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The Impacts Of Green Building Index Towards Energy Consumption In Malaysia

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ABSTRACT

Green building is the foundation of the sustainable construction development. Green building is redefining building practice and Malaysia and is poised for early adoption in recondition of the potential economic and environmental benefits that accrue to it. This study aims to investigate the prima facie conjecture that there are problems to an evaluation on development of green building in Malaysia with regard to the effectiveness of green building index (GBI). This paper describes a formal methodology for directing the process of developing and implementing green building in Malaysian building companies based on the review papers are proposed. The main barriers are as follows: deficiency of knowledge and skills, lack of specific rules and regulations, lack of awareness and commitment and lack of sustainability elements based on green building rating like GBI. Malaysian government has been playing a strong role in ensuring environment sustainability by way of introducing necessary policies and implementing them. It has resulted in the promotion of green technology that presents the most viable way of carrying out new green-related activities for environment conservation. The primary objective of this paper is to identify. The data were collected via a questionnaire survey and analysed with the help of SPSS. The major research findings indicate that there was a concordance of opinions among the respondents on the three main factors. Four hypotheses were accepted based on the analyses. This study recommends the need for all parties involved to develop plans, regulations, procedures, specific guidelines and inputs to pertinent academic programmes if the green concept and GBI elements were to be effectively practised in property development in this country as a whole. A quantitative survey was done on GBI professional members through random sampling, In conclusion, it can be inferred that the GBI is still at its infancy stage and as such serious attention is needed among the players in the development of green building in Malaysia. According to the results, this article is research paper and the level of green building development in Malaysia needs improvement and Based on the GBI, the government plays the key role in the development of green buildings in Malaysia.

INTRODUCTION

In recent years, environmental issues such as climate change, energy crisis, and pollution increase draw a great attention from the construction industry in Malaysia. Transformation of Building construction and operations are significant because the environmental impacts are expected to increase with population growth and changes in other factors such as demographic and economic factors. Various measures have been carried out to minimize the construction impacts towards environment and sustainable development was introduced to improve a quality of life for current people and future generation (Samari *et al.*, 2013). The Brundtland Commission defined sustainable development as the ability to make development sustainable to ensure that it

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meets the needs of the present without compromising the ability of future generations to meet their own needs (Kates *et al*., 2005). In order to implement the sustainable development's goals in Malaysian construction industry, the government introduced Green Building. Green building has an important role in achieving the aim of sustainable development which is to protect environment and to improve the quality of human life (Fisk and Rosenfeld, 1998). The construction industry generates the greatest environmental impacts among all other industries. Green building designs and standards are developed to improve building operation energy and embodied energy efficiencies, and minimize energy and wastes (Kwok *et al*., 2011). Figure 1 show that energy per capita in ASEAN.

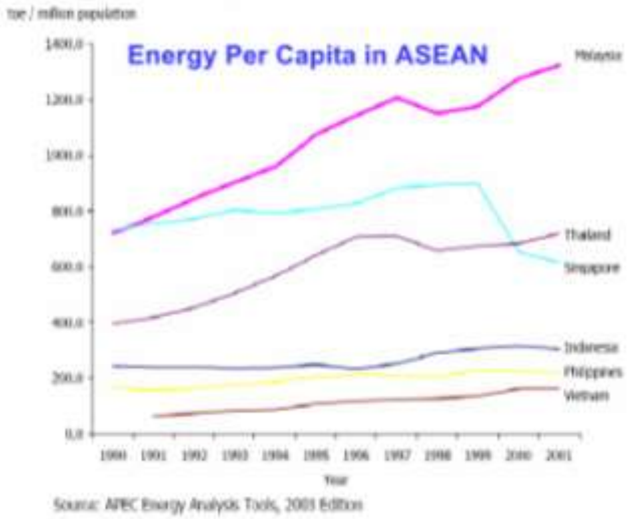

Fig. 1: Energy Per Capita in ASEAN
Source: Selvakkumaran and Limmeechokchai, (2013)

