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Comparative Study of Most Adopted Sustainable Rating System in New Construction

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Abstract: ***Various green rating systems are established globally to judge the sustainability of construction projects. Their categories and criteria are underneath constant updates to follow the sustainable trend of building development. This paper aims to develop a scientific review of the development of green rating systems. The precise objectives are: 1) discover how interest and analysis in green rating systems have developed; 2) determine the similarity, difference, strength and weakness of green rating systems; 3) examine whether or not they totally assess the projects in all aspects of sustainability. Specifically, LEED (Leadership in Energy and Environmental Design), BREEAM (Building analysis institution Assessment Method), DGNB (Deutsche Gesellschaft fur Nachhaltiges Bauen) for a developed country, GRIHA (Green Rating for Integrated Habitat Assessment) and IGBC (Indian Green Building Council) for the developing country were analyzed during this paper. The results indicate that BREEAM, LEED, and DGNB are used since late the 2000s whereas GRIHA and IGBC remain in its earlier stages. Though these five rating systems were initiated totally different in several contexts with different standards, Indoor Environment Quality, Energy, and Material are core common categories for all. Environmental issues are the main focus in New Construction manuals. Further in-depth analysis is anticipated to focus additional on economic and institutional factors to enhance the potential of green rating systems for sustainability assessment purposes.***
Keywords: GRIHA, IGBC, BREEAM, LEED, DGNB, Green Rating System, Sustainability, Green building.

I. INTRODUCTION

The construction business plays a vital role in satisfying the requirements of society, enhancing the standard of life, and conducive to the economic process of a country. However, it has been heavily criticized for being a significant contributor to carbon emissions, environmental degradation, and global warming because of its utilization of an outsized proportion of natural resources and energy consumption. The building sector consumes a third of worldwide resources, one-sixth of worldwide freshwater withdrawals, twenty fifth of wood harvested, and four-hundredth of all raw materials. About 100% of all global energy supply takes place throughout the manufacturing of building materials. Also, the building sector generates an outsized quantity of construction and demolition waste, accounting for four-hundredth of total solid waste in developed countries. Moreover, the construction business is liable for major energy consumption, accounting for 40-50% of all energy usage and anthropogenic greenhouse gas emissions globally [T. blankendaal et al (2014)].

Recognizing the importance of sustainable building practices, “going green” and “environment sustainability” has been introduced for several years. However, construction remains a serious energy consumer based on official statistics [J.K.W wong et al (2015)]. This might be due to the passive perspective of construction practitioners towards adopting sustainable solutions. Facing rising energy prices and growing environmental issues, the demand for sustainable building facilities with least environmental impact has been pushed recently [F. jalaei et al (2015)].

Authorities and organizations initiated the rating systems for green buildings to minimize/ optimize the consumption of natural resources and control pollution. Buildings certified by those rating systems are considered as exhausting less energy, providing an improved living surroundings and conducive to the general reputation of the property [S.M Yu et al (2011)]. Probable there are about 600 green rating systems globally. BREEAM (Building research establishment Assessment Method) is understood as the first rating tool to assess building performance based on bound target values for various criteria [S. vierra (2011)]. additionally, various schemes like the United States' LEED (Leadership in Energy and Environmental Design), Germany's DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen e.V.), Australia's green Star, Japan's CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), Singapore’ BCA (Building and Construction Authority) inexperienced Mark India’s GRIHA (Green Rating for Integrated habitat Assessment) and IGBC (The Indian green Building Council) scheme are presently being used to judge building performances. BREEAM certified buildings might consume 6-30% lower energy prices than noncertified buildings,

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whereas LEED-certified properties consume 18-39% lower energy usage than non-certified properties [L.M Mitchell (2010)]. However, the main target on green credentials proven like LEED misses the larger picture, sustainable aspect [J.H scofield (2013)]. This paper, therefore, focuses on certification systems because the tools for assessing and measure sustainability that has been specifically offered for new construction. The outline of this paper is as follows. In section two we study the literature review and understand the sustainable and green building. In section three we study the five well-known certification systems, specifically BREEAM NC in Europe, LEED-NC in the US, DGNB in Germany, GRIHA-NC and IGBC for new construction in India. Section four compares the above certificate systems employing a rating system, certificate process and criteria. Section five analysis the result and finally, section six concludes the paper.

II. LITERATURE REVIEW

According to Berardi (2010), and Runde et al (2010), the impact of sustainability can extend way on the far side green buildings within the close to future. Regarding this, all leading green building rating systems are ceaselessly change their criteria. LEED had a significant update in 2013 with LEED v4, and it simply updated its rating tools in mid-2016. Whereas the main update to BREEAM happened in mid-2014 with BREEAM UK New Construction. Though green building rating certifications are the main target of various researchers throughout the past twenty years, there is still no systematic review of the elaborated criteria and also the updated process of every classification system. Variety of papers targeted on the trend and credits in an individual rating tool, however, a comprehensive comparison of tools has not been established. As an example, Todd et al (2013) targeted on the global trends in LEED-NC and LEED-EBOM besides investigating the accomplishment of individual LEED credits. Cheng and Ma (2008) adopted data processing techniques to look at the link between LEED credits and climate factors. Whereas other researchers created comparisons among green rating schemes, studies to examine the update and also the international trend of these schemes together or research regarding their capability in promoting the sustainability are lacking. Lee et al (2008), for example, analyzed the energy use assessment of HK-BEAM, BREEAM, and LEED. Schwartz and Raslan (2010) examined the impact of building energy simulation tools on BREEAM and LEED ratings. S.T ng et al (2013) tried to search out the properties and standards of various building environmental assessment ratings on evaluating carbon emissions.

