A Cross Case Investigation of Sustainability Assessment tools of the LEED, BREEAM and GRIHA

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1. Abstract

With spreading of the very notion of sustainable development in the construction industry, the rating system schemes to assess the energy efficiency is becoming more vital than ever. Today, a great deal of effort is placed all over the world in achieving and implementing sustainable strategies and development in the construction industry. The aim of this paper is to provide an objective comparison of the sustainability performance assessment of three tools that are used and applied in sustainability assessment in three different countries. This paper critically examines the sustainability assessment for new buildings within three building environment assessment schemes within the BREEAM-UK, LEED-USA and GRIHA-India. Bose (2011) noted that there are many aspects, which are not been addressed to respond to the Indian context within the used assessment tools in India. The paper reviews this tools aiming at identifying those aspects and putting forward a strategy to address them in the Indian rating tool through a comparative study of this system with two of the most leading systems of the world namely the LEED and BREEAM. The paper through a cross case analysis identifies the nature and contribution, in addition to the shortcomings in the existing sustainable parameters of the three tools identified. This is followed by an evaluation of the three systems based on the similarities of their assessment criteria, credits, benchmarks and energy performance system. Scope of further development of the GRIHA assessment tool is identified particularly the need for expansion of the 3 broader categories it uses for assessment. The paper proposes that in developing countries like India there should be a scope within the sustainability assessment tools to capture the health and well being of the society.

1. Introduction

Regardless of the individual approaches towards promoting sustainability measures in the world Sustainability Assessment Methods (RATING SYSTEMS) where developed to break down the considerations of sustainable building design and construction into something quantifiable. The aim of which is reducing energy consumption and enhancing the building performance, for both their construction and management, thus limiting its consequences on people's wellbeing and on the local and global environment. (J.Burnett, 2008) (M Evans, 2009) As "Energy efficient" is a subjective term, which can be judged individually hence it was necessary to form a common ground and rating or assessment tool. The sustainability assessment tool is based on the sustainable development interrelated parameters being it economical, environmental, social and cultural aspects. (Kibert, 2008) There are few schemes aiming to be globally accepted rating systems (ESCAP, 1999-2013), where the authors argues that sustainability is defined to have a contextual and social dependency and hence, such approaches should be critically reviewed and considered.

Concomitantly, these tools are used as a means to evaluate the impact of policies, plans and projects have on the built environment in general and the sustainable development in particular. (Pope et al., 2004) The introduction of sustainability assessment methods for buildings has thus provided explanatory tools to translate sustainable development (SD) into practical terms. The common intentions behind various sustainability assessment methods is a procedure used to evaluate whether environmental and societal changes arising from man's activities and use of resources are minimising or increasing our ability to maintain long-run sustainability (Forbes, 2008, p. 28). Hence, sustainability assessment tools measures and organizes a set of Key Performance Indicators

(KPI) to address and acknowledge critical and required criteria that should be considered when designing and constructing for a sustainable future. (Kibert, 2008)

Global efforts to put together various sustainability assessment tools has increased the number of new schemes being introduced at national and international levels. The most globally known systems are LEED and BREEAM and from USA and UK respectively and GRIHA, India that are critically investigated in this paper. Although Indian rating system has another body along with the GRIHA for rating the sustainability of buildings named as IGBC (Indian Green Building Council). One of the certification developed for new and core and shell development in this program is LEED (India).It has mirrored a model same as USGBC (US green building council) program for LEED,USA. However, for the purpose of this study the GRIHA which is widely used in India will be used.

1.1 Aims and Objectives

The research interest of this paper is to review how well current Indian GRIHA assessment system appraise the sustainability of buildings. This is done through a comparative analysis of the GRIHA with two of the leading sustainability assessment methods in the World the LEED and the BREEAM. The research question to be addressed is how adequate is the assessment tool now in use in India and how it is designed to fit the socio-cultural aspects of India? Assessment tools measure achievement against targets of sustainable development within a specified region and hence enhancing monitoring and construction techniques and promoting preferred behaviour against targets (Becker, 2004).

