

A Comparison of Criteria between GreenRe and International Green Rating Tools in Green Construction Projects: A Review

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Abstract: *The global construction sector are moving towards sustainable development by implementation of green rating tool to monitor the overall process of construction activities. Existence of green rating tool during the construction and operation period will significantly reduce the emission of carbon contributed from construction industry. Besides that monitoring process by the green rating tool for the newly constructed green building also able to promote the usage of energy saving related technologies during the operation period of the constructed green building by the end user's. However despite the advent made for the establishment of green rating tools globally, not much had been done to determine, review, compare and identify the differences and similarities between green rating tools. Therefore, the objective of this paper is to compare the GreenRe rating tool to other international green rating tools. Three international green rating tools, Building Research Establishment Environmental Assessment Methodology (BREEAM) (UK), Green Star (Australia) and Leadership in Energy and Environmental Design (LEED) (US) will be compared to Malaysian rating tool, GreenRe. The findings from this study through the comparison of international and Malaysian rating tool will reveal the rating systems available in terms of their similarities and differences which will help to improve the effectiveness of green building assessment methods in Malaysia towards achieving goals of green development in Malaysian construction industry. Furthermore, research findings in this study will act as a stepping stone to guide the establisher and assessors of GreenRe to improve the green rating tool system towards perfection in Malaysian green construction industry.*

Keywords: *green rating tools, sustainable development, Malaysian construction industry*

I. INTRODUCTION

Sustainable development in Malaysia started since the year 1980's where several important environmental related policies were launched by the Malaysia government Malaysia such as National Energy Policy 1979, National Depletion Policy 1980, Four Fuel Diversification Policy

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1981 and Fifth Fuel Policy 2000 (Chua and Oh, 2011). The formulation of these policies followed by signing of the Kyoto Protocol to the United Nation Framework Convention on climate change on 12 March 1999 and further ratified on 4 September 2002 to control and combat global warming by Malaysia. (Ho and Fong, 2007). Subsequently, there are several green rating tools started to be implemented in Malaysia including GreenRe green rating tools which was created by Rehda Malaysia in the year 2013 which was based on Singapore BCA Green Mark tool and recognized across 71 countries and cities globally (GreenRe, 2017). According to Green Re SdnBhd (2017), there are a total of 76 projects certified under GreenRe certified project which are equivalent to more than 40 million square feet in assessed area since 2013. Besides that, developed countries such as United Kingdom, Australia and United States have their own green rating tools where Green Star for Australia, LEED for United States and BREEAM for United Kingdom. As currently Europe is the leading continent practicing low carbon emission. In the United Kingdom, BREEAM assessment system is being used to recognized measure of performance and rating system for building in terms of building environmental performance. Until mid of 2012, BREEAM already certified 200,000 buildings and over a million registered for assessment since BREEAM launched in 1990 (BRE Global Limited, 2011). While, LEED which was established in United States since 1990s was inspired by the desire to create a U.S version of the Building Research Establishment Environmental Assessment Methodology (BREEAM) (UK). As of year 2010, there are a total of 100 college campuses are LEED certified with sustainability programs (Richards, 2012). Subsequently, as of October 2016, more than 15.7 billion square feet of building space is LEED-certified worldwide (USGBC, 2016). In Australia, Green Star was introduced as aligned with the Howard government which introduced a Mandatory Renewable Energy Target (MRET) scheme in 2001 which requires 20% of electricity supply from renewable energy sources by the year 2020 (Parliament of Australia, 2010). Presently, there are 1374 projects where more than 21 million m² certified by under the Green Star rating tool which was launched in the year 2003 (Green Building Council Australia, 2017).



II. GREEN RATING TOOLS GLOBALLY – THE CRITERIA AND RATING SYSTEMS

According to Bahaudinet *al.* (2014), most of the green rating tools around the world was established to transform the method of building construction from conventional to sustainable construction through market driven approach. Besides that Bahaudinet *al.* (2014) also added that green rating tools are created to address the climate change and carbon dioxide emission through the construction activities.

GreenRe

The GreenRe is officially established in 2013 by Rehda Malaysia which was based on Singapore’s green rating tool, BCA a prestigious green rating tool which is recognised across 71 countries and cites globally. GreenRe rating tool is based on five pillars or criteria which are Water Efficiency, Energy Efficiency, Carbon Emission, Environmental Protection, Indoor Environmental Quality and other Green Features. GreenRe rating tool is used to assess three types of building such as residential building, non-residential building and existing non-residential building. Besides that, GreenRe rating tool is also used to evaluate township project. As of November 2016, there are morethan 70 registered building which are more than 40 million square feet in assessed area where there are projects in Penang, 2 projects in Kuala Lumpur, one each in Negeri Sembilan and Kelantan, 16 projects in Johor and 3 projects in Sabah (GreenRe, 2017). The total points for all the criteria is 183 points. Based on the evaluation, the building will be awarded Bronze, Silver, Gold and Platinum. Table below shows the scores and rating for GreenRe.

