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Green Building Rating System

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***Abstract*—Due to the recent emphasis on 'Green buildings' around the world, green building rating systems, a voluntary certification program, have emerged as one of the major recognized standards to qualify sustainability in building design and performance in India. The awareness towards sustainable development is increasing in the construction industry due to the popularity of these rating systems in our country. The rating tool become benchmark of construction industry for green measure and these buildings are helpful in reducing negative impact on the environment. The three most popular rating systems in India that are in use today. Leadership in Energy and Environmental Design (LEED), Indian Green building Council (IGBC) and Green Rating for Integrated Habitat Assessment (GRIHA). The design of these rating systems without considering the wide array of climate, social and economics variations of India, resulting in a superfluous recognition of generic and readymade design solutions that disregard the actual aim of sustainability. The main purpose of this paper is to address critical issues or problems in these rating systems and suggestions toward a new version for these rating systems.**

***Index Terms*—Green building, GRIHA, IGBC, LEED.**

I. Introduction

Green buildings are going to play a significant role in defining our future on this planet. The design approach for such buildings thus has a major impact on the very sustainability of our civilization. In response to this challenge, at present we have certain standards and rating system in different parts of the world to define and qualify sustainable aspects of buildings of different categories and scale.

LEED (Leadership in Energy and Environmental Design) developed by the US Green Building Council (USGBC) is one such Green building rating system widely accepted around the world. Through the rating system was originally developed considering the American context, it has been gradually accepted in more than 13 countries, including India. In India, before the advent of LEED there existed a number of national and international building standards and codes which fulfilled the requirements of a sustainable design guideline and rating systems in discreet manure. The official certification of LEED for Indian buildings started in November 2003, when the US Green Building Council (USGBC) certified the CII sohrabji Godrej Green Business Centre, Hyderabad with the highest "Platinum" certification level under its LEED Rating System (Version 2.0) which was followed by subsequent Indian versions. According to the survey by USGBC, the top 10 list highlights countries outside of the US that are using LEED and India, with more than 752 LEED-certified projects totalling over 20.28 million gross square meters of space, ranks third. Although certain amendments for the Indian version have been proposed to fit into the context by the steering committee appointed by Indian Green building Council (IGBC), the guidelines for India is virtually identical to the US version with its standards and definition based on the American context; for instance, there are few modifications to the ASHRAE standards. Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system of India. It has been envisioned by TERI (The Energy and Resources Institute) and built in cooperation with the Ministry of New and Renewable Energy, Government of India. GRIHA is a green building 'design evaluation system' and is fitting for every type of building in different zones across the country.

The rich and complex background of the Indian environment-conscious architecture has evolved from its geographic, climate and multi-cultural roots. Based upon those roots and principles, the selection of design techniques, choice of materials and space planning were further developed by some of the renowned Indian and international architects post-independence. This development followed the theory of critical Regionalism to a certain extent, which promoted a localized approach toward architecture. Hence, even before the advent of the term "Green buildings", India showcased appropriate examples of interplay between contemporary styles and traditional techniques under diverse contextual variations.

Hence, the argument of this paper is that these rating systems fail to respond to the essence of Indian sustainable architecture, thus misleading the design process. Immediate attention thus needs to be given to these rating systems to ensure priority for contextual design aspects and traditionally developed design techniques before the rating guideline can be accepted as the new measure for sustainable design in India.

LEED: Leadership in Energy and Environmental Design
USGBC: US Green Building Council
IGBC: Indian Green building Council
GRIHA: Green Rating for Integrated Habitat Assessment
TERI: The Energy and Resources Institute

II. Overview of Green Building Rating Systems

A. *LEED v4 Rating System*

The LEED (Leadership in Energy and Environmental

Design) Green Building Rating System is a voluntary, consensus-based standard for developing high performance, sustainable buildings in the world. LEED (Leadership in Energy and Environmental Design) developed by the US Green Building Council (USGBC) is one such Green building rating system widely accepted around the world. The USGBC has defined a number of variants of the credit systems to address individual aspects of different kinds of buildings and construction which include LEED for New Construction, Core and Shell, Homes, Commercial Interiors, Retail, Schools, Healthcare, existing buildings and Neighborhood development. All these variants, however, are based on the main credit system with modification in credit points or prerequisites. The Indian Green Building Council (IGBC) has two LEED systems applicable: LEED for New construction (NC) and core and shell. Since, LEED NC is applicable mostly to new commercial projects and large scale residential projects (four story and above), the focus of this research is on this particular system.