Two aspects of research interest emerge from this statement: the first concerns the scope of the GRIHA assessment tool in comparison to the LEED and BREEAM. This is carried out through a comparative analysis of what is measured by the choice of Key Performance Indicators (KPI); the second interest is in examining the quality of the assessment tool from the perspective of its robustness as a process of appraisal within a given context and in this case is India: that is, how well the tool satisfies a specific context and is tailored with reference to soci-cultural aspects of that given context.

1.2 Research Framework

The paper utilizes a mixed research approach, both qualitative and quantitative type of approach that is been adapted to scrutinize the sustainability parameters together within the rating system and their aims. The paper puts forward a critical comparative analysis between the 3 rating systems identified. Through the analysis of the similarities and differences of the LEED, BREEAM and GRIHA, the paper identifies the shortcoming in the recently developed rating systems like GRIHA.

A robust and credible building environment scheme plays an important role in assessing sustainability credentials and building energy performance. Hence, the building industry contributes greatly to wellbeing as well as regional and global resource consumption. Countries that currently do not have their own sustainability assessment rating schemes should aim at developing their own tailored scheme in th very near future. Therefore it is necessary to understand the various schemes in terms of assessment methods, scopes, performance, etc. (J.Burnett, 2008) Hence, the authors undertook a worldwide comparative analysis of Sustainability assessment methods, however, for the purpose of this paper, the number of assessment tools that are compared against the GRIHA is limited to the LEED and BREEAM assessment tools as a controlled boarder to the scope of research. These are assessment tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall rated assessment of the project itself and also allows for comparison against other buildings (Fowler and Rauch, 2006, p. 1).

GRIHA was analysed for the purpose of this comparative study and not the LEED (INDIA) because of the difference and variety of assessment parameters of the former. Unlike GRIHA LEED (India) is based on the per capita energy consumption of country similar to USA were as it does not work in India as India's Per capita energy consumption is very low as compared to other developed nations. GRIHA is a home grown system for promotion of Sustainable buildings in India claiming its appreciation and inclusion of socio-psychological Indian context. (COUNCIL, 2007)

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is a third part program developed by USGBS. It is a tool developed to improve energy performance of the buildings in seven key areas of human and environmental impacts as presented in Table 3. Its main aim is to make LEED the primary tool for rating sustainable buildings in the world. BRE Environmental Assessment Method (BREEAM) is a rating system developed in UK by the Building Research Establishment (BRE). GRIHA is the National Rating System developed by a body name TERI in India (TERI, 2008). It is designed to cater all kinds of buildings in different climate zones of India. (M Evans, 2009)

All three systems have a common aim of assessing the environmental behaviour, energy consumption and carbon emission of a building. They cover variety of environmental issues such as material, energy, water, pollution, indoor environmental quality and the site.

2. Sustainable Assessment tools

These are the assessment tools developed with the intention of promoting the practise of environment friendly building construction on the earth. Different countries have been formalizing their own ways of quantitatively rating the building construction for its efficiency. Although rating systems from different countries have various parameters to judge upon and rate accordingly, still all share a common aim to protecting the Mother Nature by reducing the harmful construction. (Radu Zmeureanu, 1999)

Though the basis of suitability for such assessment tools in most parts of the world is derived from the local regulatory minimum standards to form baseline assumptions (Dirlich, 2011) and (Reed, 2011), still they have incorporated aspects of traditional architecture of the contextual places providing a prototype system to rate the building as a common ground to sustainable development. (Kibert, 2008) Also with a lot of claims being made by the constrcution industry of the high sustainable aspects of their projects it was important to find appropriate tools to appraise and contrast between various projects. The requirement where choices of options are appraised to determine on a performance basis the preferred option, and that on a regular basis the effectiveness of the favoured option is evaluated thus provides a rationalised method of goal-directed decision-making (Friendand Hickling, 2005).

2.1 Sustainability and Its Parameters

“Sustainable development is development that meets the need of the present without compromising the ability of future generation to meet their own needs.” [The United Nations World Commission on Environment and Development].

Yet in this era of unprecedented global warming, climate change and energy crisis, achieving this goal seem more of an aspiration than a reality. As economies globalize, new opportunities to generate prosperity and quality of life are arising though trade, knowledge-sharing, and access to unlimited technology. However, these opportunities are not always available for an ever-increasing human population, and are accompanied by new risks to the stability of the environment. Thus, the ability to quantify environmental sustainability of building design has become a necessity more than ever.

