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Green Technology and Sustainability for Residential Infrastructure

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ABSTRACT

Application of green technology and sustainability trending featured nowadays. Various advantages can be achieved if we start from the beginning to implement green technology and sustainability starting from the home ownership. Commencement of business from developed countries such as Japan and the United States, most developing countries now participate strides to implement green technology and sustainability in every aspect. Green technology and sustainability is no stranger in the construction industry in Malaysia. However, many efforts should be intensified so that the implementation of green technology and sustainability aspects of the residential infrastructure can be accepted by public. This is because the power to buy and own a home with green technology and sustainability concepts is in the hands of the buyer or the public. To ensure that residential green technology and sustainable meet the characteristics favoured by the public, this study ensure that all parties involved in the construction industry either from the relevant authorities, government agencies, private organizations and developers can play a key role in providing the best for the community, the nation and the future.

INTRODUCTION

The criteria of green residential building consists of six elements, firstly, the community design and planning, efficient usage of resources, use of alternative resources, natural system, protection and safety, and reusing and recycling approach. All the developed countries have their own criteria and their criteria are related to each other. The main purposes of the criteria are to save energy, to use resources in the efficient manner and to conserve the environment. (Ismail *et al*., 2013)

Green buildings are developed with objectives to produce a minimum destruction influence to the environment, and healthier spaces in live and work. An increase in interests among construction players such as architects, developers, urban planners, constructors and government since a decade ago. Green residential building is part of a branch of green development and green buildings. The green residential has focused on houses resources which can be controlled from being polluted by the environment and stressed on energy saving features. (Elias *et al*., 2013)

Nowadays, green technologies play a very important role to promote a societal move toward sustainability. Green technologies are practical solutions to achieve economic development and human satisfaction in harmony with the environment. (Osman *et al*., 2012).

Problem Statement:

The concept of sustainable housing requires a new understanding of the effective and sustainable housing in synergy. In order to get the attention about sustainable residential it deserves to be implement more efficiently in Malaysia such as in developing countries.

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Barriers to green building demand, according to Aliagha *et al*. (2013) states that demand for green buildings, both commercial and residential, must come with some problems and challenges in different countries and regions while moving towards sustainable construction development. A study was carried out in Malaysia by Samari *et al*. (2013) showed that the main barriers to the development of green buildings in the country are risk of investment, lack of credit resources to cover up front cost, higher final price and lack of demand. Others barriers are lack of incentives, lack of building codes and regulation, higher investment cost, lack of strategy to promote green building, lack of public awareness, lack of design and construction team, lack of expertise, lack of professional knowledge, lake of database and information, lack of government support and lack of technology.

To prevent global warming, there needs to be new practices, from the design phase to the operation of the building in order to increase the efficiency of energy consumption, so that the carbon footprint, global warming potential and ozone depletion potential can be reduced (Komalasari *et al*., 2014). Abidin and Jaapar (2012) also listed the some of the hindrances to faster progress of green housing in Malaysia as lack of public interest and demand, the status quo in rules and regulation, organization disinterest, project cost escalation or high cost for green appliance and local authority enforcement and realised that the reduction in the energy consumption in the buildings is a major cost-effective way of reducing greenhouse gas emissions.

Nevertheless, the acceptance of the sustainability concept is not industry-wide as many developers, especially small and medium companies, are still reserving themselves. Implementation is believed to be low because of several factors such as lack of knowledge, poor enforcement of legislation, education, experience and passive culture (Abidin, 2010).

Objectives:

The objectives of this research are listed below:

1. To analyse the characteristics in design and structure of green technology and sustainability for residential infrastructure
2. To determine the most important characteristics of green technology and sustainability for residential infrastructure
3. To propose to the right department to implement the best characteristics of green technology and sustainability for residential infrastructure

Analysis Scope:

The analysis for the research will be concentrate on green technology and sustainability on residential infrastructure for building in civil engineering scope. Questionnaire form for data collection for this research will be distributed to the public in Northern Malaysia. The study area encompasses three states in northern peninsular Malaysia which is Penang, Kedah and Perak. 400 respondents were targeted in this study, Penang with 106 respondents, while Kedah with 134 respondents and the rest in Perak were 160 respondents only to be assessed. In all three states, there are differences in the number of respondents due to the population in each country.

RESULTS AND DISCUSSION

The Statistical Package for Social Sciences, Statistics Version 20 software used to analyse the data. This study received responses of 400 sets of questionnaires to investigate the criteria of green technology and sustainability for residential infrastructure and to determine the level of importance of each criterion. This analysis is divided in two sections contained in the questionnaire:

i. Section A: Personal Information
ii. Section B: Green Technology and Sustainability for Residential Infrastructure

The Cronbach's Alpha used to measure the internal consistency of questionnaire. Based on this Alpha value for the reliability test, the authors have been using the Cronbach Alpha for the reliability of the questionnaire.