A. Green vs Sustainable Building

Green and sustainable building are used interchangeably, however, these two terms are far away from synonymous. R.J Cole (2006) delineate green as “building design strategies that are less environmentally and ecologically damaging than typical practice” in 1999. Whereas Kua et al (2002), and J. Yoshida et al (2010) outlined green building as “one that meets certain criteria for environmental performance”. In 2008, it had been indicated that green is “a term encompassing methods, techniques, and construction products that are less resource-intensive or pollution producing than regular construction”. J.C Howe (2010) elaborated it as victimization land and energy with efficiency, protective water and alternative resources, rising indoor and outdoor air quality, and increasing the utilization of recycled and renewable materials. The idea of green building has been regularly revised and its definition is often accepted as “providing individuals with healthy, applicable, economical space and natural harmonious design with the utmost savings on resources (energy, land, water, and materials), protection for the setting and reduced pollution throughout its whole lifecycle”. The definition of sustainability has conjointly suffered from ambiguity and uncertainty. New definitions incorporating over 100 ideas are given. One of the earliest of its definitions was given by Brundtland Commission (1987) that expressed that “sustainable development is a development that meets the requirements of the current without compromising the flexibility of future generations to satisfy their own needs”. Though sustainability has been outlined regarding various aspects, environmental, social, and economic impacts are its three main pillars. Recently, the fourth pillar, the institutional dimension, has gained increasing recognition. The institution was introduced as the fourth pillar in 1995 by the Commission on Sustainable Development. It’s outlined as “the results of social processes, like communication and co-operation, leading to info and systems of rules governing the interaction of members of a society”. It’s clear that the ideas for each green and sustainability are straightforward and can be thought of obscure in the starting. However, they'll be clarified very well step by step. It’s noticed that though the definition of green has still been developing, the surroundings is usually its core. Whereas, sustainability can be thought of like a non-stop development idea reckoning on sustainable building practices. This is often because sustainability is multi-interpretations and a knowledge base thought, and therefore the difference in current sustainable construction practices is happening because of the various ideas of sustainable construction among countries. J. Wangel (2016) declared that sustainability ought to be a normative idea established for a specific purpose than shaping inductively. Chari et al (2012) believed that sustainability may embrace all aspects of human action, and Yanarella (2002) considered it as an idea tied to the entire systems.

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Up to date, green (GRE) buildings embrace environmental enhancements whereas sustainable buildings concentrate on four main pillars, as well as environmental (ENV), social (SOC), economic (ECO), and institutional issues (INS), see Figure-1. With the continuous update on the definition, it's anticipated that more and more pillars are established to assess the sustainability of building practices.

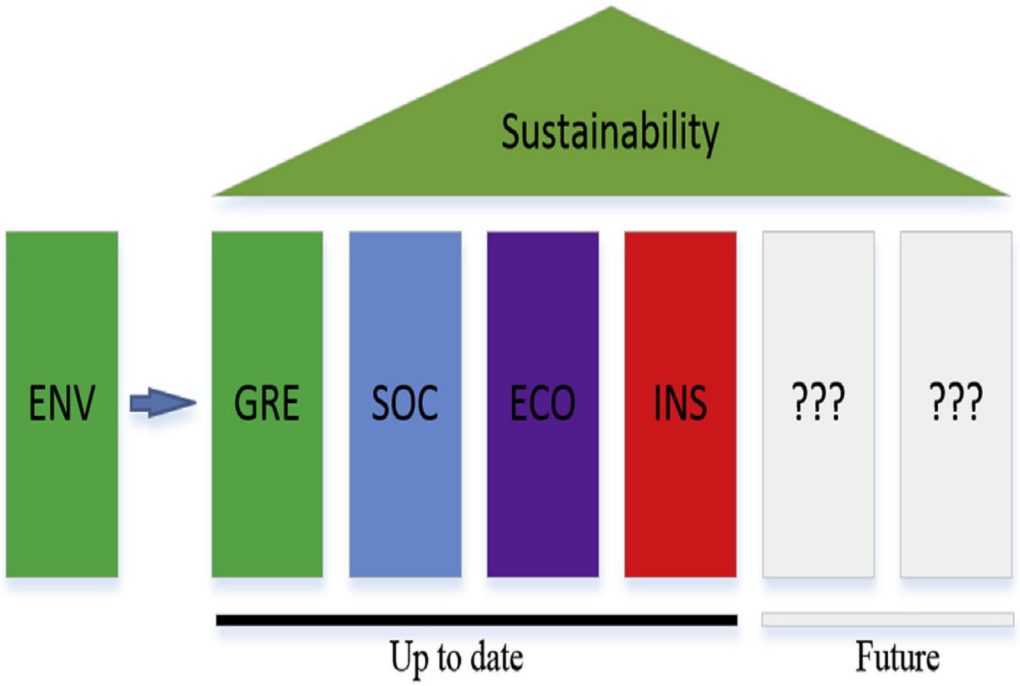


Figure-1 Sustainable framework

III. GREEN RATING SYSTEM

During this study, BREEAM, LEED, DGNB, GRIHA & IGBC, were analyzed intimately. The principle to select these rating systems is predicated on considering BREEAM, LEED, and DGNB as globally well-known leading ones alongside GRIHA and IGBC as a national rating system, which in comparison is a comparatively new system that has recently released its latest version.

