

The Study on Key Factors of Influencing Consumers' Purchase of Green Buildings

Application of Two-stage Fuzzy Analytic Hierarchy Process

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Abstract

The rapid development of industrialization all over the world has caused the acute climatic anomaly increasingly subsequent to the 21st century. The traditional building is as the industry with energy consumption, pollution and non-environmental sense. Hence, the concept of green building has been the most effective strategy to mitigate the deterioration of the environment of urban building. The design and evaluated mechanism, the strategic boost of government and related legislation of green building were explored from the former literatures. The study of related marketing issues of green building has rarely been researched. In view of this, the study has constructed 18 crucial factors regarding the influence on consumers' purchase on green buildings in Taiwan from the literature reviews and Delphi technique. Fuzzy Analytic Hierarchy Process (FAHP) was adopted to analyze the relative weight and the ranking of significance from individual factor. The result appeared the top 5 crucial factors that influenced consumers purchasing green buildings in Taiwan are the price of green building, the level of environmental awareness, green building material and internal structure, the level of green consumption and income in subsequence. The decision-making of the consumers would not be influenced by the green building label, the gender and the age, the environmental propaganda of government, the value of mainstream culture and economic conditions. The empirical result of study is able to be used as the reference that the government establishes the policy of green building impetus and the real estate deal plans the strategy of green building marketing.

Keywords: extreme climate, Fuzzy Analytic Hierarchy Process (FAHP), green building, green consumption, green marketing, purchase intention

1. Introduction

The rapid development of industrialization all over the world has caused the acute global warming on the earth increasingly subsequent to the 21st century. Mankind consumed and destroyed environmental resources on the earth so as to obtain the short-run benefit. The global climatic anomaly caused huge frequent natural disasters, e.g. Super Typhoon Haiyan in the Philippines in 2013 and Hurricane Sandy in the United States in 2012. The United Nation announced UN Global Assessment Report on Disaster Risk Reduction in May, 2013. The announcement stated the economic loss in 56 nations around the world has accumulated US\$2.5 trillion. More than 310 natural disasters took place in 2012, including flood, tropical storms and the earthquakes, and more than one million people were affected.

Mankind is supposed to focus on the issues of global warming and the severe destruction of ecosystem cautiously and address the response strategies as well. According to the statistics of the Central Weather Bureau (CWB) in Taiwan, the temperature rises 1°C to 1.39°C per year averagely of the last 100 years, which is as twice much as the global general average. Warming in Taiwan is more acute than any other places in the world. Besides, water utilization and energy supply in Taiwan are as a serious topic throughout on the ground of geographical environment. In the view of this, the allotment of resources and environmental protection in Taiwan should be proposed more properly. The concept of "ecological sustainability" is supposed to regard the

developmental issue as the core between government and people (Grace, 2005). Sustainable development emphasizes the relationship between economic development and environmental protection should be valued equally, which enables the posterity of mankind to own the right of using the environmental resources as well. Accordingly, sustainable development contains three principles as “fairness”, “sustainability” and “commonality”.

Undeniably, the traditional building, consumed the energy and caused the pollution, is a poor environmental industry. The fact of this has been verified by a number of studies and reports recently. The research sampling is taken from the building industry in the UK; Edwards (1998) stated 50% energy, 50% raw materials and 40% resources of a city are consumed by the buildings. It is urged that the government propose the measures of energy saving on buildings and the policies of related environmental protection since the consumption of building occupied the massive resources on the earth. The concept will be integrated into the green design, contained energy, environment and ecology to the future buildings in succession. Overall, the energy consumption of building division comprised about 45% of total consumption in global; furthermore, the emission of greenhouse gas also made up 30%-40% of total emission (Butler, 2008). Building industry consumes about 20%-40% of power energy per year in developed countries (Perez-Lombard, Ortiz, & Pout, 2008). The announcement of Energy Efficiency in Buildings announced the carbon emission from the building division, emitted the most carbon emission, has reached one-third of total volume in the world (World Business Council for Sustainable Development (WBCSD), 2009). Roosa and Jhaveri (2009) pointed out the houses and business divisions in the U.S. not only comprised 39% consumption of national energy consumption, but emitted 38% the emission of carbon dioxide. Architecture and Building Research Institute, Ministry of the Interior in Taiwan stated the rate of reliance on import energy is 99.7%, including 28.3% of national consumption by building industry. The cement volume of building industry in Taiwan has been the second largest country that produces 11 million tons wastes per year.