Table 1: Cronbach's Alpha Value

Cronbach's Alpha	Number of items	Number of Questionnaire
0.915	20	400

Table 1 shows the reliability coefficients of Cronbach's Alpha is 0.915, which indicates a high level of internal consistency and considered as excellent high-stakes testing internal consistency. Table 2 below explains the internal consistency Cronbach's Alpha of the each value of Cronbach's Alpha internal consistency by Sekaran and Bougie (2010).

Table 1: Consistency of Cronbach's Alpha

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent (High-Stakes testing)
$0.7 \leq \alpha \leq 0.9$	Good (Low-Stakes testing)
$0.6 \leq \alpha \leq 0.7$	Acceptable
$0.5 \leq \alpha \leq 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Analytical Result of Personal Information:

Personal information is the first section of the questionnaires. This section designed to provide general information regarding to the gender, age, marital status, number of family members, race, religious occupation, highest formal education, household income, permanent residence and type of homeownership of respondents.

Table 3: Respondents Gender Information

Personal Information	Detail	Frequency	Percentage (%)
Gender	Male	192	48
	Female	208	52
	Total	400	100

Table 4: Respondents Age Information

Personal Information	Detail	Frequency	Percentage (%)
Age	18-29	216	54
	30-39	136	34
	40-49	42	10.5
	50 and above	6	1.5
	Total	400	100

Table 5: Respondents Marital Status Information

Personal Information	Detail	Frequency	Percentage (%)
Marital status	Single	214	53.5
	Married	182	45.5
	Divorced	4	1.0
	Others	0	0
	Total	400	100

Table 6: Respondents Number of Family Members Information

Personal Information	Detail	Frequency	Percentage (%)
Number of family members	1 to 2	64	16
	3 to 4	133	33.3
	5 to 6	153	38.3
	7 and above	50	12.5
	Total	400	100

Table 7: Respondents Race Information

Personal Information	Detail	Frequency	Percentage (%)
Race	Malay	341	85.3
	Chinese	36	9
	Indian	16	4
	Others	7	1.8
	Total	400	100

Table 8: Respondents Religious Information

Personal Information	Detail	Frequency	Percent (%)
Religious	Islam	343	85.8
	Buddhism	28	7.0
	Hindus	17	4.3
	Others	12	3.0
	Total	400	100

Table 9: Respondents Occupation Information

Personal Information	Detail	Frequency	Percentage (%)
Occupation	Public Sector	90	22.5
	Private Sector	144	36.0
	Student	136	34.0
	Others	30	7.5
	Total	400	100

Table 10: Respondents Highest Formal Education Information

Personal Information	Detail	Frequency	Percentage (%)
	PMR and below	2	0.5
Highest formal education	SPM	60	15.0
	Diploma	100	25.0
	Degree	193	48.3
	Master/PHD	45	11.3
	Total	400	100

Table 11: Respondents Household Income Information

Personal Information	Detail	Frequency	Percentage (%)
Household income	Below 2000	138	34.5
	2000-4000	148	37.0
	4000-6000	75	18.8
	6000 and above	39	9.8
	Total	400	100

Table 12: Respondents Permanent Residence Information

Personal Information	Detail	Frequency	Percentage (%)
Permanent residence	Yes	350	87.5
	No	50	12.5
	Total	400	100

Table 13: Respondents Type of Homeownership Information

Personal Information	Detail	Frequency	Percentage (%)
Type of homeownership	Own house	149	37.3
	Rented house	91	22.8
	Family house	152	38
	Others	8	2
	Total	400	100

Analytical Results Using Ranking Analysis:

This finding indicates green technology and sustainability for residential infrastructure in northern peninsular Malaysia. The analysis classified into four parts in Section B in the questionnaire as below:

Part 1: Architectural Design, Planning and Infrastructure

Part 2: Green Technology and Sustainability

Part 3: Housing Development

Part 4: Policy

Part 1: Architectural Design, Planning and Infrastructure:

Table 14: Architectural Design, Planning and Infrastructure

Code	Architectural Design, Planning and Infrastructure	Important and Strongly Important		Rank
		N	%	
1a	Consumer perception and knowledge of green architectural design and green infrastructure criteria for residential.	299	74.8	5
1b	Architectural design and infrastructure may effect to the demand and supply of sustainable residential building.	332	83	1
1c	Architecture design and infrastructure with green technology and sustainability criteria enhance the public interest.	322	80.5	4
1d	The constructions of smart homes and smart city may improve transportation system, save energy, time and cost.	328	82	2
1e	Landscape with walkways, bike lanes, green and safe is the preferred criteria of a residential area.	327	81.8	3

