Sustainability Compatibility in Building Rating Systems: A Critical Analysis

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Abstract: ***Over the past decade, advancements in the built environment have led to the development of numerous building rating systems focused on various aspects of sustainability. The Brundtland Report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," which emphasizes the importance of social, economic, technical, cultural, and environmental considerations in the building sector. This paper presents an extensive literature review of seven popular building rating systems—LEED (US), BREEAM (UK), CASBEE (Japan), GRIHA, LEED India, and IGBC—analyzing their macro areas and sustainability segments. It highlights the need for a comprehensive framework to assess buildings in terms of overall sustainability and identifies gaps and opportunities for improvement.***

Keywords: Building Rating Systems, Sustainability, LEED, BREEAM, CASBEE, GRIHA, LEED, IGBC

I. INTRODUCTION

The building industry significantly influences resource consumption, from raw material extraction to construction and disposal phases, and is a major contributor to solid waste generation, environmental damage, and about one-third of global greenhouse gas emissions [1], [2] . Effective policies are essential to mitigate the negative environmental impacts of construction. According to the UN (1992), addressing environmental issues alone is insufficient, as the construction industry must also ensure economic and social development. Buildings are crucial in meeting basic human needs by providing housing and social infrastructure such as schools and hospitals. The concept of sustainability in construction extends beyond environmental sustainability (Green Agenda) to include economic and social sustainability (Brown Agenda), emphasizing the improvement of quality of life for individuals and communities [3]. Given its significant role in sustainable development, the construction industry requires robust building codes, standards, and certification systems to effectively assess sustainability.

In recent years, awareness of sustainable construction has led to the development of various building performance assessment systems aimed at promoting and contributing to sustainable practices [4], [5]. Developed countries have established methods such as BREEAM (UK) and LEED (US) to evaluate building performance against specified sustainability criteria, focusing on maintaining living standards while minimizing resource depletion and environmental harm. Rating systems typically assess attributes like energy efficiency, water efficiency, material efficiency, indoor environmental quality, waste reduction, and optimization of operations and maintenance.

Conversely, in developing countries, where the average standard of living is lower and basic human needs are often unmet, there is a pressing need to address socio-cultural and economic sustainability alongside minimizing environmental impacts [6], [7], [8]. Many developing countries have recognized the need to create and implement diverse building assessment models tailored to their specific priorities for sustainable development and construction [6], [9]. This paper aims to critically review popular rating systems in developed countries and those used in India, evaluate their categories, assess their alignment with sustainability pillars, and identify potential sustainability gaps.

II. SELECTION CRITERIA OF RATING SYSTEMS

A. Review Stage

Seven building assessment systems were identified for evaluation: LEED (US), BREEAM (UK), CASBEE (Japan), GRIHA (India), LEED India, and IGBC (India). The majority of the data used in this review was sourced directly from the official websites of these certification organizations. Additional materials were gathered from previous scientific review articles and research papers. This paper focuses on evaluating the officially declared categories of these rating system frameworks.

The keywords used in the search primarily included terms such as "building rating systems," "sustainable building assessment systems," and "green building certifications." Secondary keywords like "green building" and "green certification" were also used, generating a broader collection of search results. The rating systems most frequently studied and appearing in the search results, as well as those widely used in various countries and India, were selected and are shown in Table 1 below:

Table I Selection Criteria of the rating systems

Rating System	Year	No. of Certifications	Countries	References
BREEAM, UK	1990	>550,000	80	[10], [11], [12], [13], [14], [15], [16], [17]; [18], [19]
LEED, USA	1994	>96,000	167	[20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
CASBEE, Japan	2001	>12,000	Japan	[6], [7], [31], [32], [33], [34], [35]
DGNB, Germany	2007	>5900	30	[36], [37], [38]
IGBC	2001	>780	India	[39]
LEED-INDIA	2006	>1,400	India	[22], [24], [25], [40], [41]
GRIHA	2007	80	India	[40]]

B. Category Analysis

Each rating system is defined by credits or weightages awarded based on specific building features, and certification is granted according to the total score achieved [41]. This study focuses specifically on credits related to new residential buildings. Table II presents the main and sub categories of the considered rating systems and their associated sustainability pillars.