A. Breeam

BREEAM is seen as the initial green building rating assessment within the world, launched and operated by BRE (Building Research Establishment) within the UK. It had been introduced to the market in 1990 and was first revised to assess offices in 1993. It's widely accepted that nearly all later major green rating systems like LEED, Green Star, and CASBEE are below the influence of BREEAM. BREEAM is widely used because of its flexibility. It does not solely assess native codes and conditions however conjointly permits application in international buildings. Additionally, BREEAM permits evaluation of a building's lifecycle visible to design, built, operation and refurbishment; BRE provides New Construction, In-use, improvement and Fit-Out, Communities, and Infrastructure manuals for planners, native authorities, developers, and investors. BREEAM certifications account for eightieth of the European market share for property building certifications. Though all of the sustainability pillars can be assessed by BREEAM, the environmental issue remains predominant with eight main categories together with Management, Energy, Transport, Water, Materials, Waste, Land Use & Ecology, and Pollution.

B. LEED

LEED is a voluntary customary developed by USGBC (US Green Building Council). It had been first launched in 1998 with a pilot version (LEED 1.0). Though it had been released after BREEAM, it's considered as the most widely adopted rating scheme over the globe. Like BREEAM, LEED predominantly evaluates environmental factors together with Sustainable Sites, Water Efficiency, Energy and Atmosphere, Material and Resources, and Indoor environment Quality categories. All of the building's lifecycle can be evaluated based on the standards from Building Design and Construction, Interior design and Construction, Building Operations and Maintenance, Neighborhood Development manuals.

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C. DGNB

The DGNB (GeSBC- German sustainable Building Certificate) scoring system was founded in June 2007 by the German Federal Ministry of Transport, Construction and Urban Development. The certification was introduced to the real estate market in Jan 2009. The DGNB scoring system is split into process quality, technical quality, ecological quality, economical quality, and social quality. Purpose of the DGNB certificate is that the application for buildings of any kind like offices, high-rises, detached residential homes, infra-structure buildings etc. The goal of the rating system is to make living environments that are environmentally compatible, resource-friendly, and economical which safeguards the health, comfort and performance of their users.

D. GRIHA

GRIHA (Green Rating for Integrated Habitat Assessment) is the Indian national green building rating system. It had been developed by TERI (The Energy and Resources Institute) in 2007. This rating system is split into: sustainable site planning, health and well-being, building planning and construction, energy: end use, energy: renewable, recycle, recharge and recycle of water, waste management, and building operation & maintenance, and innovation points. A building is assessed supported its foreseen performance over its entire life cycle — from beginning to operation. The stages of the life cycle that are known for evaluation are pre-construction, building design, and construction, and building O & M (operation and maintenance). The problems that are addressed in these stages are as follows.

1) Pre-construction stage (intra- and inter-site issues)
2) Building planning and construction stages (issues of resource conservation and reduction in resource demand resource utilization potency, resource recovery and recycling, and provisions for inhabitant health and well-being). The prime resources that are considered during this section are land, water, energy, air, and green cover.
3) Building O&M stage (issues of O&M of building systems and processes, observance and recording of consumption, and inhabitant health and well-being, and also problems that have an effect on the world and native environment).

E. IGBC

The IGBC also called LEED India green building rating system was developed in October 2006. The IGBC rating system is classified into sustainable sites, water potency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design and regional priority. This assessment tool is developed for new construction, existing buildings, commercial interiors, core and shell, homes, neighborhood development, school, and retail. It uses a straightforward checklist format to rate building performance.

IV. RESEARCH METHODOLOGY

This research used a two-step approach to review green certifications comprehensively, see Figure-2.

A. Initially, a scientific desktop search was dole out via major scientific databases namely, Scopus and Web of Science (WOS), Science Direct, Google Scholar, to spot the relevant journals for this study. To narrow the chosen journals that published several relevant papers, search keywords, including “LEED”, “BREEAM”, “DGNB”, “GRIHA”, “IGBC” “Green Building”, and “Sustainable Building” were used. Journals publishing the largest variety of papers in these fields were known as Energy and Buildings (E&B), Building and environment (B&E), International Journal of Sustainable Building Technology and Urban Development (SBT&UD), Environmental Impact Assessment Review (EIAR), and Renewable and Sustainable Energy Reviews (R&SER). The aim of this first step is to a) observe the development of green rating systems, b) determine how they're widespread within the research, c) discover which rating is additional globally recognized, d) find the countries concerning regarding green building.

B. During a later step, solely latest or upgraded manuals of BREEAM, LEED, GRIHA, IGBC and DGNB were examined to see their developments, similarities, and variations beside their strengths and weaknesses to see their support to sustainability. New Construction manuals and was investigated and compared in this paper. New Construction manuals represent for a replacement individual building assessment steering. The comparison of chosen five rating system is based on their background, certification statistics, rating level, and their category criteria and sub criteria etc. Base line for comparison is based on GRIHA rating system so that similarity and differences can be find out on common categories point.