1.1 Role of Green Building:

Green building practices can play a key role in achieving sustainability in the construction industry (Chatterjee, 2009). Therefore, over the last two decades the construction industry has made efforts to develop green building practices (Gluch, 2006). Green buildings are about resource efficiency, lifecycle effects, and building performance. The core of smart buildings is integrated in building technology systems, and that is construction in the spectrum of operational efficiencies, enhanced management and occupant functions. There are several commonalities between integrating building's technology systems and constructing a sustainable or "green" building (Sinopoli, 2008). Many factors are promoting the rapid development of green buildings, including increasingly serious environmental problems, constant improvement of demands on architectural environment's quality, introduction and development of a variety of green building technologies, successive implementation of accompanying "green building evaluation criteria" and other relevant policies and regulations. As it is well known, green building's design is the premise and necessary conditions of green building development, which is itself a concept of sustainable development, and it emphasizes the adaptation to local conditions, times and issues (Zhang, 2011).

Kamana and Escultura (2011) defined "sustainable building" or "green building" as an outcome of a design which focuses on increasing the efficiency of resource use - energy, water, and materials - while reducing Building impacts on human health and the environment during the building's lifecycle, through better location, design, construction, operation, maintenance, and removal. Deuble and de Dear (2012) stated that green buildings, often defined as those featuring natural ventilation capabilities, i.e. low-energy or free-running Buildings, are now at the forefront of building research and climate change mitigation scenarios. According to Table 1 which shows comparison between green buildings and non-green buildings or traditional buildings in Malaysian building industry.

Table 1: Comparison between "Green Buildings" and "Non-Green Buildings" or "Traditional Buildings".

Building Type	Green Building	Non-Green Building
Energy Consumption	Low	High
Indoor Environment Quality	Very Good	Good
Emissions	Low	High
Waste Management	Highly Efficient	Efficient
Building Materials	Environmentally Friendly	Not Environmentally Friendly
Project Practices	Sophisticated	Normal
Feasibility	>5% than Threshold	Threshold

Source: GBI, 2013

There is deference between “green building” and “ASEAN-construction”, where the concept of Eco-construction is a part of the whole concept of green building. The charter of network for the development and use of natural resources in local construction of the Southeast Asian on Eco-construction and sustainable development defined the “Eco-construction” as a holistic and integrated approach that aims to support access to a healthy habitat, primarily in rural areas, while ensuring conservation of natural resources and to build on the cultural and architectural heritage in construction. The Eco-innovation in construction leads to the marketing of products, providing services and innovative solutions which include bioclimatic architecture, and enhancing use of local natural resource and highlight the skills of man and enterprise.

1.2 Green Technology:

Green technology refers to the development and application of products, equipment and systems to protect the environment and the natural environment and minimize or alleviate the negative effects of human activities (KeTTHA, 2011). Generally greenhouse refers to the normal greenhouse constructed for agricultural purposes and plants research. However, this study refers to green residential buildings where humans live. It also refers to residential buildings incorporating green technology with green space and energy efficiency that can provide comfort, safety and healthy living environment. Green residential buildings are also constructed using sustainable development concepts that utilize green resources which can be found easily such as wood (trees harvested and replanted), solar energy, hydroelectric power and wind power. Sustainable development is all about meeting the needs of the present (people) without compromising the ability of future generations in order to meet their own needs (Jennifer and Jackson, 2008).

1.3 What is a Green Building?:

Green building focuses on increasing the efficiency of resource use of energy, water, and materials while reducing building impact on human health and the environment during the building’s lifecycle, through better sitting design, construction, operation, maintenance, and removal. Figure 2 shows that green buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings (GBI, 2013).

Fig. 2: Aims of Green Buildings
Source: GBI Malaysia, 2013

1.4 Significance of Green Buildings:

Green buildings are designed to save energy and resources, recycle materials and minimize the emission of toxic substances throughout its life cycle. Green buildings harmonize with the local climate, traditions, culture and the surrounding environment. Green buildings are able to sustain and improve the quality of human life whilst maintaining the capacity of the ecosystem at local and global levels. According to Table 2, green buildings make efficient use of resources; have significant operational savings and increases workplace productivity. Green building sends the right message about a company or organization that it is well run, responsible, and committed to the future (GBI, 2013).