The main structure of LEED rating system, which is the same for LEED NC, is divided into seven categories as listed below:

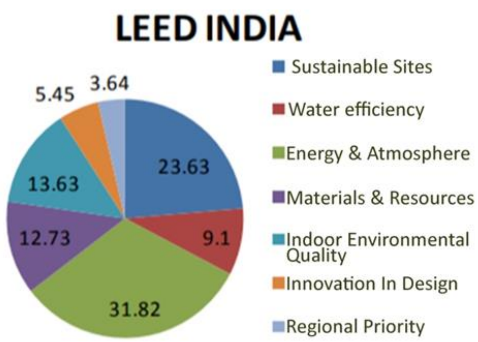

Fig. 1. LEED v4 Points category

Under these categories credits are listed which are assigned with points that can be achieved by fulfilling the requirements of respective credits in a project. The total number of points achieved, irrespective of category, is thus counted as the final measure of degree of sustainability for projects. Depending on the count different, levels of certification are provided as follows:

TABLE I
POINTS ACHIEVED IN LEED V4

Certified	40-49points
Silver	50-59 points
Gold	60-79 points
Platinum	80-110 points

B. IGBC Rating System

Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) formed in the year 2001.The council is committee-based and consensus-focused. All the stakeholders of construction industry comprising of architects, developers, product manufactures, cooperate, Government, academia and nodal agencies participate in the council activities through local chapters. The council also closely works with several state governments, central government, World Green Building Council, bilateral multi-lateral agencies in promoting green building concepts in the country.

The purpose of this rating system is to ensure that an existing or upcoming project should incorporate the finest green building practices that would ensure sustained savings and enhanced operation and processes. The vision of the council is, “To enable a sustainable built environment for all and facilitate India to be one of the global leaders in the sustainable built environment by 2025.” The council offers a wide array of services which include developing new rating system programmes, certification services and green building training programmes. The council also organizes Green Building Congress, its annual flagship event on green buildings.

The IGBC defined an important development in the growth of green buildings with different credit systems to address individual aspects of different kind of the buildings and construction which include IGBC for New Buildings, Existing Buildings, Homes, Residential societies, Interior, Health care, Schools, Factory Buildings, Data Centre, Campus, Village, Township, Cities, Landscape, Affordable housing, Health and Well-being. All the IGBC rating system are voluntary, consensus based, market- driven building programme.

The main structure of IGBC rating system is divided in seven categories as listed below:

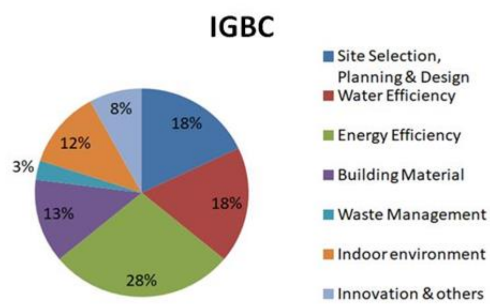

Fig. 2. IGBC points category

Under these categories credits are listed which are assigned with points that can be achieved by fulfilling the requirements of respective credits in a project. The total number of points achieved, irrespective of category, is thus counted as the final measure of degree of sustainability for projects. Depending on the count different, levels of certification are provided as follows:

TABLE II
IGBC POINTS CATEGORY

Certified	50-59points
Silver	60-69 points
Gold	70-79 points
Platinum	80-89 points
Super Platinum	90-100 points

C. GRIHA Rating System

Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system of India. It has been envisioned by TERI (The Energy and Resources Institute) and built in cooperation with the Ministry of New and Renewable Energy, Government of India as of November 1 2007, GRIHA is a five star rating system for green buildings which emphasizes on the passive solar techniques for optimizing indoor visual and thermal comfort.

GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. It has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions. In order to address energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within specified comfort limit. GRIHA integrates all relevant Indian codes and standards for buildings and act as a tool to facilitate implementation of the same.

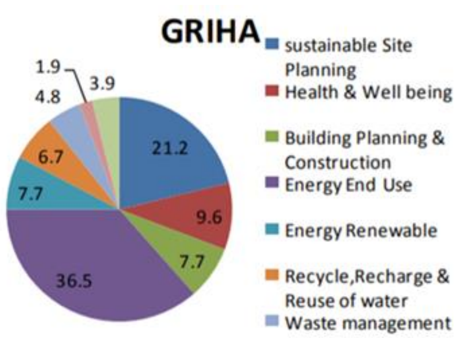

Fig. 3. GRIHA points category

GRIHA is a guiding and performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criteria has points assigned to it. It means that a project intending to qualify have to meet with each criterion and earn points. Compliances, as specified in the relevant criterion, have to be submitted in the prescribed format. While the intent of some of the criteria is self-validating in nature, there are others (for example energy consumption, thermal and visual comfort, noise control criteria and indoor pollution levels) which need to be validated on-site through performance monitoring. The points related to these criteria (specified under the relevant sections) are awarded provisionally while certifying and are converted to firm points through monitoring, validation and documents/photographs to support the award of point. The set of 34 criteria of GRIHA shall be broadly classified into two categories- applicable and selectively applicable. The applicable criteria have two further sub categories- mandatory and optional/ non mandatory. The rating applies to new building stock- commercial, 54 institutional and residential- of varied functions.