2.3 Overview of Sustainability Parameters of Three Countries

Comparing interrelated sustainability parameters or the KPI used for the assessment tools within the three countries will help in giving relevance and identifying the scope of the research, these are depicted in Table 1.

1. Total population of USA is 4.5% of total world’s population were as U.K having the minimum of 0.89% of world’s population. India being highly populated of about 17.13% of world’s population. This shows that

criterias which depended on population should vary drastically, in the Builidng sustainability assessement tool within each country.

2. India having max population out of three has 2% of land area were as USA has 6%, again another crucial parameter for consideration.
3. Environmental Sustainability parameter also depends on Bio diversity and forest cove which is minimum in U.K and max in USA. Hence, preservation of natural resource criteria should also vary.
4. India still need more application and awareness of sustainable construction within the industry.
5. Population under poverty line is another factor which needs to be highly considered by any sustainability scheme for promoting social justice and cultural sustainability in the country. India being highest percentage of poverty population needs to develop KPI to address this. (SERVICE, 2001) (Sian Atkinson and Mike Townsend, 2011) (India, 2011).

Table 1 Cross Case Analysis of the Sustainable Parameters of USA, UK and India (SERVICE, 2001) (Sian Atkinson and Mike Townsend, 2011) (India, 2011).

SUSTAINABILITY PARAMETERS	U.S.A	U.K	INDIA
POPULATION	4.5 % X WORLD	0.89% X WORLD	17.13%X WORLD
LAND AREA	6.1 % X WORLD	0.16% X WORLD	2% X WORLD
LAND UNDER FOREST	39 %	13 %	19%
AWARENESS (no of sustainable buildings)	2476 NO.	7202 NO.	290 NO.
POPULATION UNDER POVERTY LINE	15%	17%	32.7%

Measuring the countries and Public Awarenes of sustainable design is investigated here via a comprison of the number of 'Sustainable Buildings' in each of the 3 countries shown in the Table above. In this case the UK leads by far, followed by the USA, with India quite low number at 290 compared to 7207 in the UK.

3 Overview of Sustainability Assessment Methods

The general comparison between all the three assessment schemes in relation to their country of origin is shown in table 1. Following are main features of the sustainability assessment method in all the three schemes.

3.1 LEED Scheme

LEED is a system which is recognised globally as a rating scheme for sustainable buildings. It has assessed buildings in over 24 different countries. (J.Burnett, 2008) The current version is based on some prerequisites and credits for new constructions. Each credit is based on different aspect of designing like site, water efficiency, energy and atmosphere, material and resource, innovation, regional priority and indoor air quality. The points awarded in case for energy performance credit and renewable credit depends on performance achieved. Whereas, one point for all other credit issues counts for the total points of the building. There are total of 69 points that can be achieved. There are four levels of awards which depend on number of points scored (Certified, Silver, Gold and Platinum). This can be well observed in table 4. (Sleeuw, 2011)

There are two different approaches to the assessment method of LEED:

- *Credit EA1-Optimmize Energy Performance*

This is a method which is followed by the fulfilment of prescriptive measures and is also known as prescriptive compliance path.

- *The Whole Building Energy Simulation*

For each of the approaches the minimum score required are 2 points. The Whole Building Energy Simulation counts for 14.5% of the total scheme points. It uses a simulation program to analyse thermal analysis to the specification according to the ASHRAE Standards (ASHRAE, 2004) known as Performance Rating Method (PRM). This method has two building models one is the baseline building model and the other is the proposed building model. The calculation of the energy rating system is based on the annual energy cost of running against the average cost of running the base line building.