Based on results of the analysis as shown in Table 14 respondents perceived that architectural design and infrastructure may effect to the demand and supply of sustainable residential building. This criterion is important in every architectural design, planning and infrastructure. At the same time, these results indicate that most respondents aware with green technology and sustainability for residential architecture design and infrastructure is important because when a high demand from users certainly supply will be implemented. Second highest ranking is a second question of this part, where the constructions of smart homes and smart city may improve transportation system, save energy, time and cost. These results indicate that infrastructure such as

good transportation system, time saving, cost saving and extremely user-friendly and eco-friendly fulfils the needs of the public. This item is important as to set up the infrastructure will require best planning the start from the beginning. Third highest ranking of architectural design, planning and infrastructure is the Landscape with walkways, bike lanes, green and safe is the preferred criteria of a residential area. This criterion is important to encourage people to adopt a healthy lifestyle and avoid contamination. Overall, respondent concerned about architectural design, planning and infrastructure. The average of the results of the analysis indicates that all the items contained in this architectural design, planning and infrastructure part is in scale 4, which is important.

Part 2: Green Technology and Sustainability:

Table 15: Green Technology and Sustainability

Code	Green Technology and Sustainability	Important and Strongly Important		Rank
		N	%	
2a	Consumer perception and knowledge about the necessity of green technology and sustainability for residential infrastructure.	311	77.5	5
2b	Green technology installations such as solar panels, rainwater harvesting systems or environmentally friendly equipment can save energy and protect the environment.	340	85	2
2c	Criteria of energy efficiency and renewable energy are important for green residential building.	328	82	3
2d	Assessment of the Green Building Index (GBI) is a useful guide to consumers in choosing a dream home.	323	80.8	4
2e	Green technology for residential infrastructure reduces carbon, greenhouse gas, environment issues and improves social-ecological system.	340	85	1

Based on results of the analysis as shown in Table 15, based on the results of the analysis, it was found that the first ranking is for the last question which is green technology for residential infrastructure able to reduces carbon, greenhouse gas, environment issues and improves social-ecological system. Therefore, most of respondent knew the importance of preserving nature and protecting the environment for future. Second highest ranking is about the green technology installations such as solar panels, rainwater harvesting systems or environmentally friendly equipment can save energy and protect the environment. This item is important in order to protect the environment from pollutions, save energy and cost. Third highest ranking of green technology and sustainability part is the criteria of energy efficiency and renewable energy is important for green residential building. Most of respondent agree that energy efficiency and renewable energy is important for residential building because green technology able to provide the best solution for a better future. In short, green technology and sustainability are very helpful in the implementation of residential houses. Most of the result for this green technology and sustainability part indicate that all the items contained in scale 4, which is important.

Part 3: Housing Development:

Table 16 Housing Development

Code	Housing Development	Important and Strongly Important		Rank
		N	%	
3a	Construction using green technology will enhance the housing development.	311	77.8	5
3b	Consumer perception on satisfaction for housing development against sustainable residential infrastructure.	323	80.8	4
3c	Relevant authorities should support the housing market and economic recovery in sustainable housing development sector.	337	84.3	2
3d	Well planned and strategic sustainable housing development facing the increase in house prices issues.	337	84.3	1
3e	A campaign should be planned by encouraging people to participate in “sustainable housing community.”	336	84	3

Based on results of the analysis as shown in Table 16, fourth question from this housing development part is the first ranking because of the increase in house price issues due to well planned and strategic sustainable housing development. Concerning that if the criteria of the various initiatives undertaken to implement green technologies and the development of a well-planned and strategic but the high cost charged to the public. It will burden the homeowner and will lead to the development of sustainable buildings is difficult to accept the public. The second highest ranking for housing development part is the relevant authorities should support the housing market and economic recovery in sustainable housing development sector. This item is important to ensure that

sustainable housing development able properly implemented. Housing market and economic problems must be overcome with conscientious study of the responsibility for ensuring sustainable housing development and construction are not priced at a higher price. The third higest ranking is a "sustainable housing community" campaign is important to encourage people to participate and to create the awareness in instill wise in saving energy and costs such as separating garbage, retaining rainwater for use in watering the plants and the use of solar energy.

