

An Analytical Hierarchical Process (AHP) based Approach for Promoting Green Buildings among the Citizens of Next Generation in Malaysia

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Abstract. Green buildings, as many know, provide a concept for reducing the environmental impact more than the standard building. In order to implement this new kind of building efficiently and effectively in different places, this is very important of having construction managers and designers who really need to enhance and modify their understandings of cultures and interest of the customers. The aim of this study is to achieve the factors that contribute in the expanding of green building market among the Malaysian citizens of next generation through the analytical hierarchical approach. For expanding green building in Malaysia, government and businesses need a deep understanding about the people's priority. For achieving this goal, a model of Analytical Hierarchy Process has been used in this study to collect data from the next generation of Malaysian citizens considering 8 criteria related to green building and offering 3 alternatives as well. The findings reveal that the factors such as health and reduction of pollution factors have more priority among Malaysian citizens and during the expansion of green building in Malaysia the buildings that focus on Healthy and indoor environment quality are getting the interests among Malaysians.

Keywords: Green building, Leadership in Energy and Environmental Design (LEED), Analytical hierarchical process (AHP)

1. Introduction

In the present decade, buildings consume the great ratio of energy and resources in different steps of construction and also, in the period of using of the buildings. Several statistics show that approximately 25% of wood stock, 17% of fresh water and about 40% of material and energy produced in the worldwide are consumed in the building construction and thus, this procedure of using of energy and natural resources can have harmful impact on the society and its environment [1]. New findings also indicate that the Earth's temperature is in the order of 30-50% more sensitive to CO₂ in compared to the previous estimation [2]. For efficient consumption of renewable, natural and sustainable resources, leaders in the building industry should be conscious; otherwise people will face the cost of environmental damage, and this factor emphasizes the need of concept called green building. In order to have the awareness about green buildings, the rating system of buildings is developed voluntarily in accordance with the suitability in the industry of buildings in the respective countries [1].

1. Green Building

The green building is a new concept of building that appears in the recent decade. The term of Green building can enclose a large number of environmental benefits in various aspects such as economic, social etc and can be involved in different aspects of buildings such as construction techniques and sustainable design [3]. According to the United States Environmental Protection Agency in 2009, the term of the Green building is the practice for using processes and creating structures that are responsible to the environment and resource

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efficiency during the lifecycle of the building in all steps such as operation, renovation, design, construction, maintenance, deconstruction etc [4]. This kind of practice can complement and expand the classical building or high performance building [4]. At the other end of the continuum, green building can involve the sustainable design and construction techniques in every aspect of the building and designing buildings that reduce the overall impact of the built environment on the natural environment and human health [3].

2. Green Building Rating System

Green Building Rating System has launched in 2000 that is "...a voluntary, consensus-based, market-driven building rating system..." that "...evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a 'green building' " [5]. Rating systems (LEED) bring some benefits and improve the environment by reducing consumption of natural resources and greenhouse gas emissions [1]. The rating system certification points in six categories such as Water efficiency, materials and Resources, Indoor Environmental Quality, Sustainable Sites, Energy and Atmosphere, Innovation and Design[6].

3. What LEED Delivers For Green Buildings

United States Green Building Council mentioned: "participation in LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. There are both the financial and environmental benefits to earn LEED certification" [7]. LEED-certified buildings are designed to conserve energy and water, Reduce waste sent to landfills, be healthier and safer for occupants, reduce harmful greenhouse gas emissions, lower operating costs and increase asset value, qualify for tax rebates, zoning allowances and other incentives in hundreds of cities

4. Green Building And User Satisfaction

Green Building brings many tangible and intangible benefits for owners and occupants. The benefits can increase satisfaction of owners and occupants who choose green building as an ideal place for living and working [8]. "In the definitions underlining the effective component, user satisfaction in housing means reflecting the sentiments of satisfaction and happiness to the housing place which also creates these feelings" [9],[10]. In the explanation underlining the cognitive component, the user satisfaction in housing is made up by correspondence between standards which users expect and demand and the current condition of the users [10]. Different empirical studies that have been discussed about user satisfaction examine physical and personal characteristics with the social features of the residential environment [11].

5. Environmental And Social Responsibility

Obviously, an increased amount of environmental consciousness and concerns over global warming and pollution environment are significant motivating factors for the companies to construct green building [3]. No previous business had such an overwhelming impact on every aspect of environment and life on this Earth [12]. All of the businesses and people should have more self regulation for decreasing their harmful impact on environment as well as on themselves. It can go without saying that the demonstrated concern for the environment is incalculable regarding to the benefits in marketing and public relations [13]. By considering the environmental issues, companies can decrease criticisms and promote a good relation with stakeholder groups [14].