The main structure of GRIHA rating system, which is the same for GRIHA, is divides into seven categories as in Fig. 3.

Under these categories credits are listed which are assigned with points that can be achieved by fulfilling the requirements of respective credits in a project. The total number of points achieved, irrespective of category, is thus counted as the final measure of degree of sustainability for projects. Depending on the count different, levels of certification are provided as follows:

TABLE III
GRIHA POINTS CATEGORY

One star	50-60points
Two stars	61-70 points
Three stars	71-80 points
Four stars	81-90 points
Five stars	91 points and above

III. A COMPARATIVE ANALYSIS OF GREEN BUILDING RATING SYSTEMS

The primary three most prevailing rating systems were considered under study by using the thematic approach of the categorized criteria under each domain of the rating system. Despite each rating system has its goal to achieve sustainability and to create an environmental balance in the ecosystem but they largely differ with each other in their approach. The large number of difference can be explained in terms of data required in format as prescribed and pre-defined in rating system chosen. They composed of checklist of weather a credit or a pre-requisite is attempted to meet the compliance. This checklist contains more number of quantities that are optional in nature than the criteria carrying prerequisite intent. Although , there may be some criteria with some points in two or more rating system but looking from the construction point of view it may be weighted heavily thus making the rating process subjective and leading an open debate.

TABLE IV
COMPARATIVE ANALYSIS BASED ON CREDIT POINTS

CREDIT POINT ANALYSIS OF LEED,IGBC& GRIHA						
	LEED		IGBC		GRIHA	
Theme	Maximum Points	Weightage in Percentage	Maximum Points	Weightage in	Maximum Points	Weightage in
Site Selection, Planning & Design	26	23.6	18	18	20	19.2
Water Efficiency	11	10	18	18	16	15.4
Energy Efficiency	33	30	28	28	26	25
Building Material	11	10	13	13	14	13.5
Waste Management	2	1.9	3	3	8	7.6
Indoor Environmental quality	16	14.5	13	13	14	13.5
Innovation & other	11	10	7	7	6	5.8
Total	110	100	100	100	104	100

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TABLE V
COMPARATIVE ANALYSIS OF LEED V4, IGBC AND GRIHA RATING SYSTEM