The percentage of improvement is defined as below:

" % of improvement = 100 × [1-(Cost of Proposed/Average Cost of Baseline)]" *(Ya Roderick, 2009)*

Strengths of LEED

The LEED scheme provides more extensively publicly accessible resources, researches and case studies. It is concerned with Post Occupancy Evaluation (POE) that provides the scheme operators with valuable feedback on the effectiveness of particular credits in terms of their actual environment and well-being impact. In addition, heat Island Effect is reduced by introducing a credit of planting green trees and using shading devices. Thermal comfort is being offered by the other two methods as well but only LEED provide its verification after the occupancy of the building. Indoor air quality in LEED promotes the use of mechanical ventilators. This is in reference to the USA climate. (J.Burnett, 2008)

3.2 BREEAM Scheme

BREEAM is the rating system developed for buildings in UK. It forms a basis of building regulation as a benchmark to rate. There is an ongoing development for the formation of new BREEAM International for Gulf countries. (Ya Roderick*, n.d.) Different credit issues in the BREEAM on which the assessment schemes depends are management, health and wellbeing, energy, transportation, water, material, waste, land use management and pollution. Total numbers of credits are 102 available. The total score is determined in percentage calculated based on the credits available, number of credits achieved for each category and a weighting factor.

On the basis of the scoring percentage there are 5 levels of awards that are given to the building. Categorised as Unclassified (<30%), Pass (_30%), Good (_45%), Very Good (_55%), Excellent (_70%) and Outstanding (_85%) seen in table 4. (Sleeuw, 2011) Each of the credit issues are assigned with some value of the credits. But for the improvement observed in the demonstration of the energy efficiency of the building fabric and services a total of 15 points are awarded as depicted in table 3. This accounts for about 14.5% of the total score. BREEAM also CREDIT ENERGY awarded for Reduction of CO_2 emission. This is referred to as CO_2 based Index. The calculation of energy performance is based on the National Calculation Methodology (NCM) modelling guide (for buildings other than dwellings in England and Wales). (Government, 2008)

Strengths of BREEAM

Life cycle cost analysis is a part of the evaluation in BREEAM. It also has a mandatory sub metering substantial energy standard which needs to be fulfilled for very good to outstanding ratings. BREEAM encourages reducing CO2 emission to zero in relation to Building Regulations Part L 2010 to achieve maximum points worth 10.56% of the total score. (Barlow, 2011) Transportation and roots are the aspects which are seen with great importance on the system. A book named Green Book Live and the Green Guide to Specification for green material has been produced by BRE. (Sleeuw, 2011)

Table 2 GENERAL Comparison of the Key Aspects of LEED, BREEAM and GRIHA (Sleeuw, 2011) (ICE, 2011)

	LEED	BREEAM	GRIHA
COUNTRY OF ORIGIN	UNITED STATES	UNITED KINGDOM	INDIA
YEAR OF FORMATION	1998	1990	2007
TYPE OF PROJECT	New Construction Major Renovation	New Construction Major Renovation	New Construction (for 6 zones)
RESULTS REPRESENTATION	Pass, Good, Very Good, Excellent and Outstanding	Certified Silver, Gold and Platinum	*, **, ***, ****, and *****
RESULT PRODUCT	Certificate	Certificate	Award for Rating and Certificate
NO. OF CREDIT	69 Credits	150 Credits (Max)	100 Credits

3.3 GRIHA Scheme

The rating system developed to serve the building industry in India. It was developed by TERI, which is an organization which is committed to sustainable development. It is a research and development cell which also acts as a driving force to popularize Sustainable Building Design and Environmental Sustainability in the country. GRIHA is a quantitative and qualitative tool with assessment criteria's which evaluate the environmental performance of a building holistically over its entire lifecycle. It bridges the gaps between the established practices and emerging sustainable concepts within the Indian Context. Its aim is to work on following environmental aspects – Green house gas emission, reducing the stress on natural resources, and improving energy security.

GRIHA has a scheme for new construction with five stars of rating. It emphasises the use of passive design techniques to create visual and thermal comfort in indoor spaces. Out of total 32 criteria's few are mandatory and their satisfaction is primary requirement for GRIHA qualification. This is valid for five years and random audits are carried till its validity. (TERI, n.d.)

Strengths of GRIHA

The criteria's of GRIHA are more inclined towards a climate responsive designing with minimum of energy use. It is concerned with the noise pollution aspect in a building which is desired in the construction industry within the Indian context. It also provides the incentives from the government of India which makes it favourable one for the developers to choose. Similar to LEED Post Occupancy Inspection according to which the building could be inspected at any point of time within 5 year of validity. Landscape is another area which is being given

importance by GRIHA. Native species and less water use in landscape is a criteria with good points. (TERI, n.d.) Unlike the LEED and BREEAM, the GRIHA provides both a certificate as well as an award.