As a result, the improvement of building design is a vital task for the time being. Also, the concept of green building has been the most effective strategy to mitigate the deterioration of the environment of urban building. The environmental protection and sustainable development are prompted by sustainable building with great effects and assistance (Levin, 1997). Basically, the application of green concept enhanced the energy efficiency and the resource efficiency. The enhancement of energy efficiency enables to reduce the energy consumption and emission of greenhouse gas; on the other hand, the enhancement of energy efficiency enables to reduce the use of construction materials and the produce of construction wastes. Chick and Micklethwaite (2004) declared the building industry may take a practical action of sustainable building to reduce the impact brought about by environment. The use of recycling materials and conduct of green purchase may reduce the produce of wastes under way of constructing and dismantling. The concept of green building has different name around the world, the definition and cultivation of which slightly different as well. Green building, defined as the Environmental Symbiotic Housing in Japan, which is called Ecological Building and Sustainable Building in Europe. The concept emphasizes primarily on the sustainable development issues of ecological balance, conservation, biodiversity and recycling, renewable energy sources and energy saving. It focuses on the enhancement and energy saving of energy efficiency, appropriate use of resources and materials, indoor environmental quality and the correspondence of environmental carrying capacity...etc. in the U.S. and Canada. The concept of green building has been attempted to be defined or stated in the former studies. Tolba (1987) defined green building as the building not only possesses the self-sufficient development, but should not reduce environmental quality under the limited natural environment. The main features of green building are to increase the energy efficiency, enhance the efficiency of resources and materials and maintain the biodiversity, decrease the emission of pollutant and lower the carrying capacity of environment. Consequently, green building is the industry with eco-efficiency. Green building decreased the ecological impact and the use of resources while meeting the needs of consumers and policies to improve both quality of life and economic efficiency of buildings (DeSimone & Frank, 1997). Curwell (2001) reported the relationship between the building design and ecological balance is emphasized by the concept of green building. The factors, such as the ecological benefit, biodiversity, recycling, renewable energy sources and energy saving, decrease of environmental carrying capacity and being around the nature should be taken care of by the design of green building. Moreover, the design of green building has varied the construction of traditional building to reduce the consumption of building energy and operation cost (Tseng, Lin, & Chiu, 2009).

Coping with the climate change in global, BREAM system (Building Research Establishment Environmental Assessment Method) has been preliminarily developed in Britain since 1990. There are 23 sets of BREAM system all over the world, reported by Taiwan Architecture and Building Center (2013). So called “green

building”, with energy saving, waste reduction, health and ecology. The establishment of “Green Building” Logo in Taiwan was founded in 1999. There were 4201 cases including the evaluated and qualified green buildings and candidate ones from 2000 to Oct, 2013. Green buildings in private sector, 15.54%, which occupied 653 cases of those; yet, the popularization in private sector is to be strengthened obviously. Therefore, promoting green building not only achieves the efficacy of energy saving and carbon reduction, but enhances the restraint of global warming. The building greening, adequate lighting and biodiversity are promoted by the concept of green building so as to provide people better dwelling environment.

The academia and government unit have placed value on the research documentary regarding the concept of green building gradually. Lee and Yik (2004) considered the government is able to take the allowance, fund supplies, tax deduction and non-refundable credits as the incentives to advance private sector of contractors to execute the construction project on green buildings, which regarding related government policies and laws of green building as the research topic. Reducing the financial barrier on green building execution practically will enhance considerably the contractors’ willing to promote the related products with green building. The key to promote the concept of green building successfully includes the proper laws, straightforward evaluation criteria, determinative and competitive advantages and attractive policies. Knuckling under the cost and uncertain concerns to abandon the cases of green building design at all times, contractors are unable to feel either the government incentives or imperative pressure. The hotel industry as the research object, the concept of green building is not only able to deduct resource consumption, but lower operation cost effectively, reported by Jones (2002) and Gunter (2005). The concept of building as the topic with environmental protection enables to enhance business competitive capability on the market, as well as increase long-term benefits. Williams and Dair (2007) stated the main obstacle to develop green building is immature green techniques, higher cost of green materials, difficult constructing conditions, the insufficient green awareness and vague policies. As a whole, the construction method of green building costs higher than traditional one. Comparing the difference between the traditional and green buildings, Kibert (2008) considered the scale of amount on construction influenced green building cost, as the crucial factor. So as to achieve the green building design standard with advanced level, it takes greatly efforts for architects on green building cases; as the result of it, a number of details and techniques of green building design need to take into account. The green goals must be created straightforwardly and executed by architects in the preliminary stage. Earlier the integrated green building design practices, greater efficiency will bring about, less cost. The result found the operation cost on green building is lower, but the real estate is higher in comparison with traditional building by the survey of commercial reasons and obstacles by executing green building in private construction companies, the architects in Hong Kong and Singapore as the survey objects (Chan, Qian, & Lam, 2009). Osmani and O’Reilly (2009) stated the obstacle to the complicated and insufficient promotion system of green building founded by the government. Besides, the contractor plays an important role, promoting the concept of green building. The government needs to be aware of the benefit among the stakeholders respectively in the entire building industry so as to propose the most efficient policies. Prior to the effective encouraged policies are promoted by the government, few of contractors are willing to afford either extra cost or the estimated risk. Zhang, Shen and Wu (2011) reported most of the cases of green building belong to public domain, taking the market of real estate in China as the research target. For the reason of this, the official units execute the cases of green building in light of the legislative regulations and the policy obedience. Overall, the concept of green building is as the marketing strategy brings about the benefits to the contractors, including the deduction of construction cost, the appreciation of land value, the acquisition of funds and the promotion of brand reputation. Jan et al. (2012) proposed the government is supposed to take the cultivation and knowledge of environmental protection as the goal for people rather than the stress on the public awareness of basis knowledge of green building.

The design and evaluated mechanism of green building and the strategic boost of government and related legislation were explored from the former literatures mostly. The study to the related marketing issues of green building has rarely been researched by few scholars. The aim of this study is to make up the insufficiency for the former research. Moreover, the key factor to influence the consumers on purchasing green building in Taiwan will be explored, the hierarchical structure of which is constructed through literature reviews and Delphi technique. The level of significance to the key factor for purchasing green building is acquired by questionnaire with pairwise comparison. In order to eliminate the pairwise comparison value with unduly subjective and imprecise anxiety, respective factor to the relative weights and significance of subsequence is reviewed by the adaptation to Fuzzy Analytic Hierarchy Process. The result of study is able to be used as the reference that the government establishes the policy of green building impetus and the real estate deal plans the strategy of green building marketing.

