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Review Article

Comparative study on the green building rating system in developing and developed countries

Rohini Chhatrapati Kale[1]*, Mayur Shirish Jain[2]

[1]Geoenvironmental Consultant, Republic Industry for Sustainable Environment, Bhandara, 441802, India.

[2]Department of Civil Engineering, Indian Institute of Technology Indore, Simrol-453552, India

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CORRESPONDING AUTHOR*: E-mail: rohinikale28@gmail.com (R.C. Kale)*

Abstract

The building sector is one of the major producers of greenhouse gases and construction waste. In 2018, the construction industry produced 39% of carbon dioxide, 11% of the global CO_2 emission from building materials and construction, and 28% from building operations. Promoting green buildings can solve the increasing demand for infrastructural development in a fast-growing economy such asIndia. Green facilities worldwide, including India, are defined and certified by various green rating systems against different evaluation criteria. In this study, the most recent rating criteria for green buildings were addressed and contrasted, such as Leadership in Energy and Environmental Design (LEED) of USA, German Sustainable Building Council (DGNB) of Germany, Evaluation standard for green building (ESGB) of China, Green Star of Australia Green Rating for Integrated Habitat Assessment (GRIHA), and Indian Green Building Council (IGBC) of India, based on general factors, critical standard criteria, and triple-bottom-line. The study proves the equal importance of the three pillars of sustainability in an ideal green rating system. The study provides scope for policymakers to improvise and encourage the green rating systems to make them better suitable for builders to adopt.

Keywords: Construction, Green building, GRIHA

Abbreviations:

BREEAM - Building Research Establishment Assessment Method
CASBEE - Comprehensive Assessment System for Building Environmental Efficiency
CO_2 – Carbon-di-oxide
DGNB - German Sustainable Building Council
ECBC - Energy Conservation Building Code
ESGB - Evaluation standard for green building
GBRS – Green building Rating System
GHG- Greenhouse gases
GRIHA - Green Rating for Integrated Habitat Assessment
IGBC - Indian Green Building Council
LEED – Leadership in Energy and Environmental Design
PRS - The Pearl Rating System
SVAGRIHA – Simple Versatile Affordable Green Rating for Integrated Habitat Assessment
TERI – The Energy and Research Institute
USGBC – United States Green Building Council

1. Introduction

Forestry, water, ground cover, and energy are the main resources being drained for the building's development and proper functioning (Parikh, 2016). However, it is conceivable to create structures that may accommodate occupant needs while using less energy and resources while still providing the same level of comfort. The idea of "green buildings" was developed for the same purpose. Using an energy rating approach to examine buildings has become essential with the rise in the acknowledgment of sustainable development in the construction industry (Roderick et al., 2009). According to research, among other industries, building materials and construction are accountable for 11% of global CO_2 emissions (see Fig. 1) (IEA and UNEP, 2018).According to the study, the second-largest contributor of building waste and greenhouse gases (GHG) is the construction industry (CARB, 2021; Jain 2021). The process of making cement, a crucial ingredient in concrete, results in the release of CO_2 gas (Flower et al., 2007). Around the world, green buildings are graded utilizing various rating systems and assessment techniques. The rating systems are made to evaluate the green building's performance or design. Most of developing countries and developed countries have multiple green rating systems for evaluation. Hence, the users lack a standardized green rating system (Ahmed et al., 2019). While it is possible to draw another advanced country's rating tool, structure, and methodology. Each country has designed the GBRS according to the respective region, economy, and climatic pattern (Mitchell et al., 2010). This creates a need to evaluate the effectiveness of these rating systems.