Table II: Main and Sub Categories of the rating systems

CATEGORY	CASBEE	BREEAM	LEED US	LEED INDIA	DGNB	IGBC	GRIHA	Sustainability Pillar
Site								
Ecological aspects and soil conservation	×	×	×	×	×	×	×	ENVS
Local characteristics	×	×	×	×	×	×	×	ENVS
Hazards		×			×			ENVS
Site amenities	×	×			×			SCS
Urban Heat Effect	×					×	×	ENVS
Cultural heritage		×						SCS
Water								
Water quality uses and monitoring	×	×	×	×	×	×	×	ENVS
Water recycling systems	×	×	×	×		×	×	ENVS
Rainwater harvesting				×		×	×	ENVS
Effective water use fixtures			×	×		×	×	TS
Energy								
Energy use	×	×	×	×	×	×	×	ENVS
Energy monitoring	×	×	×	×	×	×	×	TS
Renewable energy production	×	×	×	×	×	×	×	ENVS
Comfort and safety								
Thermal comfort	×	×	×	×	×	×	×	SCS
Visual and acoustic comfort	×	×			×	×	×	SCS
Air quality and ventilation	×	×	×	×	×	×	×	SCS
Indoor pollutants	×	×	×	×	×	×	×	ENVS
Building amenities	×					×	×	SCS
Flexibility and functional adaptability	×	×			×			SCS
Disabled accessibility	×	×	×	×	×	×		SCS
Home office		×						SCS
Seismic aspects	×					×		TS
Safety and security aspects	×	×			×	×	×	SCS
Life-cycle costs		×			×			ES
Materials								
Eco-friendly/Sustainable materials use	×	×	×	×	×	×	×	ENVS
Life-cycle assessment		×			×			TS
Construction, segregation and demolition waste management		×	×	×		×	×	ENVS
Modular and standardized design	×					×	×	TS
Outdoor quality								
Global warming	×	×			×			ENVS
Heat island effect	×		×	×		×	×	ENVS
Pollutant emissions	×	×			×	×	×	ENVS
Noise pollution	×	×				×	×	ENVS
Light pollution	×					×	×	ENVS
Operational waste management	×	×				×	×	ENVS
Sustainable transport and mobility	×	×	×	×	×	×	×	SCS

Performance Monitoring & Validation							
Smart metering and monitoring						×	TS
Operation & Maintenance Protocols						×	TS
Performance Assessment for Final Rating						×	TS

**ENVS-Environmental Sustainability, SCS-Sustainability, ES- Economic Sustainability, TS-Technological Sustainability.*

The study summarizes the maximum achievable scores for the said building rating systems as follows:

- *LEED (US and India*): Grants up to 110 points, with the highest credits allocated to the "Energy and Atmosphere" category [42].
- *BREEAM:* Provides a maximum of 149 points, focusing solely on residential building items, with the "Energy" category receiving the most credits [43].
- *CASBEE:* Utilizes the BEE indicator, which assesses the ratio of "Building Environmental Quality & Performance" (Q) to "Building Environmental Load" (L). Each category, Q and L, can score up to 5 points, leading to a total possible score of 10 points. CASBEE assigns the highest credits to "Indoor Environment" in Q and "Energy" in L[44].
- *DGNB:* Equally distributes credits among ecological, economic, technical, and socio-cultural sustainability aspects. This system is comprehensive, with six macro-areas further subdivided and individually assessed [45].
- *GRIHA and IGBC*: Both Indian systems prioritize energy efficiency, followed by water management [19], [39], [40].

III. DISCUSSIONS

The analysis of the selected rating systems highlights their focus on four key subsets of sustainability: socio-cultural, economic, technological, and environmental. As illustrated by the radar chart (Fig. 1), most international and national rating systems, with the exception of DGNB, predominantly emphasize energy and environmental factors. This emphasis reflects a broad recognition of the urgent need to address environmental impacts and improve energy efficiency in building practices [4], [5], [6], [8], [9]. However, the limited attention given to socio-cultural and economic indicates a gap in addressing the comprehensive nature of sustainability. Socio-cultural sustainability, which includes community well-being, cultural heritage, and social equity, and economic sustainability, which involves cost-effectiveness and long-term economic viability, are crucial for balanced and holistic development. The insufficient emphasis on these areas may lead to an incomplete understanding of sustainability, potentially undermining efforts to improve overall quality of life and limit the long-term economic benefits of building projects.