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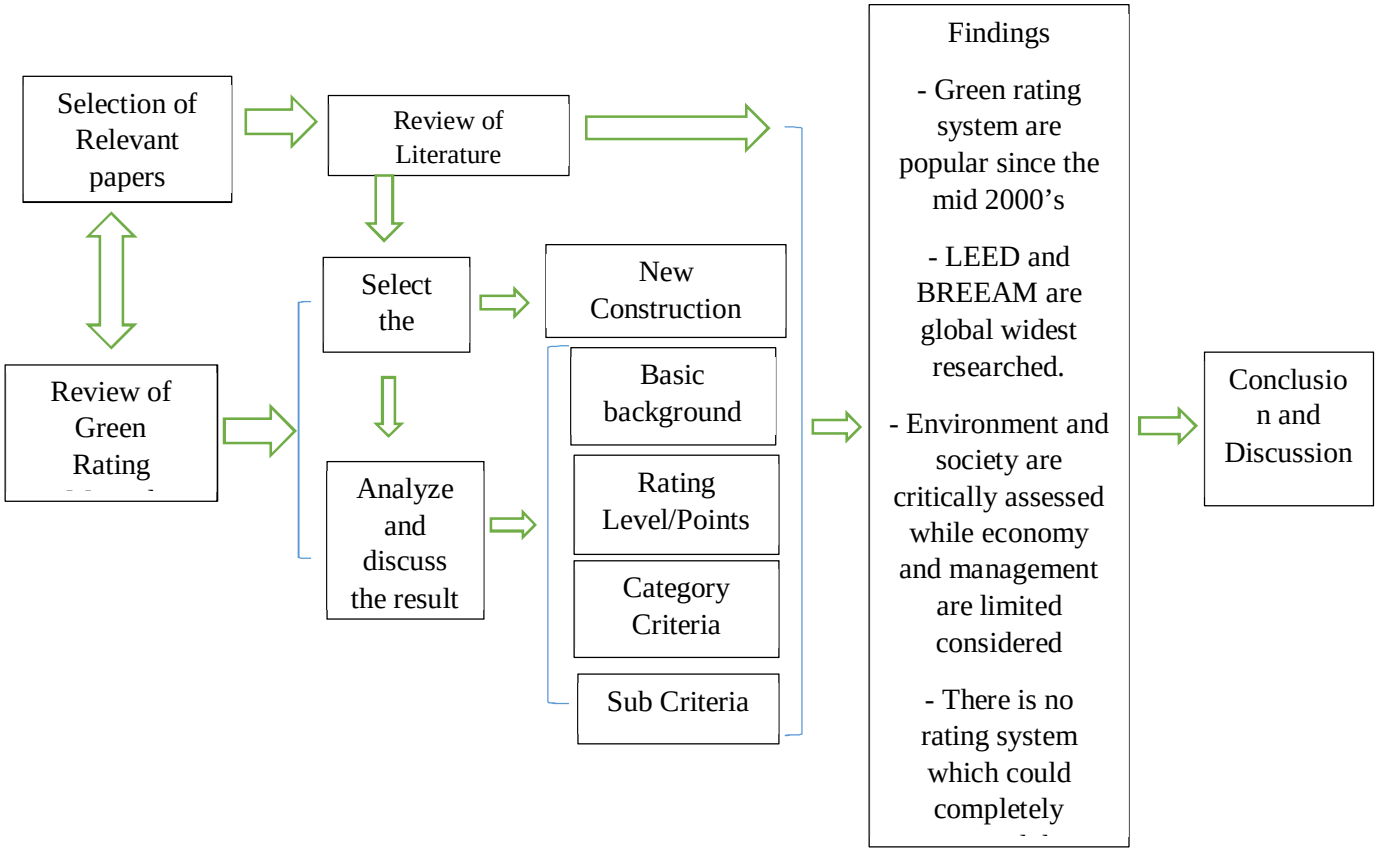


Figure-2 Methodology Steps

V. RESULT AND ANALYSIS

This section is dedicated to the comparison and evaluation of certification tools on the basis of their rating level, category comparison and criteria comparison of the chosen rating system. It is worth mentioning that this comparison does not mean to select the best certification system or recommend one of these five to be applied as a global standard; on the contrary, it intends to study and compare the features of these certification tools in order to indicate the advantages, disadvantages, and the unique features of each. Table 1 shows the overall characteristics of these five certification systems.

A. Comparison in rating level

As far as rating system is concerned, three major differences can be noticed between certification systems. The first difference is related to the weight that each criterion has for scoring. In DGNB, this weight, which is indicative of the significance of each criterion, is considered 1 to 3 for each criterion. Each main group also has a weight (DGNB has 5 main groups); for the existing main groups, this weight equals 22.5% (except the process quality which has the weight of 10%). In BEEAM, not only are the weights of criteria different, they also vary based on different locations - the nine English Regions (in general, the weight is considered between 0.5 and 1.0). Apart from this, the main groups don't have a specific weight (BREEAM has 8 main groups). LEED rating system is mostly similar to BREEAM in that the criteria have different weights based on their importance. However, main groups don't have specific weights individually; in fact, the number and weight of the existing criteria in each group determine its weight. In the Figure-3, the main groups and their

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	GRIHA	IGBC	LEED	BREEAM	DGNB
Origin	India	India	US	UK	Germany
Established	Nov 2007	Jan 2007	1998	1990	2007
Responsible	TERI and MNRE	India Green Building council	US Green Building Council	BRE Global	DGNB and BMVBS
Countries that used the certification system	India	India	Argentina, Canada, Chile, South Korea, India, Italy, Jordan, Mexico, Norway etc.	UK, Netherlands, Norway, Spain, Sweden and other countries	Germany, Austria, Bulgaria, Switzerland, Thailand
Types used in this Paper	GRIHA version 2015 for new construction	IGBC for new construction	LEED US Version v4	BREEAM for new construction	DGNB for New construction
Scheme	Voluntary	Voluntary	Voluntary, consensus based, and market driven, Performance based	Voluntary	Voluntary
Number of certified buildings in total	208* (registered so far)	250 certified buildings and 1116 registered building so far	7052 certified buildings within US	115000 Certified Building, and 7000000 homes and building registered	260 certified building
Groups of criteria	Site Planning, Construction management, Energy, Occupant discomfort and well-being, Water, Sustainable building material, Solid waste management, Socio economic strategies, Performance monitoring and validation	Sustainable architecture design, Site selection and Planning, Water Efficiency, Building material & resources, Indoor environmental quality, Innovation & design process	Integrative process, Location & Transportation, Sustainable sites, Water efficiency, Material & resources, Energy & Atmosphere, Indoor environmental quality, Innovation, Regional priority	Management, Health and Well Being, Water, Energy, Materials, Transport, Waste, Land use and ecology, Pollution, Innovation	Economical quality, Ecological quality, Process quality, Socio-cultural functional quality, Technical quality, Site quality
Rating system	1 star (25-40) 2 star (41-55) 3 star (56-70) 4 star (71-85) 5 star (86-100)	Certified (50-59) Silver (60-69) Gold (70-79) Platinum (80-100)	Certified (50-59) Silver (60-69) Gold (70-79) Platinum (80-100)	Unclassified (Less than 30%) Pass (30%-44%) Good (45%-54%) Very Good (55%-69%) Excellent (70%-84%) Outstanding (85%-100%)	Bronze (0%-34%) Silver (35%-49%) Gold (50%-64%) Platinum (65%-100%)

Importance are shown for each certification system.