2. Methodology

2.1 Fuzzy Analytic Hierarchy Process

Van Laarhoven and Pedrycz (1983), using the concept of fuzzy to solve the values in the pairwise comparison matrix with subjectivity, imprecision and vagueness...etc in traditional Analytic Hierarchy Process (AHP), who stated Fuzzy Analytic Hierarchy Process. Literature review and Delphi technique were adopted to construct the hierarchical framework on this study. Following by the establishment of hierarchy architecture, each evaluator respectively enables to give pairwise comparison matrices of the ultimate goal and criteria by a nine-point scale. To ensure the logic judgment of expert or evaluator fulfills the consistency, Consistency Ratio (CR) is used to measure (Saaty, 1980).

$$CR = \frac{CI}{RI} \quad (1)$$

Consistency Index (CI) in which λ_{\max} is the maximum eigenvalue, obtains n-dimension of the matrix.

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

For randomly generated weights, Random Index (RI) is the average index. The level of Consistency of matrix is satisfying if the value of CR is less than 0.1.

Buckley (1985) reported the adoption of geometric mean to integrate the opinions of experts enables to enhance consistency and precision of factor judgment. The score of geometric mean from all survey respondents is made up as the middle value of TFN on this study. The largest value and the smallest value of score among all survey respondents are made up respectively as the upper bound and lower bound of TFN. Subsequent to the combined opinions from all experts, the fuzzy positive reciprocal matrix is built immediately.

Lambda-max method reported by Csutora and Buckley (2001) was applied on this study to calculate fuzzy weights. According to the fuzzy positive reciprocal matrix, there are 6 main calculated procedures:

1) Take the judgment matrix $T_m = [m_{ij}]$ with the grade of membership as 1 to seek crisp weight W_m .

$$W_m = (W_{1m}, W_{2m}, \dots, W_{im}, \dots, W_{nm}) \quad (3)$$

2) Take the judgment matrices $T_l = [l_{ij}]$ and $T_u = [u_{ij}]$ with the grade of membership as 0 to seek the lower bound weights W_l and upper bound weights W_u respectively.

$$W_l = (W_{1l}, W_{2l}, \dots, W_{il}, \dots, W_{nl}) \quad (4)$$

$$W_u = (W_{1u}, W_{2u}, \dots, W_{iu}, \dots, W_{nu}) \quad (5)$$

3) Take the crisp judgment matrix T_m to proceed Consistency Test.

4) Seek adjustment coefficient to ensure the weight as fuzzy number.

$$Q_l = \min_{1 \leq i \leq n} \left\{ \frac{W_{im}}{W_{il}} \right\} \quad (6)$$

$$Q_u = \max_{1 \leq i \leq n} \left\{ \frac{W_{im}}{W_{iu}} \right\} \quad (7)$$

5) Seek adjustment lower bound weights W_l^* and adjustment upper bound weights W_u^* .

$$W_l^* = Q_l W_l \quad (8)$$

$$W_u^* = Q_u W_u \quad (9)$$

6) Integrate W_l^* , W_m and W_u^* , to obtain fuzzy weights \tilde{W} .

$$\tilde{W} = (W_l^*, W_m, W_u^*) \quad (10)$$

$\tilde{T}_1 = (l_1, m_1, u_1)$ and $\tilde{T}_2 = (l_2, m_2, u_2)$ are hypothesized as two TFNs. Chen (2000) reported the vertex method can be applied to define the distance between two triangular fuzzy numbers (TFNs), arithmetical method of which is as equation (11).

$$d(\tilde{T}_1, \tilde{T}_2) = \sqrt{\frac{1}{3}[(l_1 - l_2)^2 + (m_1 - m_2)^2 + (u_1 - u_2)^2]} \quad (11)$$

The use of distance formula is able to make fuzzy number be defuzzier as R.

$$R = \frac{d}{d^- + d^*}, \text{ where } d^- = d(\tilde{T}, \tilde{T}^-) \text{ and } d^* = d(\tilde{T}, \tilde{T}^*) \quad (12)$$

The best case value is set up as $\tilde{T}^* = (1,1,1)$, and the worst case value is as $\tilde{T}^- = (0,0,0)$. The defuzzier is the subsequence of proceeding fuzzy number and produces the adequate index, the benchmark of comparison. On this study, the value of R stands for the value in the wake of defuzzier. The larger the value of R, the more precedential sequence the factor stands for.

2.2 Hierarchical Structure of Problem in Application

This study is in accordance with the literature review and Delphi technique to construct the hierarchical structure, as the figure 1. The hierarchical structure comprises 3 criteria and 18 sub-criteria.