All three of the rating system has a scheme developed with different credit issues or criterias, to be adderessed. as seen below in Table 3.

Table 3 Comparison of the Key assessment critieria in the LEED, BREEAM and GRIHA

LEED		BREEAM		GRIHA	
ENVIRONMENTAL CATEGORY	**Weighted % points**	**ENVIRONMENTAL CATEGORY**	**Weighted % points**	**ENVIRONMENTAL CATEGORY**	**Weighted % points**
SUSTAINABLE SITES	**23.6%**	LANDUSE AND ECOLOGY	**10%**	Site Selection & Site Planning	**27%**
WATER EFFICIENECY	**9.1%**	WATER	**6%**		
ENERGY & ATMOSPHERE	**31.9%**	ENERGY	**19%**		
		MATERIAL	**12.5%**		
MATERIAL & RESOURCES	**12.7**	HEALTH AND WELLBEING	**15%**	Conservation and Efficiency of Resources	**67%**
INDOOR ENVIRONMENTAL QUALITY	**13.6%**	TRANSPORT	**8%**		
REGIONAL PRIORITY	**3.6%**	WASTE	**7.5%**	Building Operation & Maintenance	**6%**
		POLLUTION	**10%**		
		MANAGEMENT	**12%**		
INNOVATION in Design 6 %		INNOVATION (Additional) 10 %		Innovation	
Total	**110 %**	**100%**		**100%**	

Firstly, it is observed in Table 3 that LEED and GRIHA has some categoried criteria were as BREEAM has a specific section for each credit issue. LEED has a category of Regional Priority which makes it a suitable scheme for global adoption. BREEAM and GRIHA lacks this category of Regional Priority which customises the assessment tool in context.

Secondly, the Site Selection and Site Planning Categories in GRIHA has various critieria within it like Site, transport, health, pollution, etc which makes a total of 27%. Whereas It is more elaborated in LEED and BREEAM with all of the issues handled seperatly.

Thirdly, All of the three schemes has a special common critieria of innovation which shows its concerrn in innovatively exploring and developing the sustainable development and its approaches in the regions.

3.4 RATING BENCHMARKS

LEED has a total of 4 levels of rating with the highest rating called Platinum with a score of more than or equal to 80%. Minimum score required to classify the LEED rating is 40%. BREEAM has 5 levels of rating with minimum for just 30% but highest is 85% and above. In a modeling study Saunders (2008) noted that it is tougher to achieve highest rating in BREEAM in comparison to the LEED. GRIHA has a narrow scope of 50 – 100% with 5 levels of rating as seen in Table 4. Although five star rating is for 90% and above that obliges the developers to adopt highly sustainable measures.

Total no of credits are different in all three of the schemes but the benchmarks set are in percentage which makes it approximately comparable as seen in table 4, except that the BREEAM classifies ratings as low as 30% while the GRIHA lowest classified rating is 50% at one star.

TABLE 4 LEED, BREEAM and GRIHA rating Benchmarks (Sleeuw, 2011) (ICE, 2011)

LEED		BREEAM		GRIHA	
PLATINUM	**≥ 80%**	**OUTSTANDING**	**≥85%**	**FIVE STAR**	91-100
GOLD	60-70%	**EXCELLENT**	≥70%	**FOUR STAR**	81-90
SILVER	50-59%	**VERY GOOD**	≥55%	**THREE STAR**	71-80
CLASSIFIED	40-49%	**GOOD**	≥45%	**TWO STAR**	61-70
UNCLASSIFIED	<40%	**PASS**	≥30%	**ONE STAR**	**50-60**
		UNCLASSIFIED	≥00%		

4. LIMITATION

Meaningful comparisons of actual individual project ratings would require each project to be assessed under each method and compare and analyse the Total number of credits each method award, as ths will better identify the differences and discrepencies in each tool. This would be costly and could not to be undertaken for the duration of this project and the availability of resources.