6. Economic Factors

Green buildings are built to last and tend to hold their value better with lower operating costs and as a result, insurance premiums may also be lower [15]. On the other hand, many areas are facing water shortages and managing water consumption is very much essential for saving costs [3]. Energy efficient cost savings in green building may occur through standard green construction features such as natural lighting, reduction of water and energy consumption like solar heating etc [3]. The green building has led to criticisms for including an average additional cost approximately 2 to 9 percent for achieving LEED certification and it is only for

those who can afford it [16]. But, asserting the criticism of extra cost, USGBC has mentioned that in silver or certified level the cost should not be more than the conventional building [17]. Some studies indicate that LEED buildings have included standard cost range that is similar to the conventional type of buildings. For an instance, Gregory H. K. in 2003 performed a comprehensive study (a project with an average of over 18 schools and offices) that shows the green premium cost for Silver level of LEED certification is around 2 percent [18].

7. Indoor Environment Quality And Health

In green design and construction, there are some processes and features that can have positive impact on occupants' health and productivity [19]. Considering indoor environment quality (IEQ) in green building, negative effect on occupants' physical health such as asthma exacerbation and respiratory allergies caused by extreme temperature, poor air quality, excess humidity, insufficient ventilation and the negative effect on occupants' psychological health such as depression and stress caused by insufficient lighting, ergonomic design and acoustics, can be decreased [20]. The movement of green building tries to address indoor environment quality (IEQ) and occupants' health concerns by preparing healthier building environments [21].

8. The 'Feel-Good' Factor

Social value - a compound function of public image, resource conservation, marketability and corporate responsibility- is another benefit of green building. Certainly owners may tip the scales in favour of sustainability by the 'feel-good' factor, where "...choices being made to incorporate sustainability into design and construction are a result of value the client sees in the economic and environmental benefits of 'green' " [22].

9. Methodology

In this research, Analytic Hierarchy Process (AHP) has been selected to find priority of factors among Malaysian citizens of next generation for selecting green buildings. The Analytic Hierarchy Process (AHP) is based on mathematics and psychology for analyzing and organizing complex decision making and this method can assist to understand the problem better and find the required objective to be achieved, rather than merely to prescribe a correct decision. Based on the literature review and Analytical Hierarchical Model, 8 elements such as water saving, energy saving, operation and maintenance cost, the respect to society, reduction of pollution, "feel- good" factor, indoor quality environment (IEQ) and health factors have been selected and 3 alternatives have been suggested such as green building with economic orientation, green building with the orientation of indoor environment quality (IEQ) and healthy factors and lastly, green building with feel-good and modern design orientation (Figure 1). On the basis of Analytic Hierarchy Process (AHP), questionnaires have been designed by pair wise comparison for comparing each criterion with other criteria and each alternative to other alternatives that are stood on each criterion. After pre-sampling test, the questionnaires have been distributed among 50 young Malaysian citizens who belong to the next generation people and live in different places in Malaysia. Prior to the distribution of the questionnaires among the respondents, the purpose of the study has been explained to them for their better understanding of this research work and thus, an increase of data accuracy has been obtained. Finally all the data have been analyzed by both the Expert choice and Excel software.

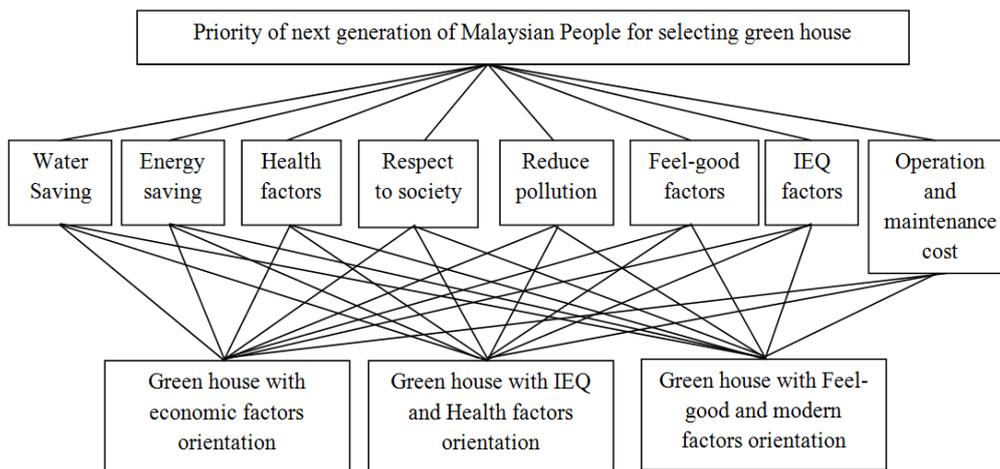


Figure 1: Analytical hierarchical model

10. Analyzing The Data

After collecting questionnaires from 50 respondents, geometric means have been used by the excel software for achieving one mean in each pair-wise comparison (Table 1). From the analysis of the data it indicates that the inconsistency ratio is 0.00526 with 0 missing judgment. Therefore, the inconsistency ratio is below 0.1 which indicates that the analysis is trustworthy.

