 29.2% of the respondents are under T20 group of income (income ≥ RM15,041). The data illustrates quite an equal distribution of socio-demographic factors among the respondents.

Table I
Demographic of Respondents

Demographic attributes	STATA Coding	Frequencies	(fraction)
Age			
18-30	1	34	(28.3%)
31-40	2	66	(55.0%)
41-50	3	15	(12.5%)
51-60	4	4	(3.3%)
61 and above	5	1	(0.9%)
Gender			
Male	1	48	(40.0%)
Female	2	72	(60.0%)
Education level			
Primary or lower	1	1	(0.9%)
Secondary School	1	8	(6.7%)
Diploma / Certificate	2	13	(10.8%)
Undergraduate Degree	2	37	(30.8%)
Postgraduate Degree or above	3	61	(50.8%)
Marital status			
Single	1	52	(43.3%)
Married	2	65	(54.2%)
Divorced	3	1	(0.8%)
Widowed	4	2	(1.7%)
Have children			
Yes	1	57	(47.5%)
No	0	63	(52.5%)
Monthly household income			
RM4,850 and below	1	39	(32.5%)
RM4,851 – RM7,100	2	26	(21.6%)
RM7,101 – RM10,970	3	20	(16.7%)
RM10,971 – RM15,040	4	20	(16.7%)
RM15,041 and above	5	15	(12.5%)

Descriptive Analysis

Table II reports the respondents' mean scores for the green features preferences. The findings demonstrate that high-performance glazing scores the highest at 8.233, followed by natural ventilation design (8.167) and sufficient daylighting (8.142), while green roof (7.3), rainwater harvesting system (7.475) and lighting with motion sensor (7.650) are the three least preferences by the respondents. Based on the findings, it shows that the preferences for green features are highly influenced by the weather in Malaysia. As a tropical climate country which is hot and humid throughout the year, most respondents are willing to pay more for high-performance glazing, natural ventilation design, sufficient daylighting, wall insulation materials, and solar shading devices.

Cronbach's alpha was used to measure the internal consistency and calculate the reliability of the questions developed via multiple-question Likert scale surveys (Boermans and Kattenberg, 2012). Table IV shows the Cronbach's alpha coefficient of EE, IQE and WE is 0.861, 0.723 and 0.766, respectively. The reliability of the measurements used in this study is satisfactory because the Cronbach's alpha coefficient for all three constructs is greater than 0.7 which satisfies the accepted rule of thumb.

Variance inflation factor (VIF) was used to measure the amount of multicollinearity in regression analysis. A VIF greater than 10 is considered unsatisfactory in which variables are highly correlated (Cleff, 2019; Lind, Marchal and Wathen, 2019). Table II shows the VIFs of independent variables are all less than 10. This indicates that the independent variables are not strongly correlated. In this case, the multicollinearity among the independent variables is not a concern.

Table II
Descriptive Statistics

Variable	Item Code	Item	Mean	Standard Deviation	Cronbach's Alpha	VIF
Energy Efficiency	EE1	Solar photovoltaic	7.792	1.786	0.861	3.10
	EE2	Solar shading	8.008	1.826		
	EE3	Wall insulation	8.083	1.683		
	EE4	High-performance glazing	8.233	1.719		
	EE5	Green roof	7.300	2.152		
	EE6	Lighting with motion sensor	7.650	2.061		
Indoor Environment Quality	IEQ1	Low-toxicity finishes and furnishing	7.883	1.924	0.867	2.99
	IEQ2	8	8.167	1.746		
	IEQ3	Sufficient daylighting	8.142	1.788		
	IEQ4	Sound insulation design	7.742	2.056		
Water Efficiency	WE1	Water-efficient fittings	7.758	1.970	0.802	2.05
	WE2	Rainwater harvesting system	7.475	2.264		

Table III presents the green features preferences by respondents' WTP. Based on Table V, 5% of the respondents are unwilling to pay for price premium (i.e., WTP = 0) and they rate only 5 to 6 point for all the green features. For those who are willing to pay additional 1% to 10%, they rate about 7 to 8 points for most of the green features, with the highest preference on IQE, followed by EE and WE. For those who are willing to pay additional 11% to 29%, their ratings are also about 7 to 8 points, with the highest rating for IQE, which is 5% higher than those who are willing to pay additional 1% to 11%, and then followed by EE and WE. Surprisingly, those who are willing to pay an additional 30% or more, only rate around 6 – 7 points for the green features, with the highest preference for EE, followed by IQE and WE.