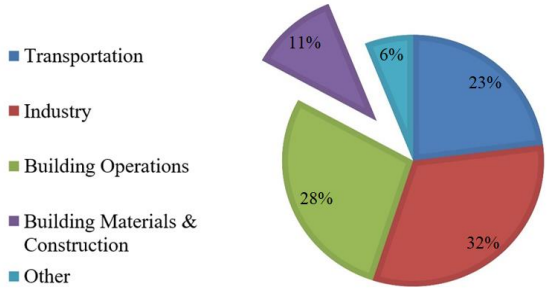

Fig 1. Global CO_2 Emissions by different sectors (IEA and UNEP, 2018)

The global building performance standard, or GBRS, was developed in several nations and focuses on a variety of construction-related issues, such as environmental considerations, building performance, user comfort, etc. The first green building grading system was BREEAM (Building Research Establishment Assessment Method), which was introduced in the UK in 1990. LEED (Leadership in Energy and Environmental Design), which was developed in the USA, then it was considered the industry standard. BREEAM also had an impact on the development of Green Star in Australia and CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan (Doan et al., 2017). Other rating systems, such as the ESGB (Evaluation Standard for Green Building), which was launched in China in 2006, the DGNB (German Sustainable Building Council), which was launched in 2007, and the PRS (The Pearl Rating System) of Estidama, which was launched by the Abu Dhabi government in 2010, turned their attention to factors related to construction management and life cycle assessment (Qadir et al., 2019).

The Confederation of Indian Industry (CII) established the IGBC (Indian Green Building Council) in India in 2001. In 2006, the council created LEED 2011 by modifying the grading system to fit the Indian context based on the CII-Sohrabji Green Business Centre, Hyderabad, the country's first LEED Platinum-rated green building (LEED India, 2011). Later, The Energy and Resources Institute (TERI) significantly contributed to reducing greenhouse emissions, reducing resource consumption, and promoting the use of renewable resources by the construction industry. This was made feasible by several activities that were crucial for mainstreaming and successfully implementing sustainable habitats. The Energy and Resource Institute (TERI) has more than 20 years of expertise in ecologically friendly and energy-efficient construction, and it was crucial in developing the Green Rating for Integrated Habitat Assessment (GRIHA), which the Indian government created as its National Rating System for Green Buildings in 2007 (Roy Varghese, 2015).

Rating systems have been more important in public policy over the past several years because of the government's incentive programs that encourage building ratings and enforcement in accordance with green building standards to stimulate the movement of green buildings. This necessitates the urgent need for a performance-based assessment system based on an appropriate green building code to guarantee that it is accomplishing its stated goals (CSE, 2021).

Many studies do not frequently consider the DGNB system of the German Sustainable Building Council, the Evaluation Standard for Green Building (ESGB) of China, and the Green Rating for Integrated Habitat Assessment (GRIHA) of India. These three rating systems have been chosen expressly to evaluate the variations in the rating systems in mature, developing, and rising economies. Furthermore, a lot of research did not compare the importance of the three sustainability pillars. There is a necessity to do a comparison study of the modern types of green building rating plans since a few new plans are developing and the existing ones are being periodically updated. The natural aspects of sustainability are often at the forefront in assessments of green buildings. To promote the creation of new evaluations, it is now required to determine whether social and economic issues should be taken into account in green building grading systems (Zhuo et al., 2014).

This study provides a relationship between six green building grading systems commonly used in America, Europe, Australia, and Asia using the most recent revisions of the accessible designs. This study aims to compare several green building rating systems, assess how each scenario categorizes features and categories, and assess how closely these plans correspond to the principles of sustainable development. This study's scope is limited to six green building rating systems: LEED (U.S.A.), DGNB (Germany), GRIHA (India), IGBC (Indian Green Building Council), ESGB (China), and Green Star (Australia).

2. Literature review

For enforcing sustainable development goals, the most pragmatic solution is green buildings. This presentation of a literature review is about sustainable development objectives and their emphasis on green building rating systems. The idea of construction in cooperation with the environment dates to the rise of humankind. In the early years, building designers or architects used local and natural materials to explore how natural elements such as wind, water, soil, and sun influenced their creations. However, the architects or engineers did not have an overview of the opposite side, which means how the constructed buildings would affect the elements and climate (Brown et al., 2008).