Table 2: Green Building Benefits

Environmental Benefits	Economic Benefits	Social Benefits
Emissions Reduction Water Conservation Storm Water Management Temperature Moderation Waste Reduction	Energy and Water Savings Increased Property Values Decreased Infrastructure Strain Improved Employee Attendance Increased Employee Productivity Sales Improvements Development of Local Talent Pool	Improved Health Improved Schools Healthier Lifestyles and Recreation

Source: GBI Malaysia, 2013

1.5 Defining the Green Building:

According to GBI (2011) “A green building focuses on increasing the efficiency of resource use energy, water, and materials while reducing building impact on human health and the environment during the building’s lifecycle, through better sitting, design, construction, operation, maintenance, and removal. Green buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings”. Buildings with green technology in Malaysia are considered new. But the efforts to develop a comprehensive green technology for buildings including residential are underway to ensure a better quality, comfortable and affordable to a wide range of social groups. The government of Malaysia is currently aware that green technology can be a practical, useful and an alternative approach for residential buildings.

1.6 Green Building Index (GBI):

The Green Building Index is a recognized Malaysia’s industry green rating Tool for buildings to promote sustainability in the built environment and raise awareness among developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and our responsibility to the future generations. The GBI rating tool provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce our impact on the environment (GBI, 2013). Tables 3 shows GBI rating system and Table 4 shows the GBI Rating tools for residential and non-residential building in Malaysia.

GBI is developed specifically for the Malaysian-tropical climate, environmental and developmental context, cultural and social needs and is created to:

- Define green buildings by establishing a common standard of measurement.
- Promote integrated, whole-building designs that provide a better environment for all.
- Recognize and reward environmental leadership.
- Transform the built environment to reduce its negative environmental impact.

Table 3: The GBI Rating System

NO	KEY CRITERIA	THE GBI RATING ON BUILDINGS FOR AWARD
1	Energy Efficiency (EE)	Improve energy consumption by optimizing Building orientation, minimizing solar heat gain through the Building envelope, harvesting natural lighting, adopting the best practices in Building services including use of renewable energy, and ensuring proper testing, commissioning and regular maintenance.
2	Indoor Environmental Quality (EQ)	Achieve good quality performance in indoor air quality, acoustics, visual and thermal comfort. These will involve the use of low volatile organic compound materials, application of quality air filtration, proper control of air temperature, movement and humidity.
3	Sustainable Site Planning & Management (SM)	Selecting appropriate sites with planned access to public transportation, community services, open spaces and Landscaping. Avoiding and conserving environmentally sensitive areas through the redevelopment of existing sites and brown fields.
4	Material and Resources (MR)	Promote the use of environment-friendly materials sourced from Sustainable sources and recycling. Implement proper construction waste management with storage, collection and re-use of recyclables and construction formwork and waste.
5	Water Efficiency (WE)	Rainwater harvesting, water recycling and water-saving fittings.
6	Innovation (IN)	Innovative design and initiatives that meet the objectives of the GBI. Achieving points in these targeted areas will mean that the Building will likely be more environment-friendly than those that do not address the issues.

Source: GBI Malaysia, 2013

Table 4: The GBI Rating Tools for Residential and Non-Residential Building

The GBI Rating Tools	
Residential	Non-Residential
The GBI Residential Rating tool evaluates the sustainable aspects of residential Buildings. This includes linked houses, apartments, condominiums, townhouses, semi-detached and bungalows. This tool places more emphasis on sustainable site planning & management, followed by energy efficiency. This serves to encourage developers and home owners to consider the environmental quality of homes and their inhabitants through better site selection, provisions of public transport access, increased community services and connectivity, as well as improved infrastructure. Such achievement will help reduce the negative impact to the environment and create a better and safer place for residents and the community as a whole	The GBI Non-Residential Rating tool evaluates the sustainable aspects of Buildings that are commercial, institutional and industrial in nature. This includes factories, offices, hospitals, universities, colleges, hotels and shopping complexes. Among the six criteria that make up the GBI rating, emphasis is placed on energy efficiency and indoor environmental quality as these have the greatest impact in the areas of energy use and well-being of the occupants and users of the Building. By improving the efficiency of active (mechanical and electrical) systems as well as incorporating good passive designs together with proper sustainable maintenance regimes, significant reductions in consumed energy can be realised. This can lead to a reduced carbon footprint and also offers long-term savings for the Building owners.