One-Way ANOVA was used to compare the means of two or more groups for one dependent variable (Cleff, 2019; Lind, Marchal and Wathen, 2019). Bartlett's equal-variances test was carried out to measure the relationship between two categorical variables. The $chi^2(3)$ for the EE is 11.574, $p < 0.01$, and $chi^2(3)$ for the IEQ is 10.226, $p < 0.05$, indicating that there is statistically significant difference in the green features preferences among respondents in different WTP categories. There is no statistical difference in the green features preferences among respondents in different WTP categories for WE ($chi^2(3) = 5.925$, $p > 0.05$).

Table III
Comparison of Green Features Preferences By Willingness To Pay

Item Code	Willingness to Pay				Bartlett's Equal-Variances Test $chi^2(3)$
	0 (0%)	1 (1% to 10%)	2 (11% to 29%)	3 (≥ 30%)	
Observation	6	78	26	10	
Total EE	5.665	8.002	8.058	7.367	11.574***
EE1	5.833	7.923	8.000	7.400	
EE2	6.167	8.359	7.615	7.400	
EE3	5.833	8.231	8.538	7.100	
EE4	6.000	8.423	8.577	7.200	
EE5	5.167	7.436	7.308	7.500	
EE6	5.000	7.641	8.308	7.600	
Total IEQ	5.208	8.099	8.529	7.325	10.226**
IEQ1	4.500	8.026	8.423	7.400	
IEQ2	5.500	8.231	8.846	7.500	
IEQ3	5.667	8.218	8.846	7.200	
IEQ4	5.167	7.923	8.000	7.200	
Total WE	5.167	7.859a	7.692	7.000	5.925
WE1	5.167	7.962	8.000	7.100	
WE2	5.167	7.756	7.385	6.900	

Note: (1) Shapiro-Wilk Normality test, $p>0.05$, shows that WTP is normally distributed. Thus, Bartlett's Equal-Variances test was adopted for the comparison among WTP groups. (2) ** $p < 0.05$, *** $p < 0.01$.

Multinomial Logistic Regression Analysis
Table IV reports the results of the multinomial logistic regression analysis, linking the WTP for GB with various green features preferences and socio-demographics of the study participants. The odds ratios for the three binary logistic models are used to compare each category versus the base category. The base category used in this study is WTP_low. Model 1 compares Y = 0 (WTP_0) and Y = 1 (WTP_low). Model 2 compares Y = 2 (WTP_medium) and Y = 1 (WTP_low). Whereas model 3 compares Y = 3 (WTP_high) and Y = 1 (WTP_low). The table reports two models of multinomial logistic regression - Model A with only three independent variables (i.e., EE, IEQ, and WE), and Model B with respondents' social-demographic attributes added (i.e., EE, IEQ, WE, age, gender, education level, have children, and monthly household income). The odds ratio analysis for models 1, 2, and 3 is shown in equations (4), (5), and (6), respectively.

$$Odds\ (Y = 0\ vs. Y = 1) = \frac{p(Y=0)}{p(Y=1)} = \frac{p(0)}{p(1)} \quad \text{Equation (4)}$$

$$Odds\ (Y = 2\ vs. Y = 1) = \frac{p(Y=2)}{p(Y=1)} = \frac{p(2)}{p(1)} \quad \text{Equation (5)}$$

$$Odds\ (Y = 3\ vs. Y = 1) = \frac{p(Y=3)}{p(Y=1)} = \frac{p(3)}{p(1)} \quad \text{Equation (6)}$$