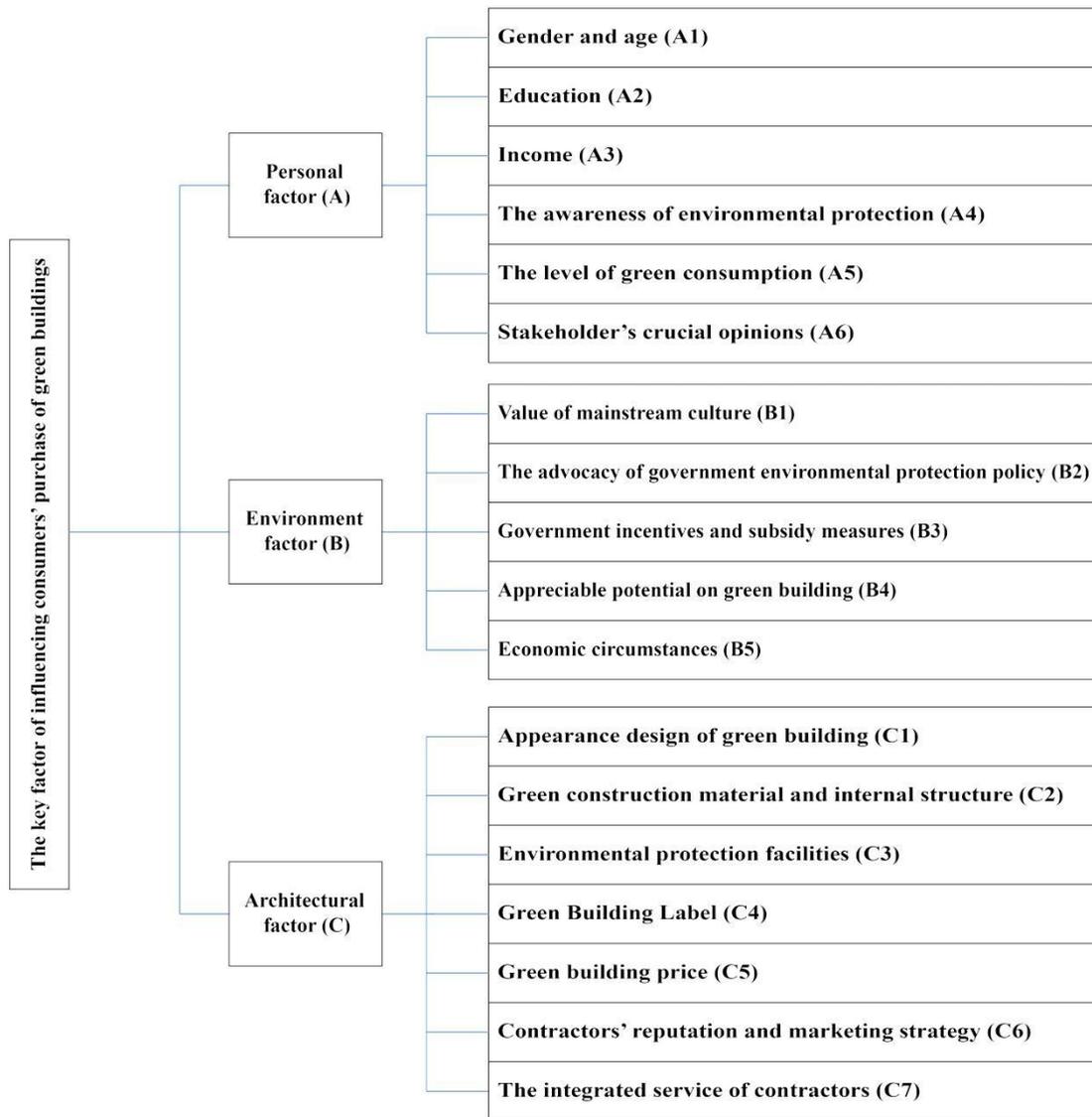


Figure 1. Hierarchical structure of problem in application

The significance of and intension of each criterion respectively is defined as below:

- Gender and age (A1): The study appeared the factor of gender and age is closely associated with consumers' green conduct. Kinnear, Taylor and Ahmed (1974) considered the younger consumers, the more willing to support on the conduct of green consumption. The female participation in the conduct of green consumption is higher than the male. As the result, gender and age of consumer may influence the factor to his/her purchase on green building.
- Education (A2): The consumers' education may influence their willing on the purchase of green building.

Coddington (1993) pointed higher income and education the consumer is, more obvious tendency of green consumption he/she has.

- Income (A3): Generally speaking, the cost and sale price of green building are still higher than the traditional buildings. Consumers' conduct on purchasing house changes gradually while the income is rising. Aside from the living facilities, individual feature of green building is able to attract different consuming group possibly.
- The awareness of environmental protection (A4): The consumers who take the awareness of environmental protection will build individual mode of consuming conduct. The features of environmental product on emphasis enable to increase the consumers' purchase willing. The concept, facilities and appeal of green building attract the consumers who value the environmental protection with awareness.
- The level of green consumption (A5): The awareness of environmental protection the consumers have is not able to convert into the conduct of green consumption completely. Hence, the environmental awareness is likely to be interfered by other factors, such as the advertisements, the marketing methods and the commodity price commodity in the realistic and commercial environment. The level of green consumption is defined as the level of involvement and habit of using green products to the purchasers.
- Stakeholder's crucial opinions (A6): The consumers are aware of the level of identity the stakeholder purchases on and the level whether they are willing to follow the stakeholder.
- Value of mainstream culture (B1): Mainstream culture means the culture is accepted, identified and participated in by most of people, as well as their values are influenced pragmatically. The concept and the value of mainstream culture of green building comply with the influence on consumers' willing.
- The advocacy of government environmental protection policy (B2): By means of advocacy enables the public to be aware of crucial concept and government concrete practices to the environmental protection. The strength of advocacy enables the consumers understand the determination of policy the government took effect as well. The government ought to take public's cultivation and knowledge of environmental protection as the foundation of advocacy on green building (Jan et al., 2012).
- Government incentives and subsidy measures (B3): Promoting the incentives and subsidy measures on environmental protection concept by the government enables the consumers who are keen on green consumption experienced significantly (Lee & Yik, 2004; Zhang et al., 2011). The incentives and subsidy measures carry out the environmental protection policy, promote government image, attract investment, reduce the cost of green commodity, promote related technique on R & D and lead the commercial conduct. Moreover, the incentives and subsidy measures are promoted to benefit the related technique on R & D, the procurement of construction materials and facilities in the official department, Green Building Certification, tax reduction and expense subsidy.
- Appreciable potential on green building (B4): Appreciable potential as the significant factor is always considered by investors and consumers who purchase the real estate. Appreciable potential of real estate lies in the excellent location, traffic facilities and building design. Chan et al. (2009) discovered the green building compared with traditional buildings, the operation cost of which is lower, the property is higher. The concept of green building is growing little by little in the heart of either investors or consumers, being likely to be the source of appreciable potential.
- Economic circumstances (B5): Macroeconomic variables such as the economic development, the level of interest rate, inflation rate and each economic indicator influence greatly on the consumers buying the houses. Indeed, it is difficult for the contractors and real estate dealers to alter the external economic factors. Either the investors or consumers are likely to draw back due to the higher cost or price of green buildings during the economic hardship.
- Appearance design of green building (C1): The design of green building is able to reach the result with low consumption and high efficiency while going after the integrated design and project of the building. The appearance design of green building has varied the design construction of traditional building to both deduct the energy consumption and reduce the operation cost (Tseng et al., 2009).
- Green construction material and internal structure (C2): Green construction material is called as environmental construction material. The concept of green construction material means the construction material possesses the features as safe, ecological maintenance, recycled or reuse, energy saving and low consumption of resources. Green construction material and internal structure is the internal space with the characteristics such as sufficient light, well-ventilated and energy saving...etc.