Table-1 overview of GRIHA, IGBC, LEED, BREEAM and DGNB

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B. Rating Levels

As far as the classification system is concerned, three major variations are detected between certification systems. The primary difference is expounded to the weight that each criterion has for evaluation. In DGNB, this weight, which is indicative of the importance of every criterion, is taken into account one to three for each criterion. Each main group conjointly incorporates a weight (DGNB has five main groups); for the present main groups, this weight equals 22.5% (except the process quality that has the weight of 10%). In BREEAM, not solely are the weights of criteria completely different, they conjointly vary supported different locations - the 9 English Regions (in general, the weight is taken into account between 0.5 and 1.0). Aside from this, most groups don't have a particular weight (BREEAM has eight main groups). LEED rating system is generally similar to BREEAM therein the criteria have totally different weights based on their importance. However, main groups don't have specific weights individually; in truth, the number and weight of the prevailing criteria in every group determine its weight. In GRIHA and IGBC equal points are given on every criterion therefore the there's no distinction in weight (weight of every criterion counted from the total a hundred points). Within the figure three, the main groups and their importance are shown for every certification system.

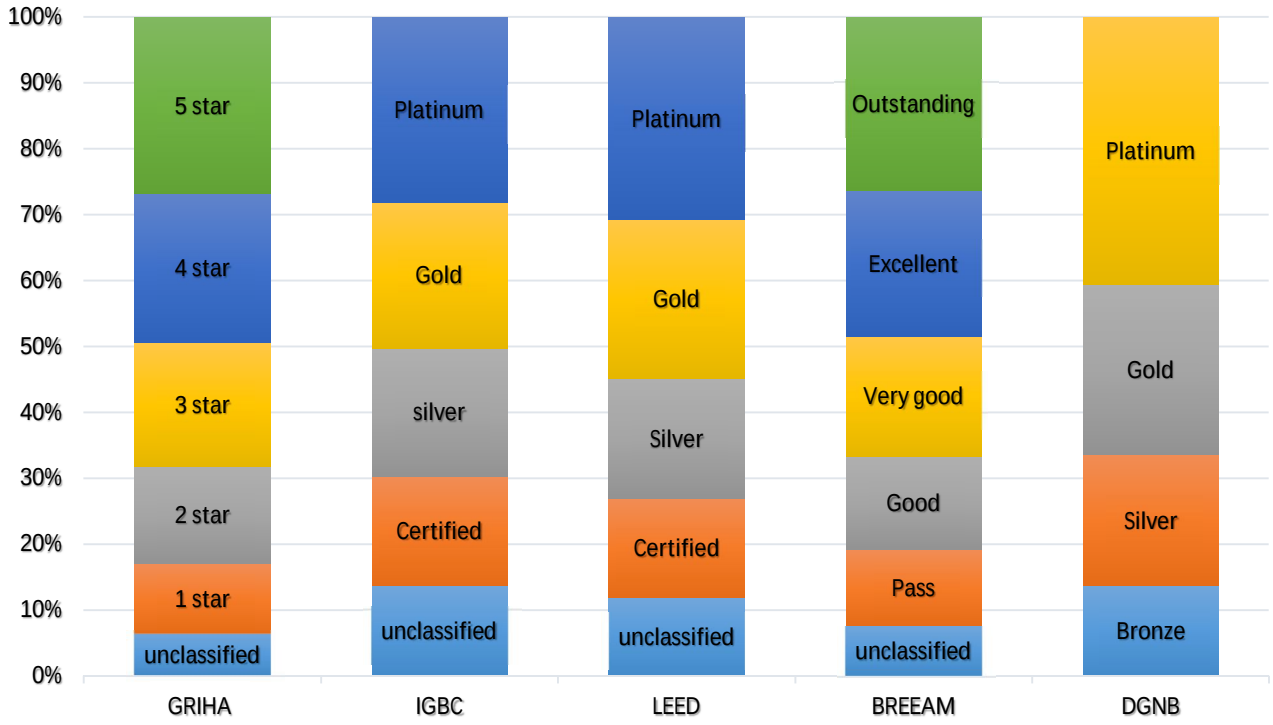


Figure-3 Comparison of rating levels

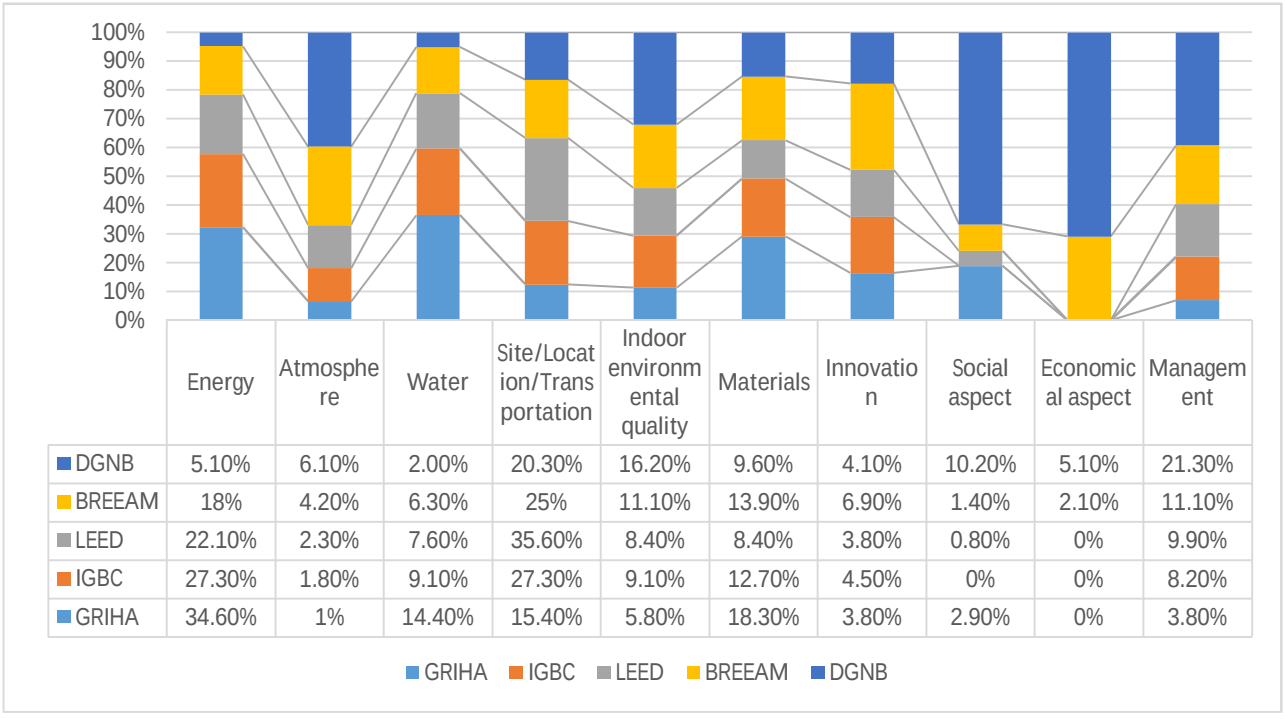
The second distinction is in the "minimum gained score". This issue is outlined as pre-requirements in LEED, and as necessary credits in BREEAM, GRIHA and IGBC; it implies that a number of the criteria are necessary and gaining the minimum score in them is important in all projects. This ensures the existence of some elementary components within the project. There are not any mandatory criteria in DGNB; the minimum gained score is taken into account in every main group. The final rating of the project depends on the final gained score moreover as this issue. As a result, a minimum quality level is guaranteed for all the elements of the project.