Source: GBI Malaysia, 2013

1.7 Classification of Green Building Systems:

Green Building classification system is under the sustainable construction umbrella, and it is used to measure sustainability of a building. Presently, the classification system has several standards and most countries have their own ones based on their particular climate, soil, environmental, and geographical location. Each country uses a different system to suit the social and cultural development of their respective countries (see Table 5). All the above classification systems for green building have the same objectives; to incorporate green technology in housing construction projects and new business premises. According to this study conducted in 2007 by professional builder (Adnan, 2009) ,in Malaysia only, 92% of respondents indicated that energy-efficient features either extremely important or very important with respect to new house of green building implementation especially for CO2 reduction. It is also in line with the goals of the Malaysian government to reduce CO emissions by 40% from year 2008 onwards and overcome the problem of global warming according to the GBI. In addition, Green Building design can reduce the benefit of electricity consumption by up to 30%, the ability to reduce carbon emissions by 35%, reduce water consumption around 30% to 50% and help to reduce the cost to be produced Between 50% to 90% (GBI, 2011). Table 6 shows GBI Classification.

Table 5: Classification System of Green Building

Name Country Year	BREEAM UK 1990	LEED USA 1996	GREEN STAR Australia 2003	GREEN MARK Singapore 2005	Green Building Index Malaysia 2009
Assessment Criteria	1. Management 2. Health & Comfort 3. Energy 4.Transportatn 5. Water Consumption 6. Materials 7. Land Use 8. Ecology 9. Pollution	1. Sustainable Site 2. Water Efficiency 3. Energy & Atmosphere 4. Materials & Resources 5. Indoor Environmental Quality 6. Innovation & Design / Construction Process	1. Management 2. Transport 3. Ecology 4. Emissions 5. Water 6. Energy 7. Materials 8. Indoor Environmental Quality 9. Innovation	1. Energy Efficiency 2. Water Efficiency 3. Environmental Protection 4. Indoor Environmental Quality 5. Other Green Features	1. Energy Efficiency (EE) 2. Indoor Environmental Quality (EQ) 3. Sustainable Site Planning & Management (SM) 4. Materials & Resources (MR) 5. Water Efficiency (WE) 6. Innovation (IN)

Source: GBI Malaysia, 2011

Table 6: GBI Classification

Points	GBI Rating	Energy Efficient
86+	Platinum	>60%
76 to 85	Gold	50-60%
66 to 75	Silver	40-50%
50 to 65	Certified	30-40%

(*Source:* GBI Malaysia, 2013)

Research Methodology:

In this research, quantitative analysis is used to analyze the data. This study analyzes data which include descriptive statistics, goodness of measures, reliability analysis, validity analysis, hypothesis testing and mediation effects testing. It investigates relationships between Awareness of Environment, Technology, Social Element, Legislation and Green Building Performance. The data collection resources (tools) are classified into two groups of primary and secondary sources or information. In the case of secondary resources, articles, books, researches, studies and the theses conducted in this field (collected from libraries and internet websites) have been used. Also, the primary information has been collected using the field research method (questionnaire).

A draft of the questionnaire is evaluated by ten academic professors in the areas of GBI and Green Building in Malaysian building Industry. These processes enable a researcher to develop a questionnaire with high content validity. according to our respondents who are a group of experts,where all the ambiguities in the questionnaire were made clear and items have been designed and reviewed. A structured questionnaire is according to a 5-point (Likert-type) scale ranging from 1 to 5 namely Strongly Disagree, Disagree, Neither Disagree nor Agree, Agree and Strongly Agree. Because, the Likert scale makes available more information about the respondents' degree of contribution, it can make available deeper implications of the perception to be surveyed. Table 7 shows the reliability coefficient of the questionnaire. It shows that the Cronbach's alpha of the questionnaire is 0.8235 which means the reliability of the present research questionnaire is acceptable. (Cronbach, 1951).