Model Fit
Model fit describes the relationship between a dependent variable and one or more predictor variables (Liu, 2016). Table IV provides fit statistics calculated across all of the models. Several fit statistics included log-likelihood (LL), Akaike's Information Criteria (AIC), Bayesian

Information Criteria (BIC), and three pseudo R-squared (McFadden, Cox and Snell, and Nagelkerke) are used to evaluate how well the model fits the data.
In the fit stat output, the log-likelihood (LL) for the null model without predictor variables is -116.2, the LL for model A is -103.4 and LL for model B is -77.3, indicating model B is a better fitted model for this study. This is further supported by the LL ratio x^2. The LL ratio x^2 for fitted model A is ${x^2}_{10}$ = 25.61, p < 0.01, and model B is ${x^2}_{10}$ = 77.74, p < 0.01. As a comparison to being in the base category, the fitted model B offers a better fit than the model A in predicting the logit of being in any other category of WTP.
AIC and BIC are used to measure the model performance. The smaller the AIC and BIC means the better fit of the model (Liu, 2016). Based on Table IV, the AIC and BIC for model A are 231 and 264, whereas model B are 251 and 384. Even though the AIC for fitted model B is not decreasing, there is no significant difference compared with fitted model A. The BIC increase could be due to more predictor variables, which increase the BIC value for fitted model B.
As Table IV shows, the three pseudo-R-squared values for model B are higher compared to model A indicating that the effect size of model B is getting stronger as the study added social-demographic attributes in the model. The McFadden's pseudo R^2 value for model B is 0.335 ranging between 0.2 and 0.4 indicates a very good model fit (Petrucci, 2009).

Results Analysis
The study presents the analysis and discussion based on the fitted model B, since it has better effect size and LL. For green features EE, OR(0,1) = 1.724, z = 0.38, p > 0.05 indicating that, when all other predictors are held constant, the odds of being in the WTP_0 rose by 1.724 compared to the base category (WTP_low). The odds of being in the WTP_medium and WTP_high categories compared to the base group fell by 18.4% and 11.7%, respectively, for a one-unit increase in the EE predictor when all other predictors were held constant, according to OR(2,1) = 0.816, z = -0.60, p > 0.05, and OR(3,1) = 0.883, z = -0.21, p > 0.83. However, the results are not significant, indicating that H1 is not supported. EE does not affect WTP for GB.
For green features IEQ, OR(0,1) = 0.202, z = -1.01, p > 0.05 indicating that, when all other predictors are held constant, the odds of being in WTP_0 against the base category (WTP_low) reduced by 79.8% for a one-unit increase in the IEQ predictor. Holding all other variables constant, OR(2,1) = 3.666, z = 3.05, p < 0.01, and OR(3,1) = 1.010, z = 0.02, p > 0.05, respectively, show that the odds of being in WTP_medium and WTP_high categories rose from the base category by 3.666 and 1.01 times, respectively. The result is significant for OR(2,1), showing that respondents are willing to pay an additional 11% to 29% for IEQ. Thus, the study concludes that H2 is partially supported, since OR(3,1) is not significant.
For green features WE, OR(0,1) = 0.874, z = -0.16, p > 0.05 indicating that, when all other predictors are held constant, the odds of being in WTP_0 against the base category (WTP_low) dropped by 0.874 for each unit increase in the WE predictor. Holding all other variables constant, OR(2,1) = 0.572, z = -2.4, p < 0.05, showing that the likelihood of being in WTP_medium as compared to the base group fell by 42.8%. The odds of being in WTP_high versus the base category reduced by 11.1% for a one-unit rise in the WE predictor when all other predictors were held constant, according to OR(3,1) = 0.889, z = -0.31, and p > 0.05. The study concludes that H3 is not supported because respondents are not willing to pay additional for GB.
In terms of socio-demographic factors, age groups are having a positive relationship with WTP. Respondents under age group 31 to 40, 41 to 50, and 51 to 60 years old with OR(2,1) =