Table. 1 GreenRe Scoring and Rating Award for Non Residential

Criteria	Credit Allocation	Total Score	Rating Award
Energy Efficiency	106	90 and above	Platinum
Water Efficiency	15	85 to 90	Gold
Environmental Protection	41	75 to 85	Silver
Indoor Environmental Quality	10	50 to 75	Bronze
Other Green Features	7		
Carbon Emission of Development	4		

According to Table 1, GreenRe scoring and rating award for non-residential consists of 6 criteria which are energy efficiency, water efficiency environmental protection, indoor environmental quality, carbon emission of development and other green features which totalled at 183 points.

BREEAM

Table. 2 Breeam Final Percentage

Criteria	Final Percentage Score Allocation
Water	6%
Energy	19%
Health and Wellbeing	15%
Materials	12.5%
Management	12%
Land Use and Ecology	10%
Pollution	10%
Transport	8%
Waste	7.5%

BREEAM or Building Research Establishment Environmental Assessment Methodology was established in the year 1990 in the United Kingdom being used to recognized measure of performance and rating system for building in term of building environmental performance ((BRE Global Limited, 2011). Currently, BREEAM has certified 2,259,324 buildings across 78 countries in the world. There are total of nine criteria of BREEAM which are Energy, Health and Wellbeing, Land Use and Ecology, Materials, Management, Pollution, Transport, Waste and Water. Based on the table below, there are nine categories for final percentage score allocation where water; 6%, Energy; 19%, Health and Wellbeing; 15%, Materials; 12.5%, Management; 12%, Land Use and Ecology; 10%, Pollution; 10%, Transport; 8%, and Waste; 7.5%. Assessments are carried out by BREEAM where developments rated and certified on a scale of Pass, Good, Very Good, Excellent and Outstanding. During the assessment process, each category is sub-divided into a range of issues, which promotes the use of new benchmarks, aims and targets before the final rating awarded after the final performance rating is achieved (Parker, 2012).

LEED

Table. 3 LEED Credit Allocation Based on Criteria

Criteria	Credit Allocation
Location and Transportation	16
Sustainable Sites	10
Water Efficiency	11
Energy and Atmosphere	33
Material and Resources	13
Indoor Environmental Quality	16
Innovation	6
Regional Priority	4

LEED which was introduced through Green Building



Council in the year 1993 covers all aspect of development and construction process. There are more than 14000 projects certified by LEED throughout United States and 30 countries covering 1.062 billion square feet of development area. LEED covers eight major areas which are Location and Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation and Regional Priority USGBC, 2017). Based on the Table 3, the rating system of a total of eight categories with total of 109 points for credit allocation in LEED green rating tool which are Location and Transport; 16 points, Sustainable Sites; 10 points, Water Efficiency; 11 points, Energy Atmosphere; 33 points, Material and Resources; 13 points, Indoor; 33 points, Environmental Quality; 16 points, Innovation; 6 points and Regional Priority; 4 points. LEED where developed, rated and certified on a scale of Certified, Silver, Gold, and Platinum (USGBC, 2017).

Green Star

Green Star which was launched in the year 2003 by Green Building Council is the only green rating tool practiced in Australia for green constructed building. Since Green Star's introduction to the market in 2003, more than 5.5 million square meters of building area have been certified by Green Star. Certifications are based on nine categories which are Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emission and Innovation (GBCA, 2017). Based on Table 4, Green Star credits allocation based on nine categories with the total credits of 110 points which are Management; 17 points, Indoor Environment Quality; 18 points, Energy; 24 points, Transport; 7 points, Materials; 10 points; Land Use and Ecology; 6 points, Emission; 6 points, Water; 12 points and Innovation; 10 points. Certification process based on number of star given and certified on a scale of One Star, Two Star, Three Star, Four Star, Five Star and Six Star.