- Environmental protection facilities (C3): The environmental protection facilities represent the equipment is unable to cause excessive pollution and harm but energy saving brought about to the earth. Facilities enable to carry out the energy saving or reuse of resources effectively. The waste disposal, waste disposal, energy saving system and environmental monitoring and inspection system are common facilities to the environmental protection.
- Green Building Label (C4): Green Building Label refers to the medal awarded to the buildings with use license or legal buildings in light of green building evaluation indicator by the government. The green building is reviewed promptly subsequent to the examination through Green Building Label Review Committee. There were seven indicators for labeling green buildings including Greenery, On-site Water Retention, Daily Energy Saving, CO2 Reduction, Construction Waste Reduction, Water Resource and Sewage & Garbage Improvement.
- Green building price (C5): One of the obstacles is the high cost of green building reported by Williams and Dair (2007). Kibert (2008) and Zhang et al. (2011) considered the scale of amount on construction as the key factor, influencing the cost of green building. The construction cost reflects the sales price on green building; hence, the factor to purchase the green building is the influence of price.
- Contractors' reputation and marketing strategy (C6): The contractors' reputation is built by promoting the image of environmental protection. The contractors explain the consumers the values of environment and the concrete contribution of participating non-profit events to attain the reliability and identity. The contractors attempt to create the brand of building and the image with high quality by means of drawing up effective marketing strategy.
- The integrated service of contractors (C7): The service is passed on to the consumers the outcome they expected. The service contractors offer including project integration, designs, facilities, engineering monitoring and after-sales service. To adapt to the follow-up maintenance and upgrade, the integrated service of contractors will influence the consumers' purchase willing.

3. Empirical Results

On the ground of the statistics by Yung Ching Realty Group, the ratio of buying house through the real estates is 70% in Taiwan. Real Estates possess abundant sales experience to compile and reflect objectively the optimum influence the key factors on purchasing green building as the relative significance. The sampling objective of this study is the real estates in Taiwan, the survey respondents of which aim at the administrative agents. The total 20 copies of expert questionnaires are given out, and the effective questionnaires are 18 copies, the effective ratio of which is 90%. Each expert filled out the questionnaire by pairwise comparison method. Then, the expert questionnaires were compiled by advance integration to proceed the analysis by self-written program as FAHP through Matlab.

According to the study method, fuzzy pairwise comparison matrix of each criterion in level 2 is compiled as equation (13).

$$T_2 = \begin{bmatrix} (1,1,1) & (2.00,3.09,6.00) & (0.33,0.97,3.00) \\ (0.17,0.32,0.50) & (1,1,1) & (0.17,0.30,0.50) \\ (0.33,1.03,3.00) & (2.00,3.30,6.00) & (1,1,1) \end{bmatrix} \quad (13)$$

The fuzzy judgment matrix as equation (13) is divided into three judgment matrixes as equation (14) to equation (16).

$$T_{2l} = \begin{bmatrix} 1 & 2.00 & 0.33 \\ 0.17 & 1 & 0.17 \\ 0.33 & 2.00 & 1 \end{bmatrix} \quad (14)$$

$$T_{2m} = \begin{bmatrix} 1 & 3.09 & 0.97 \\ 0.32 & 1 & 0.30 \\ 1.03 & 3.30 & 1 \end{bmatrix} \quad (15)$$

$$T_{2u} = \begin{bmatrix} 1 & 6.00 & 3.00 \\ 0.50 & 1 & 0.50 \\ 3.00 & 6.00 & 1 \end{bmatrix} \quad (16)$$

The priority vector weights of three matrixes as equation (14) to equation (16) are calculated as equation (17) to equation (19) respectively.