The three pillars of sustainable development—the environment, the economy, and society are referred to as the "triple-bottom-line" (Basiago et al., 1998). It is suggested that green buildings be used to lessen the overall effects of development on the economy, society, and the environment. Green building ratings have been devised to examine, classify, and rate green structures at various levels. These three pillars have been utilized in many certification systems. The three pillars are interdependent on one another. Most of the rating systems focused on environmental and technical factors initially. Nevertheless, social factors were introduced later as they were equally important. These methods offer immediate and long-term benefits to mankind, enhancing population health, safety, and well-being while preserving the environment. Utilizing green building rating systems, the triple bottom line concept will be included in the development of buildings.

A comparison analysis is the most appropriate method for assessing green building rating systems. As a result, a comparative analysis of different rating systems is used to evaluate them based on a variety of variables, including their history, the importance of the criteria, and sustainability considerations. It was discovered that different rating systems vary in terms of the primary elements (Mattoni et al., 2018). This credit structure's heterogeneity is a significant barrier to comparability. Due to the stark differences in green building grading systems' treatment of sustainability indicators, several important standards have been established and used as a starting point for comparative research. Energy conservation, water conservation, material conservation, interior environmental quality, site selection, and outside environment are the primary considerations. The Analytical Hierarchical Process (AHP) ranks the significance of common building elements in terms of their contribution to long-term sustainability (Verma et al., 2019).

Several comparative studies have identified certain crucial areas where green building rating systems need to be improved. Many projects that use energy efficiency as their primary criterion have been found to achieve only partially some of the SDGs. The literature usually emphasizes the need of addressing the environmental, economic, and social elements of green buildings. The differences between several grading scales that apply to the same circumstance must be compared.

3. Research methodology

This study analyses six green building rating systems used across the USA, Germany, India, China, and Australia. The rating

systems and their latest versions are used for the study. They are (a) LEED (USA): Building Design + Construction: New Construction and Major Renovation, version - 4.1 (LEED, 2019); (b) DGNB (Germany): New Construction, Buildings for international use, version – 2020 (DGNB System, 2020); (c) GRIHA (India): New Construction with area > 2500 m², version – 2019 (GRIHA India, 2019); (d) IGBC (India): Green New Buildings, version – 3.0 (IGBC, 2019); (e) ESGB (China): New Construction, version – 2019; (f) Green Star (Australia): Design & As Built, version – 2019.

Fig. 2 shows the research methodology used in the study. The comparison is made based on three factors: general, standard criteria, and triple bottom line. The following definitions of each sort of comparison:

Type 1 – General considerations, including history, certification level, and point distribution.

Type 2 – Common vital criteria such as water, materials, energy, site parameters and indoor environmental quality. The significance of these standard criteria is produced as graphs.

Type 3 – Triple-bottom-line comparison using Analytical Hierarchy Process (AHP) is made. The three pillars of sustainability, the environment, the economy, and social concerns, are each given a certain number of points in the ranking system. Their weighted percentages are contrasted and graphically represented.