Alternatively, statistical or modelling analyses require a process of normalisation of credits and local contextual factors, which in turn involves a number of value judgements.

5. Discussions and Conclusion

The authors of this paper have sought to examine the adequacy of the GRIHA assessment tool now in use in India by the design, building control and construction professions as the means by which to judge the performance of buildings in meeting the needs of sustainability since 2007. This primary question required that the authors should assess the GRIHA tool in reference to other more widely and long established assessment tools in the world, to be able to compare and benchmark GRIHA to other Tools. This also requires reviewing the scope of the assessment tool in reference to those most widely applied throughout the world to rate the sustainability of buildings and for this paper the BREEAM-UK and LEED-USA was used to assess the objectivity evident in the framing and use of the GRIHA-India in reference to these tools.

In general, the adequacy of the three reviewed systems with respect to aiming for objectivity in their analytical and evaluation processes can be regarded as satisfactory. It is evident though that the BREEAM tool has more particularly specified environmental categories that they look at and is much more detailed than the LEED and GRIHA.

The BREEAM and LEEDS systems have been up-dated in recent years to expand both the scope of their interest and the environmental categories they look at, both to include the building life cycle and the understanding of

the dynamics of environmental change as well as POE in case of the LEED. Their systems are sufficiently transparent to make it possible to identify the methods of calculation, the setting of targets and benchmarks, and the assumptions taken to support weighting of indicators. In respect to the GRIHA the Environmental categories are more condensed and crammed into 3 main categories in addition to the innovation category which makes it significantly harder to identify the methods of calculation under each category and complicate benchmarking and increases assumptions taken for each of the indicators. It is worth noting that the innovation category can vary a lot between the 3 schemes, hence what can be considered highly innovative within the GRIHA scheme can only be categorized under one of the other categories in the case of the BREEAM and LEED.

The examined sustainability assessment methods have evolved around their respective Country's building code standards that are responsible for varying baselines. However, other factors that should evidently be considered are the local and regional context due to which direct comparison is difficult. More research is to be undertaken to examine the claims that these assessment tools has their own tailored criteria which works well in their own contextual region.

Differences were indicated between the rating systems in their treatment of weighting of factors and the categories they look at as discussed in this study. In terms of aims, approach and structure there are certain similarities between the three of them but when it comes to scope of environmental issues, metrics, and standards they are different.

- LEED has a collective category that is 'Sustainable Sites' that includes issues covered mainly by BREEAM 'Land Use and Ecology', but also by 'Transport, Pollution and Management'. While GRIHA 'Site Selection and Site planning' includes all the above in addition to 'Health and Wellbeing' in BREEAM.

- LEED 'Energy and Atmosphere' and GRIHA 'Conservation and Efficiency of Resources' include issues covered mainly by BREEAM 'Energy,' but also by 'Waste, Pollution and Management' as well as 'Material 'in the case of GRIHA. LEED 'Materials and Resources' includes issues covered mainly by BREEAM 'Materials', but also by 'Waste and Management' (Reed et al., 2010).

- LEED placed a high rating on 'Sustainable sites' and 'Energy and atmosphere', but gave a low comparable rating on 'Water Efficiency, Material and Resources and Indoor Environmental Quality'. Whereas BREEAM, although - also rating low for 'Water, Transport and Waste', gave higher weight to 'Land Use and Ecology, Materials and Management' and the highest weight to 'Energy'.

These differences invite further scrutiny to understand and better clarify how these aspects are defined and what value drivers are being applied. From the rating benchmark it can be interpreted that BREEAM has the most difficult and detailed credit scoring system and GRIHA has the highest level of grouping of categories within the award. It is seen from the study that BREEAM has a wider scope of sustainable KPI's with more assessed categories than LEED and GRIHA.

It is worth noting that USGBC aims to have a global rating system for sustainable buildings but this study shows that there is a requirement that any system developed should have an exclusive strength which caters to its country context. India being the most highly populated country with highest '%' of poverty population among the three countries examined in this paper should have special credit categories addressing the health and well being of the society. Hence, with a vast variation in economic, social and cultural aspect, same level of human satisfaction and comfort cannot be achieved with general or similar rating system strategies.

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