Part 4: Policy:

Table 17: Policy Analysis

Code	Policy	Important and Strongly Important		Rank
		N	%	
4a	The importance level of general knowledge by public about the residential infrastructure policies.	313	78.3	5
4b	Consumer perception and satisfaction of existing sustainable housing policy.	316	79	4
4c	Affordable housing development must apply the elements of sustainable and green technology.	333	83.3	2
4d	Significance of policy may effect to the demand and supply of residential industry.	331	82.8	3
4e	Policy in implementation of green technology and sustainability should be enforced among housing developers.	333	83.3	1

Based on results of the analysis as shown in Table 17, first higher ranking is a policy in implementation of green technology and sustainability should be enforced among housing developers. This item is important in order to ensuring that housing prices will not be increased indiscriminately without compromising to the sustainable development. Second highest ranking is affordable housing development must apply the elements of sustainable and green technology. This item is often overlooked because of the particular houses are affordable housing. This is due to the aspects of sustainable housing construction should be carried out regardless of the type of home. Third highest ranking is significance of policy may effect to the demand and supply of residential industry item. Significant of policy play an important role in ensuring that all parties concerned in the housing industry and users adhere to the instructions issued.

Conclusions:

Green technology and sustainability for residential infrastructure are committed to create a better standard of living. This research is the review of green technology and sustainability for residential infrastructure which gives potential benefits to environment, human, flora and fauna where green technology and sustainability are able to reducing impact on health and other environment issues. The research is able to provide a practical philosophy about the most popular characteristic in perspective of green technology and sustainability for residential infrastructure. Finally, policy actions in terms of politics, technology, economy and social can make a difference by provide guidelines to the authorities such as Kementerian Perumahan dan Kerajaan Tempatan, Kementerian Kesejahteraan Bandar, Perumah Kerajaan Tempatan and Majlis Perumahan Negara to achieve green technology and sustainability for residential infrastructure in future. At the same time, guidelines by the authorities can be as guidance for developer, architect, engineer, contractor and public to implement green technology and sustainability in residential infrastructure in Malaysia. Malaysia is still less research on residential infrastructure that is based on the use of green and sustainable technology. The research was conducted by previous researchers may have been inappropriate use today. For example infrastructure or facilities in the former residential infrastructure is not focused on bike paths and bicycle park, this led to the less populated residential areas using bicycles as vehicles for daily use or cycling as a leisure activity. This is how sustainable landscape architecture practice in residential infrastructure able to convert to a healthy lifestyle. The next example about green technology and sustainability for residential infrastructure is a green roof system that should be used in each residence can reduce the cost air conditioning use during hot weather. In addition, through the use of clean energy technologies, such as solar power at home can help reduce the rate of growth of greenhouse gas emissions. Green technology and sustainability for each type of building construction are important because it takes an intelligent approach to energy, minimises waste and maximises reuse, creates resilient and flexible structures and promotes health and well-being. From the above statements, shows that the research about the green technology and sustainability for residential infrastructure that needed by public is important to investigate and to obtain its level of adoption based on the most important characteristics of each residential infrastructure in green technology and sustainability context. This research is important in order to determine the demand and supply to implement the green technology and sustainability for residential infrastructure in future.

REFERENCES

Abidin, N.Z., 2010. Investigating the awareness and application of sustainable construction concept by Malaysian developers. Habitat International, 34(4): 421-426.

Abidin, N.Z. and A. Jaapar, 2012. Sustainable Concept Awareness in Malaysia Construction Practices. In The 3rd Built Environment and Natural Environment Conference, 4(1): 137-144.

Aliagha, G.U., M. Hashim, A.O. Sanni and K.N. Ali, 2013. Review of Green Building Demand Factors for Malaysia. Journal of Energy Technologies and Policy, 3(11): 471-478.

Elias, E.M., A. Abu Bakar, A.Y. Bahaudin and F. Mohd Hussain, 2013. Green residential buildings: The Perspective of Potential Buyers. Proceedings of 3rd Global Accounting, Finance and Economics Conference, Rydges Melbourne, Australia. Energy and buildings, 43(9): 2108-2117.

Ismail, R., M.W.M. Shafiei, I. Said and F.A. Ibrahim, 2013. Green Homes Development Practices and House Buyers' Requirements: A Review. Australian Journal of Basic and Applied Sciences, 7(13): 7-15.

Komalasari, R.I., P. Purwanto and S. Suharyanto, 2014. Green Building Assessment Based on Energy Efficiency and Conservation (EEC) Category at Pascasarjana B Building Diponegoro University, Semarang. American Journal of Energy Research, 2(2): 42-46.

Osman, W.N., Z.M. Udin and D. Salleh, 2012. Adoption Level of Sustainable Construction Practices: A Study on Malaysia's Construction Stakeholders. Journal of Southeast Asian Research, 1: 1-6.

Samari, M., N. Ghodrati, R. Esmaeilifar, P. Olfat and M.W.M. Shafiei, 2013. The investigation of the barriers in developing green building in Malaysia. Modern Applied Science, 7(2): 1.

Sekaran, U. and R. Bougie, 2010. Research Method for Business, A Skill Building Approach. John Wiley & Sons Inc.