6.593, z = 1.90, p < 0.10, OR(2,1) = 29.095, z = 2.50, p < 0.05, and OR(2,1) = 37.342, z = 2.11, p < 0.05, respectively, indicating the odd of being in WTP_medium versus the base category increased by 6.593, 29.095, and 37.342 time, respectively when compared with age group 18 to 30 years old while holding all other predictors constant. Besides, respondents under age group 31 to 40 years old, with OR(3,1) = 15.877, z = 1.78, p < 0.10, indicating that the odd of being in WTP_high versus the base category increased by 15.877 times, when compared with age group 18 to 30 years old, while holding all other predictors constant. Results indicate that consumers under the age group 51 to 60 years old are willing to pay an additional 11% to 29% for GB.

In terms of education level, the study notes that respondents who obtained a postgraduate degree and above are less willing to pay for GB. This can be seen under OR(2,1) = 0.078, z = -2.22, p < 0.05, and OR(3,1) = 0.031, z = -2.00, p < 0.05, indicating that the odd of being in WTP_medium and WTP_high versus the base category decreased by more than 92%, when compared with those who obtained only secondary school and below, while holding other predictors constant.

For monthly household income, the study finds a negative relationship between monthly household income and WTP for GB. The results only significant for two groups of income level, which are RM4,851 to RM7,100 (OR(2,1) = 0.141, z = 1.96, p < 0.05) and RM15,041 and above (OR(2,1) = 0.124, z = -1.94, p < 0.10), indicating the odd of being in WTP_medium versus the base category decreased by 85.9% and 87.6%, respectively when compared with income level RM4,850 and below, while holding other predictors constant. The study finds no significant relationship between gender, having children (yes or no) and WTP for GB, respectively.

Table IV
Results of the Multinomial Logistic Regression Model

	Model A		Model B	
Variables	b (SE(b))	OR	b (SE(b))	OR
WTP_0 (Y=0 vs Y=1)				
Energy Efficiency	-0.189	0.828	0.544	1.724
	(0.527)	(0.436)	(1.419)	(2.446)
Indoor Environment Quality	-0.909	0.403	-1.598	0.202
	(0.773)	(0.312)	(1.577)	(0.319)
Water Efficiency	0.192	1.212	-0.135	0.874
	(0.562)	(0.681)	(0.843)	(0.737)
Age				
31-40			-3.837	0.022
			(2.767)	(0.060)
41-50			-1.347	0.260
			(2.165)	(0.563)
51-60			-12.108	5.52e-06
			(8765.167)	(0.048)
61 and above			13.601	806897.4
			(1611258)	(1.3e+12)
Gender				
Female			2.894	18.068
			(2.200)	(39.749)
Education level				
Diploma / Certificate / Undergraduate Degree			-4.203	0.015
			(6.127)	(0.092)
Postgraduate Degree or above			-4.943	0.007
			(6.409)	(0.046)
Have children				
Yes			-4.674	0.009
			(5.914)	(0.055)