$$W_{2l} = [0.43 \quad 0.14 \quad 0.43] \tag{17}$$

$$W_{2m} = [0.42 \quad 0.14 \quad 0.44] \tag{18}$$

$$W_{2u} = [0.45 \quad 0.10 \quad 0.45] \tag{19}$$

Making use of crisp judgment matrix as equation (15) proceeded Consistency Test to acquire $\lambda_{\max} = 3.0001$ and $CI = 0.00005 < 0.1$. The adjustment coefficients are $Q_{2l} = 0.9474$ and $Q_{2u} = 1.3188$. The adjustment lower bound weights (W_{2l}^*) and the adjustment upper bound weights (W_{2u}^*) are obtained as equation (20) and equation (21) respectively.

$$W_{2l}^* = [0.41 \quad 0.14 \quad 0.41] \tag{20}$$

$$W_{2u}^* = [0.59 \quad 0.14 \quad 0.59] \tag{21}$$

Accordingly, the fuzzy weights of each criterion in level 2 are showed as equation (22) to equation (24).

$$W_A = [0.41 \quad 0.42 \quad 0.59] \tag{22}$$

$$W_B = [0.14 \quad 0.14 \quad 0.14] \tag{23}$$

$$W_C = [0.41 \quad 0.44 \quad 0.59] \tag{24}$$

The fuzzy pairwise comparison matrices of sub-criteria under the personal factor, the environment factor and the architectural factor in level 2 are compiled respectively as equation (25) to equation (27).

$$T_{31} = \begin{bmatrix} (1,1,1) & (0.20,0.32,0.50) & (0.17,0.22,0.33) & (0.14,0.18,0.33) & (0.14,0.20,0.33) & (0.25,0.60,3.00) \\ (2.00,3.13,5.00) & (1,1,1) & (0.25,0.50,3.00) & (0.17,0.37,4.00) & (0.20,0.38,2.00) & (0.50,1.99,6.00) \\ (3.00,4.63,6.00) & (0.33,2.00,4.00) & (1,1,1) & (0.25,0.67,3.00) & (0.25,0.91,3.00) & (0.50,3.08,5.00) \\ (3.00,5.48,7.00) & (0.25,2.72,6.00) & (0.33,1.49,4.00) & (1,1,1) & (0.20,1.33,4.00) & (3.00,4.65,7.00) \\ (3.00,5.08,7.00) & (0.50,2.63,5.00) & (0.33,1.10,4.00) & (0.25,0.75,5.00) & (1,1,1) & (2.00,4.05,7.00) \\ (0.33,1.66,4.00) & (0.17,0.50,2.00) & (0.20,0.32,2.00) & (0.14,0.22,0.33) & (0.14,0.25,0.50) & (1,1,1) \end{bmatrix} \tag{25}$$

$$T_{32} = \begin{bmatrix} (1,1,1) & (0.25,0.68,4.00) & (0.17,0.28,0.50) & (0.20,0.40,4.00) & (0.33,1.22,6.00) \\ (0.25,1.47,4.00) & (1,1,1) & (0.17,0.38,2.00) & (0.20,0.45,2.00) & (0.50,2.15,3.00) \\ (2.00,3.54,6.00) & (0.50,2.65,6.00) & (1,1,1) & (0.33,1.12,4.00) & (2.00,4.22,7.00) \\ (0.25,2.52,5.00) & (0.50,2.24,5.00) & (0.25,0.90,3.00) & (1,1,1) & (2.00,3.99,5.00) \\ (0.17,0.82,3.00) & (0.33,0.47,2.00) & (0.14,0.24,0.50) & (0.20,0.25,0.50) & (1,1,1) \end{bmatrix} \tag{26}$$

$$T_{33} = \begin{bmatrix} (1,1,1) & (0.14,0.26,0.50) & (0.17,0.45,3.00) & (0.25,1.51,6.00) & (0.17,0.23,0.50) & (0.17,0.47,4.00) & (0.33,1.56,5.00) \\ (2.00,3.86,7.00) & (1,1,1) & (0.50,2.27,5.00) & (3.00,4.86,7.00) & (0.33,0.76,3.00) & (0.25,1.70,6.00) & (3.00,5.00,6.00) \\ (0.33,2.24,6.00) & (0.20,0.44,2.00) & (1,1,1) & (2.00,3.30,6.00) & (0.17,0.45,3.00) & (0.20,0.94,7.00) & (2.00,3.47,5.00) \\ (0.17,0.66,4.00) & (0.14,0.21,0.33) & (0.17,0.30,0.50) & (1,1,1) & (0.13,0.20,0.33) & (0.14,0.38,2.00) & (0.25,1.14,3.00) \\ (2.00,4.33,6.00) & (0.33,1.32,3.00) & (0.33,2.24,6.00) & (3.00,5.11,8.00) & (1,1,1) & (0.33,2.15,5.00) & (3.00,5.24,7.00) \\ (0.25,2.15,6.00) & (0.17,0.59,4.00) & (0.14,1.06,5.00) & (0.50,2.66,7.00) & (0.20,0.46,3.00) & (1,1,1) & (0.33,2.52,8.00) \\ (0.20,0.64,3.00) & (0.17,0.20,0.33) & (0.20,0.29,0.50) & (0.33,0.87,4.00) & (0.14,0.19,0.33) & (0.13,0.40,3.00) & (1,1,1) \end{bmatrix} \tag{27}$$

Accordingly, the fuzzy weights of sub-criteria under the personal factor in level 2 are as equation (28) to equation (33).