NO.	CATEGORY	LEED	IGBC	GRIHA
1	SUSTAINABLE SITE AND DESIGN			
a)	Site selection/Reuse of land/Reclaimed land/sustainable construction/site preservation	✓	×	✓
b)	Preserve and protect the landscape during construction/Protect or Restore Habitat/Existing topography and vegetation	✓	✓	✓
c)	Soil conservation/Top soil laying & stabilization/ Reduce hard landscaping & boundary protection	×	✓	✓
d)	Brownfield redevelopment	✓	×	×
e)	Design to include existing site features	✓	×	✓
f)	Passive Architecture	×	✓	✓
g)	Sustainable landscape design	×	✓	✓
2	ENERGY/ENERGY EFFICIENCY/ENERGY USE			
a)	Renewable energy utilization	✓	✓	✓
b)	Minimum energy performance/optimize ozone depletion	✓	✓	×
c)	Fundamental building commissioning/Measurement & verification/ Energy monitoring /metering & monitoring	✓	✓	✓
d)	Ozone depletion	✓	✓	✓
e)	Additional commissioning	✓	✓	×
f)	Energy improvement/ Green power	✓	✓	✓
3	INDOOR ENVIRONMENTAL QUALITY			
a)	Optimize building design to reduce the conventional energy demand/ Naturally ventilated design/ Localized ventilation	×	×	✓
b)	Day lighting & veiws/ visual comfort / Daylighting/ External veiws/ Artificial lighting minimization/ Interior lighting normally specified	✓	✓	×
c)	Reduced heat island effects/Thermal comfort/ Thermal insulation/Thermal performance of building	✓	×	✓
d)	Low emitting material/Indoor chemical and pollutant source control/ CO2 monitoring and control / Hazardous material/ Indoor air pollutants/ ETS control	✓	✓	✓
e)	Minimise ozone depleting substance/ HCFC & CFC free HVAC/Low & zero carbon technology	✓	✓	✓
f)	Acceptable indoor & outdoor noise levels/ Acoustic performance / Background noise	✓	×	✓
4	HEALTH & WELL BEING			
a)	Minimum level of sanitation/ Safety facilities for construction workers	×	✓	✓
b)	Reduce air pollution during construction/Air Quality Test	✓	✓	✓
c)	Ensure water quality	×	×	✓
5	RECYCLE, RECHARGE & REUSE OF WATER			
a)	Water Consumption/ Water meter/ Water usage monitoring	×	✓	✓
b)	Waste Water Treatment	✓	✓	✓
c)	Water recycle & reuse	×	✓	✓
d)	Minimize Waste generation/ Waste segregation / Storage and disposal/ Recovery from waste	×	×	✓
e)	Innovative waste water technologies/ Strom water management / Water recycling effluent discharge to foul sever	✓	✓	✓
6	MATERIAL			
a)	Building Reuse/ Reuse of facade/ Reuse of structure	✓	×	×
b)	Conservation and efficient utilization of resourses	✓	✓	✓
c)	Utilization of fly-ash in building structure	×	×	✓
d)	Storage and collection of Recyclables/ Construction water management / Resource reuse/ Recycled aggregates/ Recycle content of steel/ Recycled content of reused products & material	✓	✓	✓
e)	Reduce volume, weight & time of construction by adopting an efficient technology	×	×	✓
f)	use low energy material in the Interior	✓	✓	✓
g)	Sustainable procurement/ Recycling waste storage/ Sustainable construction/ Sustainable products / Adaptibility & Deconstruction/ sustainable forest product / waste recycling facilities / waste management	✓	✓	✓
h)	Local or regional material	✓	✓	×
7	TRANSPORTATION			
a)	Alternative transport/ Public transport accessibility/ commuting mass transport/ Green transport/ Local transport/ Vehicular access	✓	✓	✓
b)	Alternative transprtation /Travel Plan/ Fue	✓	✓	×
c)	Pedestrian route / Local tranport	✓	✓	✓
d)	amenities /Amenities features	✓	✓	×
	INNOVATION			
a)	Innovation in Design	✓	✓	✓
	CONSIDERED	✓		
	NOT CONSIDERED	×		

IV. A COMPARATIVE CASE STUDY

The current credit structure of these rating systems and guidelines in India is not sufficient to emphasize the critical issues for sustainable building design. These rating systems has allowed buildings with unsuitable design elements to claim equal, and in some cases even more sustainable, credits over buildings reflecting context sensitive design solutions. These positive rating systems thus, become a marketing tool for builders to sell poorly designed and in efficient buildings. The purpose of this case study is to inspect real world examples to understand the effect of LEED on design decisions made by comparing certified green building and non-certified building in the same context.

For research purpose, the following buildings have been selected for comparison:

A. Buildings for Case Study

1. Rajiv Gandhi Infotech Park, Hinjawadi, Pune

This is a LEED Platinum certified building by the United States Green Building Council (USGBC) and become the largest in the world to achieve this distinction.

Building type: office, year of completion: 2008, Architect-Hafeez Contractor.

2. Tata Technologies Campus, Pune

The TATA Tech centre is based on the concept of rent houses in the US- workspaces that are leased out as small offices. Ten such centers are placed around three courtyards with accommodation on three levels, including a small triple- height sky lit courtyard.

Building type: office, year of completion: 2003, Architect- Charles Correa

Both the buildings are in operation and share the same, climatic, geographic and functional context. The first building was a LEED Platinum rated structure while the other one is good example of passive architecture, the format remains the same with respect to the research framework, and thus can be considered good for comparison.

B. Criteria for Analysis

Designs of both the buildings are analyzed with the project checklist from LEED to compare the building based on the following aspects:

- *Indoor Air and Ventilation:*

The design of the TATA Technologies campus shows serious concerns for natural ventilation throughout the year, responding to the Semi arid climate of Pune. Natural ventilation is the easiest and most economic way to maintain comfort level with in the building. The orientation of the building allows the prevailing breeze to flow through the building.