Monthly Household Income (RM)				
4,851 – 7,100			1.463	4.318
			(1.842)	(7.953)
7,101 – 10,970			3.649	38.436
			(2.254)	(86.616)
10,971 – 15,040			-14.695	4.15e-07
			(2164.991)	(0.001)
15,041 and above			-10.904	0.000
			(3093.596)	(0.057)
cons	3.744*	42.280*	8.668	5813.945
	(2.128)	(B9.953)	(6.563)	(38156.53)
WTP_low (Base Category Y = 1)				
WTP_medium (Y=2 vs Y=1)				
Energy Efficiency	-0.195	0.823	-0.203	0.816
	(0.291)	(0.239)	(0.338)	(0.275)
Indoor Environment Quality	0.871**	2.389**	1.299***	3.666***
	(0.343)	(0.819)	(0.427)	(1.564)
Water Efficiency	-0.413**	0.662**	-0.559**	0.572**
	(0.207)	(0.137)	(0.233)	(0.133)
Age				
31-40			1.886*	6.593*
			(0.995)	(6.558)
41-50			3.371**	29.095**
			(1.347)	(39.187)
51-60			3.620**	37.342**
			(1.712)	(63.930)
61 and above			2.464	11.754
			(861252.9)	(1.01e+07)
Gender				
Female			0.548	1.730
			(0.591)	(1.023)
Education level				
Diploma / Certificate / Undergraduate Degree			-1.641	0.194
			(1.125)	(0.218)
Postgraduate Degree or above			-2.555**	0.078**
			(1.150)	(0.089)
Have children				
Yes			-0.325	0.723
			(0.711)	(0.514)
Monthly Household Income (RM)				
4,851 – 7,100			-1.961**	0.141**
			(0.999)	(0.141)
7,101 – 10,970			-1.071	0.343
			(0.954)	(0.327)
10,971 – 15,040			-1.523	0.218
			(0.967)	(0.211)
15,041 and above			-2.085*	0.124*
			(1.076)	(0.134)
cons	-3.550*	0.029*	-4.837*	0.008*
	(1.908)	(0.055)	(2.402)	(0.019)
WTP_high (Y=3 vs Y=1)				
Energy Efficiency	-0.143	0.867	-0.124	0.883
	(0.403)	(0.350)	(0.579)	(0.511)
Indoor Environment Quality	-0.154	0.857	0.010	1.010
	(0.448)	(0.384)	(0.635)	(0.641)
Water Efficiency	-0.073	0.930	-0.118	0.889
	(0.319)	(0.297)	(0.377)	(0.335)
Age				
31-40			2.765*	15.877*
			(1.550)	(24.605)
41-50			2.038	7.677

			(1.935)	(14.853)
51-60			-13.784	1.03e-06
			(9259.403)	(0.010)
61 and above			50.006	5.21e+21
			(430649.6)	(2.25e+27)
Gender				
Female			-1.115	0.328
			(0.882)	(0.289)
Education level				
Diploma / Certificate / Undergraduate Degree			-0.836	0.433
			(1.344)	(0.582)
Postgraduate Degree or above			-3.471**	0.031**
			(1.736)	(0.054)
Have children				
Yes			-0.616	0.540
			(1.090)	(0.589)
Monthly Household Income (RM)				
4,851 – 7,100			-1.809	0.164
			(1.205)	(0.197)
7,101 – 10,970			-0.895	0.409
			(1.274)	(0.520)
10,971 – 15,040			-1.454	0.234
			(1.390)	(0.325)
15,041 and above			-18.153	1.31e-08
			(4287.355)	(0.000)
cons	0.781	2.184	1.003	2.727
	(1.874)	(4.092)	(2.529)	(6.897)
N	120		120	
LR (McFadden's) R^2	0.110		0.335	
ML (Cox and Snell's) R^2	0.192		0.477	
Nagelkerke R^2	0.225		0.557	
Log likelihood	-103.4		-77.3	
LR x^2_{10}	25.61		77.74	
Prob > x^2_{10}	0.002		0.002	
AIC	231		251	
BIC	264		384	

Note: (1) Standard errors in parentheses, (2) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
(2) WTP_0 = not willing to pay for price premium; WTP_low = willing to pay for 1% to 10% price premium; WTP_medium = willing to pay for 11% to 29%; WTP_high = willing to pay for more than 29%

Discussion

This study investigates how consumers' WTP for the price premium associated with green buildings is influenced by attributes such as energy efficiency, indoor environment quality, and water efficiency. Surprisingly, H1 and H3 are not supported with the assumption that increased energy efficiency and water efficiency, respectively in GBs has a positive effect on the WTP for price premium. The responses given by the participants only partially supported the H2 with the assumption that increased indoor environment quality in GBs has a positive effect on the WTP for price premium. One possible explanation for this result may be due to the COVID-19 pandemic that has increased uncertainty in large parts of human life, including job, home, and free time. Today, many people work from home and spend all of their free time at home. Thus, people start realising the importance of the IEQ which may affect their quality of life. The items incorporated under IEQ include low-toxicity finishes and furnishing, natural ventilation design, sufficient daylighting, and sound insulation design are crucial to incorporate into the building during the design stage. It may cost a huge amount to the home buyers if they would like to have such green features in their building after the construction stage. Hence, homebuyers are willing to pay a higher price premium for IEQ than EE or WE.