Table 7: Reliability Statistics

Cronbach's Alpha	N of Items
0.8235	39

Sampling technique in this research is stratified sampling, where, the researcher divides the population into separate groups, called strata. Then, a probability sample (often a simple random sample) is drawn from each group. The sample size of research can be determined according to Morgan's Table (Krejcie and Morgan, 1970). In this research population size is N=800 and According to Morgan’s Table the sample size should be n=260 but could were collected 266 (33.25%). The target population of this research consisted of managers and non-managerial staff and professional members of GBI.

2.1 Analysis and Interpretation:

This part discusses the objectives of the research, namely the effects of GBI in Malaysian Building Companies. In data analysis part, the collected data and summarized information, are studied, categorized and tested using the descriptive and inferential statistical techniques in order to achieve the research objectives, answer its questions/hypotheses and its problems as well as the detailed process of how it works will be explained.

2.2 Mahalanobis Distance:

Mahalanobis distances provide a powerful method of measuring how similar some set of conditions is to an ideal set of conditions, and can be very useful for identifying which regions in a landscape are most similar to some “ideal” landscape. Moreover, Mahalanobis distances are based on both the mean and variance of the predictor variables, plus the covariance matrix of all the variables, and therefore take advantage of the covariance among variables. The region of constant Mahalanobis distance around the mean forms an ellipse in 2D space (i.e. when only 2 variables are measured), or an ellipsoid or hyperellipsoid when more variables are used (refer to Table 8).

Table 8: Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	4.0000	4.6667	4.4211	.16039	266
Std. Predicted Value	-2.625	1.531	.000	1.000	266
Standard Error of Predicted Value	.000	.000	.000	.000	266
Adjusted Predicted Value	.	.	.	.	0
Residual	.00000	.00000	.00000	.00000	266
Std. Residual	.000	.000	.000	.000	266
Stud. Residual	.	.	.	.	0
Deleted Residual	.	.	.	.	0
Stud. Deleted Residual	.	.	.	.	0
Mahal. Distance	23.095	25.504	24.906	1.043	266
Cook's Distance	.	.	.	.	0
Centered Leverage Value	.087	.096	.094	.004	266

a Dependent Variable: dv

The tests results show that minimum is for Mahalanobis distance (23.095) and maximum for Mahalanobis distance is (25.504). It means that, our data value is between min and max range.

2.3 Skewness and Kurtosis Test Results:

Skewness and Kurtosis it can be used to test the normality of a given data set. Since the statistics is between (-2, 2) means that the distribution of the sample is normal.

The amount of skewness for all variables respectively is -0.590, -0.391, -0.277, -0.592 and -1.365. Its shows these variables were normal and symmetric distribution.

The amount of kurtosis for all variables respectively are -0.040, -0.657, -0.644, -0.467 and 1.872.Its shows that variables distribution is normal (refer to Table 9).

Table 9: Descriptive Statistics to Skewness and Kurtosis

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
DV	266	-.590	.149	-.040	.298
IV1	266	-.391	.149	-.657	.298
IV2	266	-.277	.149	-.644	.298
IV3	266	-.592	.149	-.467	.298
IV4	266	-1.365	.149	1.872	.298
Valid N (listwise)	266				

2.4 The Regression Test among Independent Variables (Awareness of Environment, Technology, Social Element, Legislation) and Dependent Variable (Green Building Performance):

Multiple linear regression (MLR) is a method used to model the linear relationship between a dependent variable and one or more independent variables. The dependent variable is sometimes also called the predictand, and the independent variables the predictors. MRA to identify the significant factors that affect of green building performance on Malaysian green building. Analysis of Variance (ANOVA) shows that factors identified by this analysis together significantly related to the dependent variable. This means that the factors identified in this analysis are significantly related to the green building performance (refer to Table 10). If there is a change in the factors, there will be change in the green building performance.

Below Table shows the individual factors relationship with the dependent variable of the regression model. It shows that all impact factors such as, awareness of environment (2.035); technology (2.744), social element (2.774) and legislation (5.599) are significantly related to the green building performance.