Table. 4 Green Star Credit Allocation Based on Criteria

Criteria	Total Credits
Management	17 points
Indoor Environment Quality	18 points
Energy	24 points
Transport	7 points
Materials	10 points
Land use and Ecology	6 points
Emission	6 points
Water	12 points
Innovation	10 points

III. DISCUSSION

The result of study related to all the green rating tools including GreenRe as illustrated in Table 5 clearly shows that Energy Efficiency, Indoor Environmental Quality and Water Efficiency merged as the most important elements by the list of green rating tools as mentioned above followed by other elements such as Environmental Protection, Materials and Management. Element of Energy Efficiency leads in all green rating tools as mentioned above where 57% for

GreenRe, 19% for BREEAM, 33% for LEED and 24% for Green Star with a total average of implementation at 32.2% . Element of Energy Efficiency are enclosed with elements such as thermal performance of building envelope, air-conditioning system, daylighting and many other sub-elements.

Thermal performance of building envelope referring to calculation of thermal transfer value (OTTV) which helps to minimize heat gain through the building envelope. According to Hong Kong Institute of Architecture (2012), OTTV referring to the average rate of heat transfer into a building through the building envelope. Basically, roof, walls and window of all side. Calculation are carried out by using two types of assumption where rate are calculated based on heat transferred through opaque wall, Q_{wc} and window class, Q_{gs}.

The other important elements of energy efficiency which is the air-conditioned are based on air-conditioned plants, air distribution system and unitary air-conditioned. According to Fine Homebuilding Magazine (2015), room air conditioners are rated by an energy efficiency ratio, or EER. The differences between the seasonal energy efficiency ratio (SEER) and energy efficiency ratio (EER) are the first is measured based on seasonal ratio while the second is measured according to performance at a high peak load. Therefore, he higher the EER, the more efficient the appliance.

The following elements of energy efficiency which is the building envelope are based on design and building or building thermal parameters which focused on reduction west facing window opening, effective sun shading for west window and better u-value for west facing wall and roof. Identification of u-value in a green building is essential as contribute to better understanding of energy usage for heating and cooling system in a green building. Besides that, u-value also act as an elements for selection of materials for construction process (Hussain, 2015).

Besides that, natural ventilation which is the another factor to be considered for analyzing energy efficiency are divided to process of maximizing the level of prevailing wind to achieve required cross ventilation and identification of most effective building design and layout by using the software related to ventilation simulation. Awbi (2010), has said that there are several types of natural ventilation involved in a green building such as single sided, stack and solar induced ventilation which are handled and analyzed using two basic approaches such as internal flow simulation and external simulation through Computational fluid dynamics (CFD) Modelling Techniques.

As mentioned earlier, another sub category of energy efficient is daylighting that required at least 50 percent of levels of daylight illuminance effectiveness as stated in MS 1525: 2014. Besides that, requirement also covered the common areas such lift lobbies, corridors, staircases and car parks (GreenReSdnBhd, 2016).

Besides the Energy Efficiency, Indoor Environmental Quality is the second most important criteria which



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contributed most of the credit allocation of GreenRe, Breeam, Green Star and Leed. Indoor Environmental Quality encompasses with Thermal Comfort, Noise level, Indoor Air Pollutant and many other sub-elements. Indoor Environmental Quality became the second most vital criteria where 16% for Green Star, 14% for LEED and 5% for GreenRe with a total average of implementation at 9.1%. However, Indoor Environment Quality is not applicable under the BREEAM green rating tool. Thermal comfort which is the one of the elements used for analyzing indoor environment quality referring to the function of human's thermal preference and presumption which based on reactivity contributed by existing indoor climate (Singh *et al*, 2013). This clearly indicated that the point's allocation are based on indoor temperature and RH or relative humidity value.

The following sub elements which is the part of Indoor Environment Quality is Noise Level. Noise Level referring to good ambient sound level contributed from surrounding environment. Basically noise level measured based on STC or Sound Transmission Class which help to identify the level of effectiveness of wall, ceiling or floor in withstanding the process of moving through of airborne sound (Naima, 2016). There are other sub elements as well which counted in measurement of indoor environmental quality such as air pollutant, indoor air quality and high frequency ballasts.

The Water Efficiency became the third most covered element by all the green rating tools which enclosed with water efficiency features, water usage and leakage detection, water consumption and other sub-elements. The Water Efficiency recorded the third most essential criteria where 8% from GreenRe, 10% from LEED, 6% from BREEAM and finally 11% from Green Star with a total average of 9%. The water efficiency features which is the one the sub elements of the water referring to water efficient fittings which certified and labelled for efficient usage of water. In Malaysia, water efficient fittings are certified under WEPLS or water efficient product labelling scheme. Water Efficient Product Labelling Scheme referring to voluntary scheme initiated by National Water Service Commission.