The third and last distinction in rating systems of the certification tools is related to totally different rating levels. The subsequent figure shows the rating levels for BREEAM, LEED, GRIHA, IGBC and DGNB: according to the figure three, DGNB is usually the strictest regarding certifying projects, and then comes LEED and IGBC then GIRHA and at last BREEAM. However, BREEAM uses the most labels for certification; and ranking highest (outstanding for which special necessities are presented) in it's much more difficult than ranking highest in different certification systems (gold for DGNB; platinum for LEED). Overall, LEED and IGBC utilize an easier rating system than the other two certification systems; BREEAM and GRIHA stand in the middle and at last DGNB has the most complicated and strict classification system.

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C. Categories

Within the boundary of green building features every certification system has its own format and methodology of distribution of criteria and weighting so one on one comparison is quite complicated. Therefore, for the purpose of comparison of certification system the criteria and sub criteria are again re-categorized as per the criteria of chosen certification system and allotted values for the sub-criteria are converted into percentage to achieve better result. The common points of comparison are selected on the basis of GRIHA rating system because it is newly developed rating system for developing country. However some limitation are raised because of unassigned values for few of the important sub criteria, which cannot be weighted for example in LEED. So for effective comparison some more additional categories like social aspect, economical aspect and management are also included in comparison. For the purposes of comparing 'like for like' in terms of the certification systems, the values of certain sub-criteria within DGNB (e.g. quality of the location) have been scored, though DGNB doesn't truly include these scores when calculating a building's rating. The Figure-4 shows that GRIHA contributing more for energy efficiency, DGNB for Management, and LEED US and BREEAM give importance to site and transportation, whereas IGBC provides equal weighting to each energy efficiency and site and transportation. DGNB has less weightage on energy efficiency, whereas more focused on atmospheric/ environmental protection, social and economic aspects, and management comparative than other certification systems. Apart from energy efficiency, GRIHA emphasizes water and material efficiency. This variation in the prioritization of the weightings for the factors reflects however the criteria and sub-criteria are given totally different priorities in keeping with their importance to the given country. However, the distinction in weighting for green buildings depends upon the country's considered standard/baseline (for energy efficiency, water efficiency, material efficiency and different country codes), technological acceptance and affordability for the population and their behavior and native conditions.