Table 10: The Regression Test among IVs and DV

IV	DV (Green Building Performance)								
	Coefficients[a]				Annova[b]		Model Summary		
	B	Beta	t	Sig	F	Sig	R	R^2	Durbin Watson
Constant	3.697	-	6.336	0.000	11.236	0.000[a]	0.383[a]	0.147	2.285
Awareness of Environment	0.181	0.124	2.035	0.043					
Technology	0.310	0.171	2.774	0.006					
Social Element	0.223	0.161	2.744	0.005					
Legislation	0.469	0.350	5.599	0.000					

a. Predictors: (Constant), legislation, social building, awareness of environment , technology

b. Dependent Variable: D

As observed in the above table, since the obtained sig in ANOVA table is smaller than 0.05 (0.00<0.05), the whole regression has the required statistical validity. In the next stage, the effects of independent variable on the dependent variable are assessed. The Beta coefficient and significance value (sig) of the variables imply that all of the independent variables have statistical validity, because the significance value of these variables are smaller than the significant level 0.05.

♦- Unstandardized Model

$Y= 3.698 + (0.181\ x_{1)} + (0.310\ x_{2)\ +}\ (0.223x_3) + (0.469\ x_{4)}$

♦- Standardized Model

$Y= (0.124\ x_{1)} + (0.171\ x_{2)\ +}\ (0.161\ x_3) + (0.350\ x_{4)}$

Y= Dependent Variable (green building performance)

x1=Independent Variable1 x2=Independent Variable2

x3= Independent Variable 3 x4= Independent Variable 4

2.5 Pearson's Correlation Coefficient :

The Pearson Product-Moment Correlation Coefficient is a measure of the linear correlation (dependence) between two variables X and Y, giving a value between +1 and −1 inclusive, where 1 is total positive correlation, 0 is no correlation, and −1 is total negative correlation. It is widely used in the sciences as a measure of the degree of linear dependence between two variables. It was developed by Karl Pearson from a related idea introduced by Francis Galton in the 1880s. Early work on the distribution of the sample correlation coefficient was carried out by Anil Kumar Gain and R. A. Fisher from the University of Cambridge. Pearson's correlation coefficient is defined between two random variables equal to their variance divided by the standard deviation (refer to Table 11).

Table 11: Correlation Pearson Coefficient Test between Variables (c1, c2, c3, c4 and c5).

Independent Variables (IV)	Dependent Variable (DV) (Green Building Performance)	
Awareness of Environment	Pearson Correlation	0.227 **
	Sig. (2-tailed)	0.000
Technology	Pearson Correlation	0.137*
	Sig. (2-tailed)	0.03
Social Element	Pearson Correlation	0.271**
	Sig. (2-tailed)	0.000
Legislation	Pearson Correlation	0.399
	Sig. (2-tailed)	0.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Statistical Hypotheses:
Null Hypothesis (H0): There is no significant positive relationship between c1 and c2, c3, c4 and c5.
Hypothesis A: There is significant positive relationship between c1 and c2, c3, c4 and c5.
Test results: Considering that the significance levels are smaller than 0.05, the null hypothesis is rejected and therefore hypothesis A is accepted .There is significant positive relationship between Dependent Variable and Independent Variables.

Conclusion:

This paper has discussed the barriers towards green building technology application in Malaysia. The problems related to green technology in building industry were identified. The problems are common to all countries in terms of energy efficiency and the major barriers are education and training, awareness, professional training, government support, financial support, legal implications and attitude. There are some barriers that are particularly common for Malaysia, for example, awareness, government support and attitude of the population towards green technology in building industry. The government should develop incentive schemes for the projects which adopt green ideas in Buildings. The government should encourage in green technology in building industry for energy efficiency. The other four aspects managerial defects, social and cultural defects, political and legal defects, and environmental and biological defects) are less critical compared to the technical aspect but it does not mean that they are not important and should not be paid attention to. By considering these critical factors, this study hopes to contribute to raising awareness for those who are involved in Green Building development in Malaysia.

The results of the study can be summarized as follows:

(i) The Green Building concept and exposure is still in its early stages in Malaysia and therefore needs a strong and particular awareness and acceptance by the community well as close collaboration between all players in the construction industry.

(ii) House buyers‟ perspectives towards Green Residential Buildings are still vague and lack proper understanding. Perhaps, the present conditions (e.g., economy, financial, social and culture) prevent them from understanding the potential benefits.

(iii) The government’s cooperation and intervention is needed intensely in providing more information, knowledge transfer and financial incentives sufficient for Green Buildings, renewable energy, energy-efficient and hybrid technologies.

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