The following criteria which was taken into consideration is Environmental Protection. But Environmental Protection is only applicable for GreenRe with 22.4% which consists of several sub-elements such as Sustainable Construction, Sustainable Products, Green Transport, Greenery Provision, Environmental Management Practise, Storm Water Management and Refrigerant with a total average of implementation at 6%. The other criteria which is the Materials also part of the elements used for certification purpose where 12% for LEED and 9.1% for Green Star with a total average of implementation at 5.3%. It is not applicable for other two green rating tools. Another criteria which need to be discussed as significantly implemented based on the total average of implementation among list of green rating tools discussed is Management. Management emerged as one of the important criteria for overall green rating tools where 12% for BREEAM and 15.4% for Green Star with a total average percentage of implementation at 7%. Management enclosed with sub-elements of Green Star

Accredited Professional, Building Information, Metering and Monitoring, Tuning and Commissioning, Environmental Management, Green Cleaning and many other related elements as well.

There are another two elements which are not covered by all the green rating tools. Firstly, element under the carbon emission of development which are not covered by LEED and BREEAM. Secondly, element under the other green features which are not covered by all the other green rating tools except the GreeRe. Element under the carbon emission of development referring to computation of carbon footprint of constructed building and building materials used for construction activities. While element under the other green features related to green features which installed in building or constructed units such as pneumatic waste collection system, self-cleaning façade system and integrated storm water treatment into landscaping

Therefore, there are similarity between all the green rating tools; GreenRe, LEED, BREAAM and Green Star in terms of recognition of list of criteria practised for green certification purpose. There are two main elements which are Energy Efficiency and Water Efficiency have been taken for consideration for certification purpose by all four green rating tools. There are other criteria as well such as the Indoor Environmental Quality which covered by at least three out of four green rating tools including GreenRe. Other criteria which are taken into consideration by number of two green rating tools out of four green rating tools which are discussed are Carbon Emission on Development, Materials, Land Use and Ecology, Transport, Innovation and finally the Management. This clearly indicates the importance of elements agreed by all green rating tools for certification of green building including GreenRe in Malaysia.

IV. CONCLUSION

Construction activities involving green constructed units are starting to increase at around the world. World leading nations such as United States, United Kingdom and Australia pledged to increase green construction and reduce conventional constructions and to significantly increase the figures of green building by period of 10 years as green constructed buildings use less water and energy, saved more money and contribute in safeguarding the environment over the long period of time. While in Malaysia, government initiative in building and certifying of green constructed building is visible through the establishment of green rating tool such as GreenRe which reflected the passion and responsibility of the government in steering the nation towards achieving success as par as leading nations in the world in green construction activities. GreenRe rating tool which was established by Rehda Malaysia is endorsed by the government of Malaysia as a locally developed green rating tool as par as international green rating tool to certify green construction building in the country. All the elements by Various Green Building Rating Tools which used for consideration to certify



green constructed building by GreenRe rating tool are according to international standard as based on Singapore BCA's prestigious Green Mark tool which is recognised across 71 countries and cities globally. Furthermore, research study which was carried out as above proven that GreenRe green rating tool followed almost all the important criteria based on international standard. Subsequently, this will encourage the government and parties involved in green construction industry to achieve the primary objective of sustainable development and great success in overall green construction in Malaysia

Table. 5 A Comparison of the Green Building Criteria

Criteria	Green Re	LEED	BREEAM	Green Star	Average Total
Energy Efficiency	58%	30%	19%	22%	32.2%
Water Efficiency	8%	10%	6%	11%	9%
Environmental Protection	22.4%	n.a	n.a	n.a	6%
Indoor Environmental Quality	5.4%	15%	n.a	16.3%	9.1%
Other Green Features	4%	n.a	n.a	n.a	1%
Carbon Emission of Development	4%	n.a	n.a	5.4%	2.4%
Health and Wellbeing	n.a	n.a	15%	n.a	3.8%
Materials	n.a	12%	n.a	9.1%	5.3%
Land Use and Ecology	n.a	n.a	10%	5.5%	3.9%
Pollution	n.a	n.a	10%	n.a	2.5%
Transport	n.a	n.a	8%	6.4%	3.6%
Waste	n.a	n.a	7.5%	n.a	n.a
Location and Transportation	n.a	15%	n.a	n.a	4%
Sustainable Sites	n.a	9.1%	n.a	n.a	2.2%
Innovation	n.a	5.5%	n.a	9.1%	4%
Regional Priority	n.a	4%	n.a	n.a	1%
Management	n.a	n.a	12%	15.4%	7%

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