Among the four items under IEQ, natural ventilation design and sufficient daylighting present an average mean above 8 out of 10. Natural ventilation design in a GB is able to provide sufficient fresh air to occupied spaces in order to maintain acceptable air quality in the building and to improve interior comfort (Green Building Index, 2014). Natural ventilation design encompasses cross and/or stack ventilation design to supply adequate fresh air to occupied spaces has proven to be a successful method of lowering energy consumption and improving the quality of the interior environment for the occupants (Green Building Index, 2014; Designing Buildings, 2022). Sufficient daylighting can be achieved through the windows, roof lights and atrium spaces (Green Building Index, 2014). Daylighting can assist minimise the need for artificial lighting, which has been found to lower building energy demand (Lim *et al.*, 2017). Hence, natural ventilation design and sufficient daylighting indirectly reduced the energy consumption of the GB.

The study presents a statistically significant difference among the respondents in different WTP categories for energy efficiency and indoor environment quality. Sixty-five percent of the respondents are WTP a price premium between 1% to 10% for EE and IEQ and twenty-two percent of the respondents are WTP a price premium between 11% to 29% for EE and IEQ. Overall, the findings are consistent with past studies as the majority of the respondents (87%) are WTP price premium between 1% to 29% (Zhang *et al.*, 2018). Samari *et al.* (2013) mentioned that improving consumers' awareness and knowing their green features preference will lead to the demand for the GB. Results from this study shows that only 53% of the respondents are familiar with the concept of GB. This may conclude that the sampled participants irrespective of whether they are familiar or not with the concept of GB, are willing to pay for their green features preferences. Hence, knowing homebuyers' green features preference will be the first priority in supporting the GB development (Lee, Azmi and Lee, 2020; Wong *et al.*, 2021).

In terms of socio-demographic factors, the results imply that older homebuyers under the age group 41 to 60 years old are willing to pay an additional 11% to 29% for GB compared with younger homebuyers under the age group 18 to 30 years old. The results support the notion that older homebuyers are able and WTP price premium for GB. In terms of education level, the study reveals that respondents who obtained a postgraduate degree and above are less WTP for GB. The study also finds a negative relationship between monthly household income and WTP for GB. Hence, the home buyers WTP for GB are mainly affected by their green features preference.

Notably, it is essential to identify homebuyers' green feature preferences for green development to increase demand for green projects, the majority of which are currently driven by market forces (Chau, Tse and Chung, 2010). The government acts as the major stakeholder to encourage green development in the construction sector, a deeper understanding of homebuyers' green feature preferences is valuable for the Penang government as this may act as a primary guideline for the government in developing strategies to emphasise GB development and further encourage developers to take the initiative for GB development to pursuit of sustainability excellence in Penang. The greatest strategy that the government can take is to promote sustainable development by providing an incentive programme for developers who incorporate sustainability into their projects (Samari *et al.*, 2013). Moreover, green building will be able to progress without government involvement if market demand is high.

However, it is important to emphasise that the study’s findings could be affected by several possible flaws, which could reduce the representativeness of the samples and findings. First, since the study only focused on Penang, thus, the findings may not be representative for the whole Malaysia. Furthermore, there is a chance that the findings will not accurately reflect the opinions of the population who live in Penang due to small sample size. Thus, future research should recruit more respondents.

Conclusion

The key contribution of this study is a better understanding of how choosing green features for potential homebuyers can influence their WTP for price premium. Data from respondents in Penang were gathered via a self-administered questionnaire. For analysis, a multinomial logistic regression model using Stata 17.0 was used to fulfil the objective of this study. One hypothesis was supported out of a total of three. Among all the green building features, the results indicated that natural ventilation design, sufficient daylighting, low-toxicity finishes and furnishing, and sound insulation design have a significant positive effect on the homebuyers’ WTP for higher price premium. Contrary to previous studies, the green features under energy efficiency and water efficiency were not found to have a significant effect on the homebuyers’ WTP for price premium.