DGNB distinguishes itself by offering a more balanced approach, integrating ecological, economic, technical, and socio-cultural aspects into its evaluation framework. This comprehensive perspective aligns with a broader view of sustainability that encompasses not only environmental performance but also economic and social dimensions essential for sustainable development.

The predominance of energy and environmental factors in other systems highlights the need for a more nuanced approach that equally values the socio-cultural and economic dimensions. Incorporating these aspects more thoroughly could enhance the effectiveness of rating systems in promoting truly sustainable building practices. Future efforts should focus on developing frameworks that balance these dimensions to better support sustainable development goals globally.

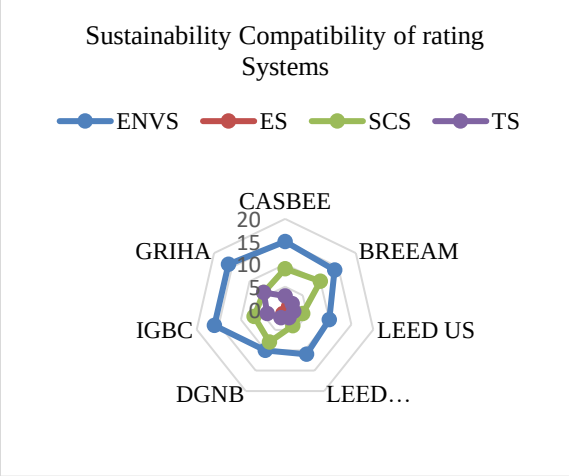

Fig1 Sustainability Compatibility of the rating systems

Social aspects of sustainability should address crucial issues like social care and community well-being. Key elements include equity, participation, and social cohesion [46], [47], [48]. Despite progress in

environmental sustainability, building rating systems often neglect the economic and social dimensions [19]. For instance, while LEED includes some social considerations, such as promoting walkable neighborhoods and proximity to public transit and amenities, these are not mandatory requirements. Important factors like social equity, local employment conditions, and overall safety are not consistently addressed [2], [49]. Moreover, LEED tends to underprioritize economic aspects and lacks a comprehensive evaluation of financial factors, which are essential for a balanced approach to sustainable development [23], [50], [51].

BREEAM, on the other hand, predominantly focuses on the environmental impacts of buildings. While this is crucial, the system often overlooks the social and economic dimensions of sustainability. Several studies have noted that BREEAM's narrow focus on environmental factors may limit its effectiveness in promoting a holistic approach to sustainability [14], [15], [17].

The limited attention given to socio-cultural and economic factors in these rating systems underscores the need for a more integrated approach to sustainability. Future rating systems should aim to balance environmental concerns with equal consideration of social and economic dimensions. By doing so, they can better support comprehensive, sustainable development that enhances the quality of life for all stakeholders involved.

IV. CONCLUSION

This study analyzed seven prominent building rating systems—BREEAM, CASBEE, DGNB, LEED (US and India), GRIHA, and IGBC—focusing on their macro areas to understand the critical aspects of building sustainability assessment. The analysis reveals that energy efficiency is the primary criterion across all rating systems, followed by indoor environmental quality, sustainable sites, and water and resource efficiency. Each system incorporates a range of environmental sustainability aspects, including life cycle assessment, material recycling and reuse, indoor comfort, heat island effects, and pollution control.

In developed countries, where basic human needs are largely met, rating systems like BREEAM and LEED-US have historically focused on maintaining living standards while minimizing resource depletion and environmental damage. These systems have set a benchmark for evaluating environmental performance. DGNB is notable for its broader approach, incorporating social, economic, and technological aspects of sustainability alongside environmental concerns.

In contrast, developing countries such as India face the challenge of addressing fundamental needs while promoting sustainability. Indian rating systems like GRIHA and IGBC highlight the importance of energy efficiency but need to broaden their scope to include socio-cultural and economic dimensions more comprehensively. This review underscores the urgent need for building rating systems, particularly in developing countries, to adopt a more holistic approach to sustainability. Incorporating socio-cultural and economic factors alongside environmental considerations is essential for creating balanced and effective sustainability frameworks. Future efforts should focus on developing and integrating rating systems that prioritize these dimensions, ensuring that sustainability principles are robustly applied to meet the diverse needs of communities and support sustainable development globally.

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