Fig. 4. TATA Technologies campus, Pune

The division of building in 10 zones also helps to minimize the requirement of mechanically ventilated space. To ensure continuous airflow in three courtyards are provided to enhance air flow and penetration. In contrast to the Rajiv Gandhi InfoTech Park, Hinjawadi the design was mostly on mechanical systems for HVAC control. These controls enable the required amount of fresh air intake and other aspects following the LEED and ASHRAE standard to maintain the indoor air quality. Provision for natural ventilation is absent in the design. As stated earlier, the climate in Pune is pleasant and almost comfortable throughout the year. Mechanical heating, therefore, is the least important factor to be concerned about while designing the HVAC system. For cooling, the temperature is not very high, provision of natural ventilation and shade does half the job. The project follow the ASHRAE standards for indoor environmental quality which is the standard required for any building today and a green building is rated on the amount of betterment it achieves over that standard. It relevant note that even the most sufficient and economic mechanical HVAC system cannot match the energy savings of natural ventilation, as it will always require some energy to run itself.

Fig. 5. Rajiv Gandhi Infotech Park, Hinjawadi, Pune

- *Solar Radiation and Day lighting:*

In Rajiv Gandhi Infotech Park, Hinjawadi, extensive amount of steel glass and aluminum cladding on overall building, which is the current trend in almost every new corporate building in India, complicates the task of controlling solar heat gain and glare. Though the building incorporate glazing with low U factor and solar heat gain coefficient, it seems to be a secondary solution to compensate for the wrong material selection. However, situation could be easily made better using louvers, light shelves or blinds on either sides of the glazing common practice in that region, without a significant increase in construction cost.

In Rajiv Gandhi Infotech Park, Hinjawadi,Pune, a huge glass dome (in a tropical climate) which traps heat and increase the temperature inside making it difficult to work inside. They have AC inside which is cranked up to counteract the heat trap.

Fig. 6. View of Glass façade of Rajiv Gandhi Infotech Park, Hinjawadi, Pune

TATA Technologies Campus, Pune campus designed around three large courtyards which bring the larger building units together. It is not designed like a conventional IT glass facade building which is what makes this unique.

Fig. 7. View of TATA Technologies Campus Courtyard, Pune

V. Issues or Problems in Green Building Rating System

- The certification process is overly complicated, time consuming and expensive. Unable to fulfill actual aim of sustainability. It will be good approach for those who are financially stable and high cost of construction is not an issue.
- "GAME THE SYSTEM" by going after low-hanging fruit to rack up score, even if underlying measures don't result in environmental improvements. More emphasis on earning points than improving the degrading condition of environment. Consultants are picking points which are easy to gain and don't have good effect on nature.
- It is not compulsory to clear the report of LCA (Life Cycle Assessment), even report shows that building is environmentally unfriendly still building can get its Green Building certificate.
- These rating systems formerly ignored land use and site ecology. However, no points are deducted for destroying ecology.
- The main motive of Green Rating System is to do "more good" but rating system encourages for "less bad" due to which Consultant or Engineer depends on active techniques to gain credits easily and install that machine or system which have more impact on environment rather than saving it.
- These rating systems are indiscriminate in weighting of credit its point.
- These rating systems make no discriminate of location like design a building just to gain certificate and calling it green but the building fails to reflect its local culture and architecture.
- India has tremendous diversity in terms of climate, location and culture but these rating systems were designed depends on active techniques for gaining thermal comfort in the building. No significance was given to passive architecture.

VI. Suggestions

While the suggestions are for the credit structure and scoring system, correct explanations of these credit points must be provided in the reference guide that is primarily followed during the design process. For example, the guide should clearly specify the importance of passive techniques while designing the ventilation or solar protection system and should mention the available additional credits for this initiative. Examples of preferred systems should be cited under the Potential Technologies and strategies section for each of those credits.

These suggestions respect the structure of these rating systems, which thus do not intend to change the entire system in order to incorporate solutions for the identified issues. Thus, it is very obvious that they will have limitations and boundaries defined by the system and can be observed as the beginning of further steps in future.

VII. Conclusion

This study began with a discussion on the changing approach toward architectural practice in India over the past few decades. Majority of the buildings designed in the country today lack the connection to this traditional knowledge base. An urge for modern design and techniques are reflected in these highly sophisticated buildings, which draw inspiration from developed countries that have very different backgrounds. It is evident that there is a big debate on the effect of adoption of modern active technology against traditional against traditional passive techniques for Green Building design. It is not easy to decide between these two and the decision depends on various factors including context, economy, technical resources and finally the choice of the architect.

However, looking back at the very primary objectives of sustainability, it can be argued that there is a preference for passive design approach indigenous to the context before shifting to the active and more generalized solutions. It is also true that there is a dire need for a Green building standard and guidelines, especially for India, to push the design process away from a mere imitation of other buildings and look back into the approach that was developed and tested over ages inside the country. These rating systems need to take this additional responsibility and it can be only achieved with the confirmation that the respect towards sustainable design aspects of India. This research can be considered as a step towards the immediate major modifications that must be incorporated in these rating systems credit structure.

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