	Energy	Atmosphere	Water	Site/Location/Transportation	Indoor environmental quality	Materials	Innovation	Social aspect	Economical aspect	Management
DGNB	5.10%	6.10%	2.00%	20.30%	16.20%	9.60%	4.10%	10.20%	5.10%	21.30%
BREEAM	18%	4.20%	6.30%	25%	11.10%	13.90%	6.90%	1.40%	2.10%	11.10%
LEED	22.10%	2.30%	7.60%	35.60%	8.40%	8.40%	3.80%	0.80%	0%	9.90%
IGBC	27.30%	1.80%	9.10%	27.30%	9.10%	12.70%	4.50%	0%	0%	8.20%
GRIHA	34.60%	1%	14.40%	15.40%	5.80%	18.30%	3.80%	2.90%	0%	3.80%

Figure-4 Comparison of sustainability categories

D. Credit Criterion

After comparing all the main categories it is necessary to compare credit criteria for each category so that advantages and disadvantages in each certification system can be highlighted. From Figure-5 it is clearly shown that energy is prioritize in all the rating system except in DGNB. Within this category, the credit criterion 'energy optimization' features powerfully through the reduction of standard energy use and then the increase of renewable energy to cut back environmental impact. In atmosphere criteria reduction of environmental impact in terms of depletion of ozone is prioritize in DGNB followed by BREEAM. Water conservation is the main concern of LEED US and BREEAM whereas water reusability is prioritize in GRIHA and IGBC. The selection of location is main feature of LEED US and DGNB whereas soil conservation is prioritize in GRIHA and BREEAM. GRIHA and IGBC is more focused on utilization of low volatile organic compound where as DGNB is on thermal comfort and BREEAM

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prioritize visual and acoustic management. IGBC produce priority to material recycle and utilization. The main aim of innovation criteria is to standardize the building through innovative design and also keep system low environmental impact with higher performance and human comfort level. BREEAM priorities this criteria. Health, safety and quality life is prioritize in DGNB followed by GRIHA. The reduction in building life cycle cost is also under the focus of DGNB and BREEAM. Planning quality is major concern of DGNB whereas LEED and GRIHA focused on air quality management.

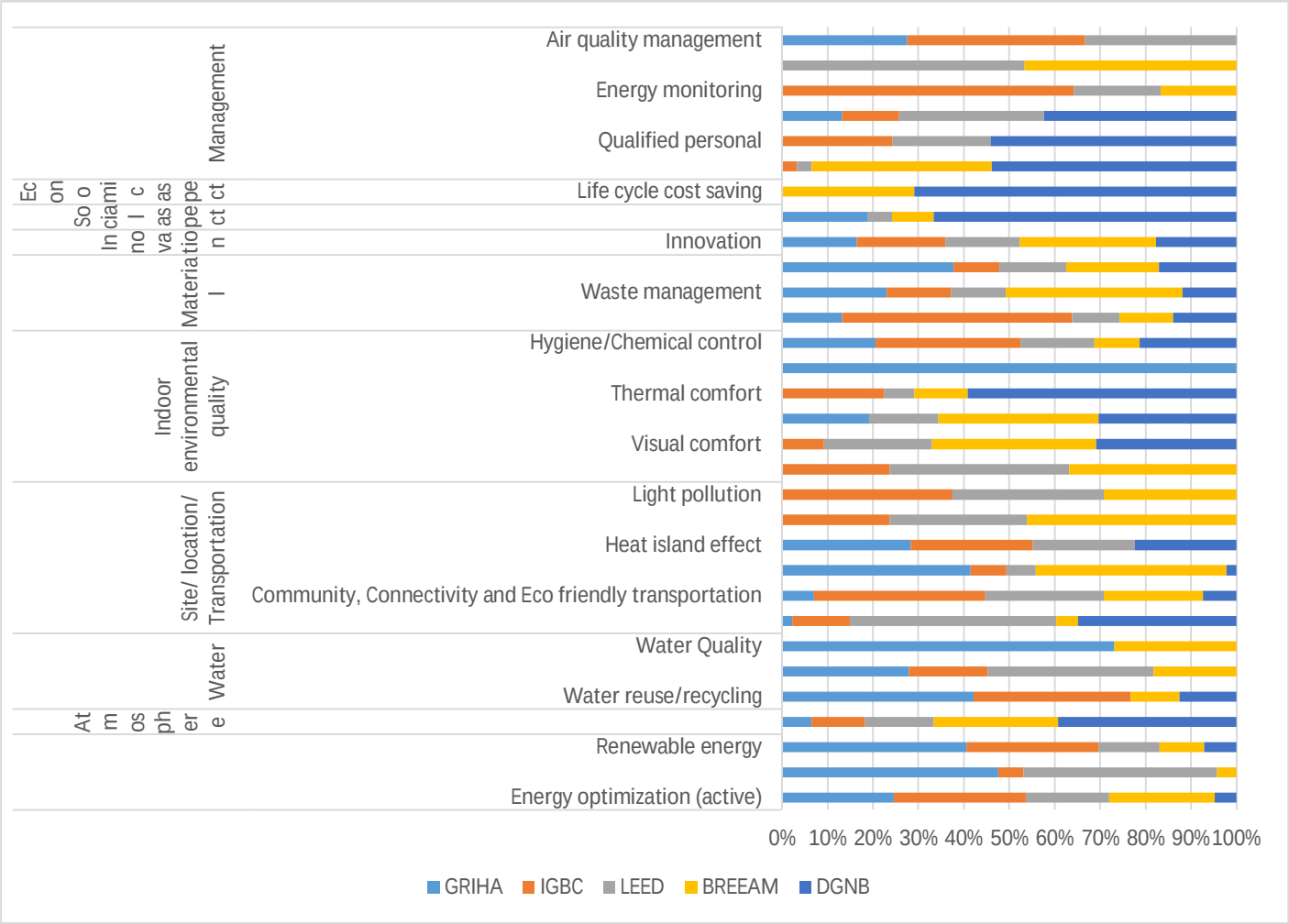


Figure-5 comparison of credit criteria of sustainable rating system

VI. CONCLUSION AND DISCUSSION

All of the building rating systems have evolved over the years and are updated to become more rigorous in line with technological advances. This paper aims to develop a systematic review of the development of green rating systems specializing in five well-known rating systems, specifically BREEAM, LEED, DGNB, GRIHA and IGBC, to 1) discover how interest and analysis in green rating systems have developed; 2) determine the similarity, difference, strength and weakness of green rating systems; 3) examine whether or not they totally assess the projects in all aspects of sustainability. The results indicate that green rating systems became the main focus point of assorted researchers recently. Green or sustainable building assessment is a global concern in each developed and developing countries. The similarity, difference, strength, and weakness of green rating systems were conjointly known supported the research manuals. The entire categories, sub-categories, points, and obligatory credits tend to extend an additional comprehensive so as to fully assess the sustainability of a project. BREEAM is taken into account because the strongest classification system within which environment and Society are rigorously assessed in conjunction with the consideration in Economy and institution. The weakest system can be GRIHA when it might solely concentrate on one pillar of the sustainability, environment. Whereas Society is critically evaluated by LEED; and IGBC is a well-balanced tool in environment, Society, and