The study's contribution in terms of its implications is that it adds to the literature on GB development which was relatively limited from the market demand point of view. The empirical findings identify the green features which provide the highest WTP for GB price premium. Due to the increasing significance of sustainable development in Malaysia, this research is timely for adding knowledge about the demand for the GBs in the construction industry. Hence, in this research, it is expected to provide insights and enhance the knowledge of various stakeholders in the construction industry. Firstly, this study can act as a primary guideline for the government in developing strategies to emphasise GB development in Penang. Secondly, developers are able to benefit from the empirical results of the study as it highlighted the homebuyers’ green features preferences and their WTP and this may encourage them to take the initiative for GB development in Penang. Finally, the study intends to provide reliable information to enhance the knowledge of consultants about the market demands in Penang and encourage them to design the projects which suit end-users.

There are a few limitations of this study that can be enhanced in future studies. First, the modest sample size adopted in this study may have reduced some of the outcomes that are found to be significant. Additionally, the scope of this study, which is restricted to Penang homebuyers, can be expanded to homebuyers of other states in Malaysia for future research in line with the growth of green residential projects.

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Appendix: Questionnaire

On a scale of 1 (will not affect at all) to 10 (will strongly affect), please rate the extent to which the following green features may affect your willingness to purchase a house or an apartment rated as a green building, instead of purchasing a similar conventional house or apartment:

		1 will not affect at all	2	3	4	5	6	7	8	9	10 will strongly affect
1.	**Solar photovoltaic** a system used to generate renewable energy which absorbs and converts sunlight into electricity, eg. solar panels	1	2	3	4	5	6	7	8	9	10
2.	**Solar shading devices** shading which able to block out the direct hot sunlight to decrease the overall thermal transfer value of building, eg. awnings, blinds	1	2	3	4	5	6	7	8	9	10
3.	**Wall insulation materials** enhance the indoor thermal comfort of building and help to reduce energy consumption as lower indoor temperatures, eg. composite insulated walls	1	2	3	4	5	6	7	8	9	10
4.	**High-performance glazing** improves window insulation and makes building heating and cooling more efficient, eg. tinted windows	1	2	3	4	5	6	7	8	9	10
5.	**Green roof** a layer of vegetation planted over a waterproofing system that is installed on top of a flat or slightly–sloped roof	1	2	3	4	5	6	7	8	9	10
6.	**Lighting with motion sensor** sensors which will switch off the light when there is enough sunlight or when the building is unoccupied	1	2	3	4	5	6	7	8	9	10
7.	**Low-toxicity finishes and furnishing** non-toxic materials to reduce the harmful impact on occupants' health, eg. recycled carpet, non-toxic paints	1	2	3	4	5	6	7	8	9	10
8.	**Natural ventilation design** the use of wind to create air movement in and out of building without the use of mechanical systems	1	2	3	4	5	6	7	8	9	10
9.	**Sufficient daylighting** admission of natural light, direct sunlight and diffused-skylight into a building to reduce electric lighting	1	2	3	4	5	6	7	8	9	10
10.	**Sound insulation design** the reduction in sound across a partition	1	2	3	4	5	6	7	8	9	10
11.	**Water-efficient fittings** reduction in potable water consumption through the use of efficient devices, eg. water closets, showerheads, shower taps, basin taps, bib taps	1	2	3	4	5	6	7	8	9	10

12.	**Rainwater harvesting system** maximise rainwater collection from the rooftop lead to a reduction in potable water consumption	1	2	3	4	5	6	7	8	9	10

In the table below, please choose the maximum price premium that you will be willing to pay for purchasing a new house or apartment rated as a green building, in comparison with purchasing a similar conventional house or apartment:

0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%
22%	23%	24%	25%	26%	27%	28%	29%	30% and more		