$$W_{A1} = [0.05 \quad 0.05 \quad 0.05] \tag{28}$$

$$W_{A2} = [0.09 \quad 0.12 \quad 0.22] \tag{29}$$

$$W_{A3} = [0.13 \quad 0.21 \quad 0.24] \tag{30}$$

$$W_{A4} = [0.17 \quad 0.30 \quad 0.30] \tag{31}$$

$$W_{A5} = [0.17 \quad 0.25 \quad 0.31] \tag{32}$$

$$W_{A6} = [0.05 \quad 0.07 \quad 0.09] \tag{33}$$

The fuzzy weights of sub-criteria under the environment factor in level 2 are as equation (34) to equation (38).

$$W_{B1} = [0.09 \quad 0.11 \quad 0.23] \tag{34}$$

$$W_{B2} = [0.09 \quad 0.15 \quad 0.21] \tag{35}$$

$$W_{B3} = [0.28 \quad 0.36 \quad 0.37] \tag{36}$$

$$W_{B4} = [0.19 \quad 0.31 \quad 0.31] \tag{37}$$

$$W_{B5} = [0.08 \quad 0.08 \quad 0.12] \quad (38)$$

The fuzzy weights of sub-criteria under the architectural factor in level 2 are as equation (39) to equation (45).

$$W_{C1} = [0.05 \quad 0.07 \quad 0.15] \quad (39)$$

$$W_{C2} = [0.21 \quad 0.26 \quad 0.29] \quad (40)$$

$$W_{C3} = [0.12 \quad 0.14 \quad 0.26] \quad (41)$$

$$W_{C4} = [0.04 \quad 0.05 \quad 0.09] \quad (42)$$

$$W_{C5} = [0.20 \quad 0.29 \quad 0.29] \quad (43)$$

$$W_{C6} = [0.06 \quad 0.14 \quad 0.27] \quad (44)$$

$$W_{C7} = [0.05 \quad 0.05 \quad 0.09] \quad (45)$$

After that, the fuzzy weights of each criterion in level 2 multiplied by the fuzzy weights of each sub-criteria. The defuzzier values (R) of each sub-criteria and final fuzzy weights are presented in table 1.

Table 1. Final fuzzy weights and Defuzzier values

Rank	Sub-Criteria	Final Fuzzy Weights	Defuzzier (R) Values
1	Green building price (C5)	(0.0828,0.1296,0.1737)	0.1331
2	The awareness of environmental protection (A4)	(0.0697,0.1286,0.1798)	0.1327
3	Green construction material and internal structure (C2)	(0.0850,0.1127,0.1734)	0.1283
4	The level of green consumption (A5)	(0.0672,0.1069,0.1823)	0.1267
5	Income (A3)	(0.0510,0.0909,0.1391)	0.0996
6	Contractors' reputation and marketing strategy (C6)	(0.0236,0.0617,0.1611)	0.0985
7	Environmental protection facilities (C3)	(0.0474,0.0633,0.1516)	0.0975
8	Education (A2)	(0.0384,0.0495,0.1330)	0.0839
9	Appearance design of green building (C1)	(0.0199,0.0304,0.0902)	0.0556
10	Government incentives and subsidy measures (B3)	(0.0381,0.0486,0.0501)	0.0459
11	Appreciable potential on green building (B4)	(0.0257,0.0417,0.0417)	0.0371
12	Stakeholder's crucial opinions (A6)	(0.0193,0.0279,0.0544)	0.0369
13	The integrated service of contractors (C7)	(0.0197,0.0214,0.0558)	0.0362
14	Green Building Label (C4)	(0.0172,0.0225,0.0506)	0.0334
15	Gender and age (A1)	(0.0185,0.0192,0.0269)	0.0219
16	The advocacy of government environmental protection policy (B2)	(0.0126,0.0201,0.0282)	0.0213
17	Value of mainstream culture (B1)	(0.0117,0.0142,0.0315)	0.0210
18	Economic circumstances (B5)	(0.0107,0.0107,0.0156)	0.0125

It will be seen from the defuzzier values (R) in Table 1 that the top 5 key factors influence the consumers on purchasing the green buildings are "Green building price" (R=0.1331), "The awareness of environmental protection" (R=0.1327), "Green construction material and internal structure" (R=0.1283), "The level of green consumption" (R=0.1267) and "Income" (R=0.0996). Comparatively speaking, the key factors are unable to influence the consumers on purchasing such as "Economic circumstances" (R=0.0125), "Value of mainstream culture" (R=0.0210), "The advocacy of government environmental protection policy" (R=0.0213), "Gender and age" (R=0.0219) and whether obtained "Green Building Label" (R=0.0334).

Green building price is the most taken account of by consumers. For most of consumers, purchasing the house is the major policy decision in their lives. Longer time and more aspects need to be taken into account for consumers, wherefore the sum of money on purchasing the houses is far higher than purchasing the common articles. The result is echoed mutually with the study made up by Cheng et al. (2013). Cheng et al. (2013)

described the public call in question on the cost of green building is far higher than the common ones, which became the main obstacle to development the green building in public. Generally speaking, the ratio of the construction cost of small-scale residence is merely approximate 20%~30% of general budget in Taiwan. Increased cost as the green building technique is 10% ~15% of the original budget though, economizing roughly NT\$35,000~\$40,000 per year on utility bills, as well as extending construction lifecycle near 20 years. Hence, green building which is by no means of high-priced building is proved. The promotion and marketing of green building are aimed at to strengthen the advocacy of cost-benefit analysis.