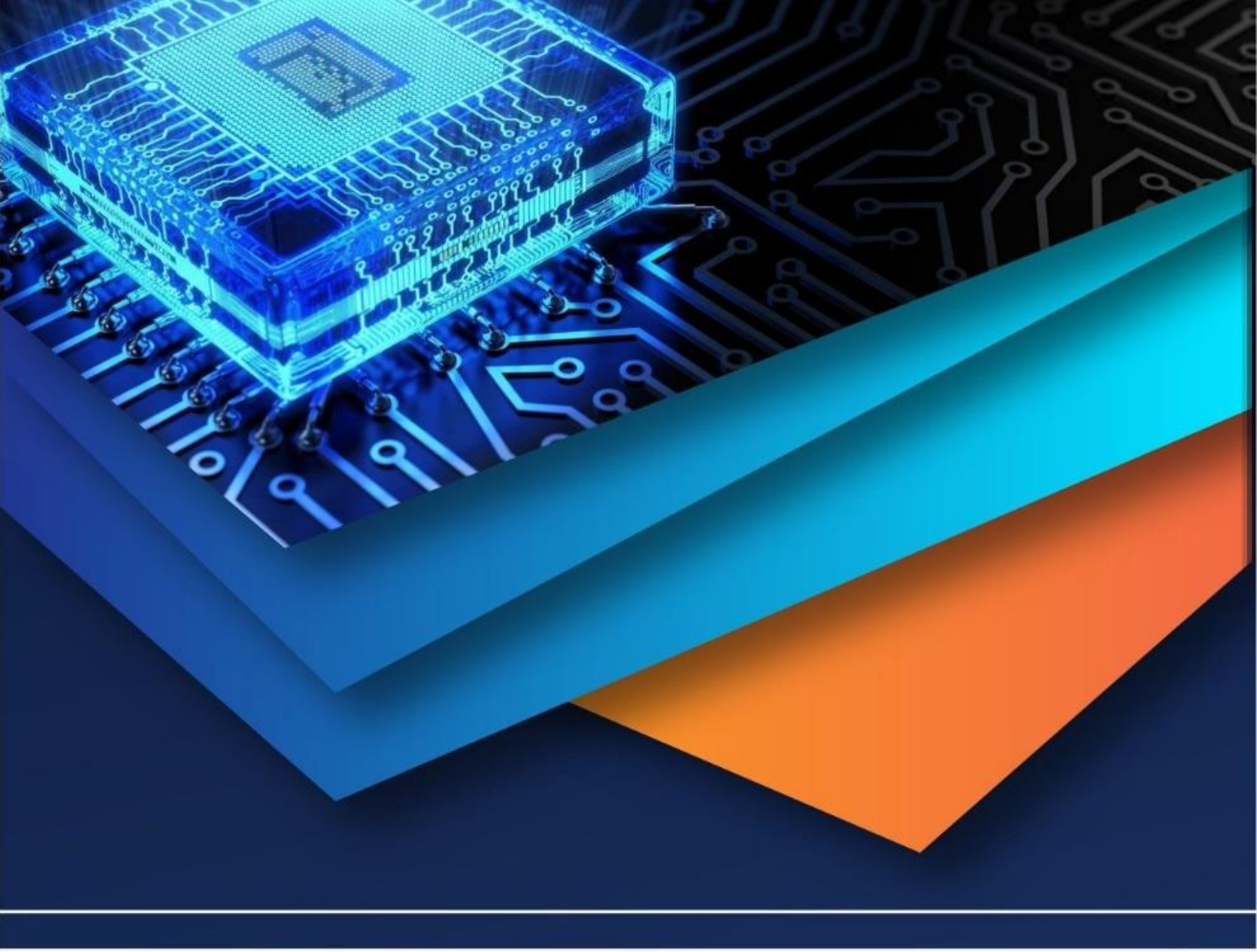
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Economy assessment. DGNB is most important rating system as a result of it satisfy the majority sustainability pillar except energy. However, no rating scheme may assess a project in all aspects of sustainability. This paper can be valuable for each green practitioners and researchers to possess an overall understanding of BREEAM, LEED, DGNB, GRIHA and IGBC. Categories, points, and obligatory credits were mentioned in details to pinpoint the present status/ tendency of the green building rating systems. Additionally, the strengths and weaknesses of every rating system were conjointly analyzed. Besides, the New Construction manual was conjointly examined to identify sustainable pillars can be assessed by these tools. It's suggested to incorporate Economic and Institutional factors as supplementary assessment criteria and manuals for green building rating systems for an additional comprehensive and thorough review of the project. Additional analysis is required to validate the impacts of adding Economic and Institutional factors to current green building certification systems. To provide more robust background knowledge of green rating systems, Interior design, Building Operation and different manuals ought to be examined, however, this analysis was solely considered one main manual, New Construction manual. Moreover, the examination within the five chosen rating schemes might not replicate the general trend of many schemes worldwide. These may be the constraints of this research.

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