Table 1: Weights of pair wise comparison

CRITERIA	Water Saving	Energy saving	Operation cost	Reduce pollution	Respect to society	Feel-good	IEQ	Healthy
Water Saving	1	0.73	1.05	0.43	0.69	1.27	0.53	0.44
Energy saving		1	1.25	0.46	0.75	1.23	0.72	0.42
Operation cost			1	0.3	0.62	0.67	0.43	0.3
Reduce pollution				1	2.15	2.04	1.45	1.02
Respect to society					1	1.17	0.62	0.51
Feel-good						1	0.54	0.43
IEQ							1	0.54
Healthy								1

11. Criteria Analysis

Inserting the data by the expert choice and analyzing the criteria, the results indicate that among all criteria, criterion of health has secured first priority and other criteria such as reduction of pollution, indoor environment quality, the respect to society, energy saving, feel-good factors, water saving and operational and maintenance cost are in the position of next priority (Figure 2).

12. Alternative Analysis

In the next step of analyzing the data by expert choice, each alternative is compared to other alternative by considering each criterion. After collecting the responses from all the 50 respondents and getting geometric mean for achieving one mean, the weights have been inserted into the software. After performing the data analysis the result shows that the Green building with its orientation of indoor environment quality (IEQ) and health factors (alternative 3) gets the first ranking while Green building with economic orientation (alternative 1) and Green building with feel-good and modern design orientation (alternative 2) secure the second and the third ranking respectively (Figure 2).

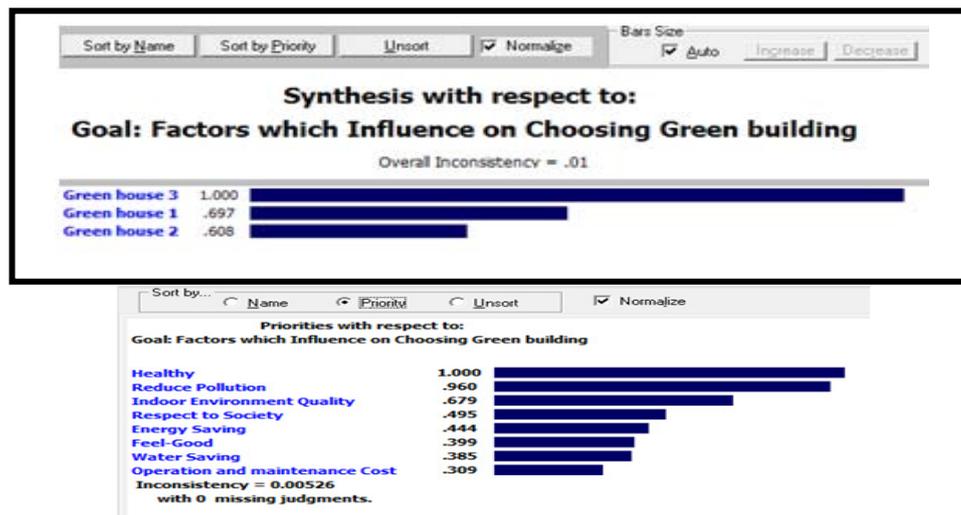


Figure 2: Priority of criteria and alternatives

13. Conclusion

This paper has tried to find the essential priorities of criteria among next generation of Malaysian citizens and have a better understanding from their interest behind the selection of a green building. Understanding of these priorities and interests can help government and firms expand better the green building market in Malaysia in future. In this paper, based on the literature review and past studies, 8 criteria of green buildings have been selected. The criteria are, namely, water saving, energy saving, operation and maintenance cost, the respect to society, the reduction of pollution, “feel- good” factor, Indoor quality environment (IEQ) and health factors. Also 3 kinds of green buildings with their 3 orientations are recommended as alternatives. In this research work, it has been mentioned already that after analyzing the data by expert choice and inserting the data into the software, the health factor has been found to be the top most priority among all the criteria and the rest of the criteria, namely, reduction pollution, indoor environment quality, respect to society, energy saving, feel-good factors, water saving and operational and maintenance cost are positioned in the next priority. The results from the alternative analysis indicate that the green building with the orientation of indoor environment quality (IEQ) and health factors have been secured the first ranking and Green building with economic orientation and Green building with feel-good and modern design orientation are in the position of second and third ranking respectively. The findings show that for the success in the market of green buildings in Malaysia the government and the firms should consider the investment on health and indoor environment quality factors rather than the other factors. Some criteria like water saving, feel-good factors and operation and maintenance cost are in the last priority among the next generation of Malaysian citizens and most interestingly this research explores that the investment on expensive equipments in green building for saving water is not rational and economical at all in Malaysia as it merely can boost up the price of the buildings and decrease their value among the Malaysian citizens.

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