The second significant factor to influence consumers on purchasing green building is “the awareness of environmental protection”. Sheth, Newman and Gross (1991) accounted for the green related products are unable to accept on sale at all times caused by people who are fail to be understood the real request on the awareness of environmental protection and the consumption. The consumers take the awareness of environmental protection and concept as the mode of individual consumption conduct. Consequently, the promotion and marketing strategies need to inspire the awareness of environmental protection for consumers aside from the government or the contractors require understanding the public’s the level of the awareness of environmental protection positively. “Green construction material and internal structure” is the third influence on green building purchase, representing besides the purpose of the deduction of waste, recycling and reuse for the construction materials, either the construction or the house structure contains the safety with fireproof and shock-proof.

The fourth significant factor is “The level of green consumption”. The so-called green consumption not only includes using green product up, but contains the energy use effectively, resources recycling and the concept of non-excessive consumption on the protection of environment and ecology during the consumption process. Green consumption aims at protecting the eco-environment aside form fulfilling people’s consuming requests. Nevertheless, Taiwanese public have the awareness of environmental protection in common, the concept and conduct on green consumption has not matured yet currently, causing the blind consumption. It is proposed to strengthen the consumers’ awareness of environmental protection to promote the level of green consumption on the promotion strategy of green building.

“Income” which influences the consumers to purchase green buildings is the fifth significant factor. Most families are influenced to purchase the house by the house prices except for the consumers at the top of the economic pyramid. In accordance with the data of Construction and Planning Agency Ministry of the Interior (CPAMI) announced the housing price and income ratio (PIR) has risen from 5.37 times in Q1 up to 8.40 times in Q2 in 2003. Accordingly, the real estate agents are proposed to aim at the survey of the public’s income as well as construct the market segmentation properly. Then, the customers with different income segmentation are offered different green buildings.

Besides, the empirical results exposure other notable messages. First of all, “Green Building Label” ($R=0.0334$) is not quite valued by the consumers, for the possible reason of which the consumers are not familiar with the establishment of Green Building Label. Thus, the government should extend the advocacy of Green Building Label, which enables the consumers to understand the implication of Green Building Label impressively. Both contractors and real estate agencies are supposed to apply various publicized methods and instruct the consumers to obtain the intent and significance of Green Building Label. Second, less impact on the factors as “Contractors’ reputation and marketing strategy” ($R=0.0213$) and Value of mainstream culture ($R=0.0210$) is explored by the analysis result. Finally, “Economic circumstances” ($R=0.0125$) is relatively the least key factor that appeared the macroeconomic variables such as the economic development, the interest rate standard, inflation ratio and macroeconomic variables such as the economic development, the level of interest rate, inflation rate and each economic indicator influence greatly on the consumers buying the green houses. From it to be inferred, the decision making of purchasing green building will not be influenced by economic environment transition as long as the consumers who are willing to purchase may afford to pay on green building by their income.

4. Conclusion

The development of green building has formed preliminarily subsequent to the establishment of evaluated indicator since 1999. Green Building Label began to accept the application in 2001. The cases of applying are increased gradually all the year round, yet the most are the public building (the construction cost is NT\$50 million above) as mandatory applications. This study adopted FAHP to discuss and analyze the key factors for customers to purchase the green building so as to promote and marketing the green building in private sector. The contribution of respective factor to the relative weights and significance of subsequence is able to be the reference regarding the establishment developed by government and the marketing strategies drawn up by real estate agencies.

“Green building price”, the consumers think highly of the most according to the study result among all the factors. However, the stereotype of the high price for green building has rooted in common people, as the result, the advocacy should be emphasized on the cost-benefit analysis aiming at the promotion and marketing of green building. “The awareness of environmental protection” is the secondary factor to impact the consumers to purchase the green building. Consequently, the promotion and marketing strategies need to inspire the awareness of environmental protection for consumers aside from the government or the contractors require understanding the public’s the level of the awareness of environmental protection positively. “Green construction material and internal structure” is the third influence on green building purchase, representing besides the purpose of the deduction of waste, recycling and reuse for the construction materials, either the construction or the house structure contains the safety with fireproof and shock-proof. The fourth significant factor is “The level of green consumption”. The concept and conduct on green consumption has not matured yet currently, causing the blind consumption. It is proposed to strengthen the consumers’ awareness of environmental protection to promote the level of green consumption on the promotion strategy of green building. “Income” which influences the consumers to purchase green buildings is the fifth significant factor. Accordingly, the real estate agencies are proposed to aim at the survey of the public’s income as well as construct the market segmentation properly.

Moreover, seeing that the consumers ignored neither the importance nor the familiarity with the establishment of “Green Building Label”, the government should extend the advocacy of Green Building Label as well as the contractors and real estate agencies are supposed to apply various publicized methods and instruct the consumers to obtain the intent and significance of Green Building Label. Less impact on the factors as “Contractors’ reputation and marketing strategy” and Value of mainstream culture explored by the analysis result. “Economic circumstances” is relatively the least key factor at last. While the consumers’ income may support the decision making of purchasing green building, it will not be influenced by economic environment transition.

Environmental and eco-protection is the evitable issue that the mankind should comply with no matter takes place at the moment or in the future. The major key point to all environmental concerns lies on the attitude of awareness of environmental protection and green consumption conduct. As long as the intangible awareness of environmental protection is transformed into concrete greening action, the resources on the earth will be maintained effectively and reduce the loss of life property the natural disasters brought about. The energy consumption of construction has occupied the massive resources; accordingly, it is urged the promotion and marketing of green building be publicized all over the world.

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