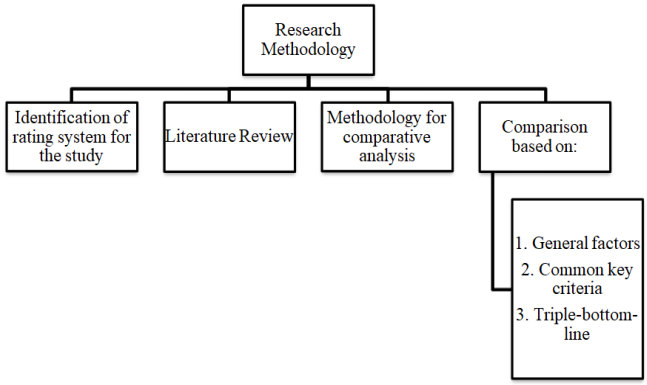

Fig. 2. Research methodology

4. Results & discussion

4.1 Comparison based on general factors:

One of the earliest green grading systems is LEED, created by USGBC in 1993. It follows 'Certified, Silver, Gold, Platinum' with 'Certified' as the lowest certification level with 40 – 49 points and 'Platinum,' the highest certification level with 80 above points. IGBC, formed in 2001, secured a license from USGBC to provide LEED certification in India, known as LEED – India. The rating system follows the certification level similar to LEED except for 'Super Platinum' that gives 'Global Leadership' recognition with 90 – 100 points. The German Sustainable Building Council (DGNB) was established in 2007 by 16 founders and worked with the Federal Ministry of Transport, Building, and Urban Affairs to create (BMVBS). The certification levels available are Bronze, Silver, Gold, and Platinum, with Bronze being the lowest and Platinum being the highest. In 2003, the Green Building Council of Australia (GBCA) introduced the Green Star environmental grading system. This rating system follows a star level rating system with 1 star for the achievement of 10 – 19 points as the lowest and six stars for 75+ points as the highest level of certification. GRIHA is India's other green rating system, and TERI developed it in 2005. It offers a five-star ranking system to categorize green buildings with 1 star at the lowest level with 25 – 40 points and five stars at the highest level with 86 + points. China's Ministry of Housing and Urban-Rural Development adopted the evaluation standard for green buildings (ESGB) in 2006. The rating scale uses a three-star system, with one star (50–59 points) representing the lowest rating and three stars (>=80 points) representing the highest. This analysis indicates that the certification level is different for each rating system. While LEED, IGBC and DGNB provide 'Certified' or 'Bronze' to 'Platinum' level, GRIHA, ESGB, and Green Star follow a star rating system. Each rating system has different upper and lower-level points for certification. Hence it is difficult to compare with points given to each system. Moreover, each rating system has undergone up-gradation to consider various indicators to evaluate green buildings. These indicators vary from one rating system to another and are difficult to compare.

4.2. Comparison based on common critical criteria

Energy-related factors are given a lot of weight in all rating systems, except for the DGNB system. This emphasizes important energy protection. Prerequisites outlined in the LEED USA, IGBC Framework, and Green Star grading systems ensure a minimum level of performance before credits are granted to any classification. Like the energy characteristic, except for the DGNB system, all other rating systems consider water-saving an essential criterion for rating (see Fig. 3). The same trend that is shown in the energy and water criteria is found in the material aspect of each of these rating systems. Here, DGNB is the rating system that provides the least priority to material handling and saving. DGNB and Green Star have given high priority to indoor environmental quality. Other rating systems also provide enough importance for indoor ecological quality making it an essential criterion for certification. The lower limit of scores needed to be achieved for certifying the structure in many rating systems may, in general, leave a critical piece of the sustainability targets unaccomplished. For example, the combined points needed for achieving a single category are more than those needed for certification. This could lead designers and builders to focus during certification on problems with higher scores while ignoring the other relevant areas.

4.3. Comparison based on triple-bottom-line

The three pillars of sustainability – environment, economy, and socio-cultural factors- have proven significant in the evaluation. Most of the grading systems taken into consideration in the study, as shown in Fig. 4, place a significant emphasis on environmental aspects while only minimally considering social and economic issues. DGNB system is the only rating system that provides equal importance of 22.5% to the three elements. Among the social and economic factors, the latter seems to be neglected by the different rating systems. While LEED, GRIHA, and IGBC give an average of 3.5% weightage, ESGB and Green star have not considered the factor in their rating system for evaluation. Other factors do not fall in any of the three elements, such as evaluation procedure, innovation, and design perspective, providing extra points to the users. DGNB stands out from other rating systems based on the comparison due to its detailed design and structure. The analysis also shows that GRIHA and IGBC of India are far behind considering social and economic factors. The data provides a vivid understanding of how each rating system has significance to sustainability.

5. Conclusions

The comparative study indicates that each rating system differs in its structure, indicators, and level of certification based on its specific requirements. Even with geographical differences, most rating systems give energy consumption critical significance. This could be due to its massive share in the daily operation and construction of the building by users across the globe. However, the triple-bottom-line comparison showed that most grading systems. The lack of importance given to social aspects and complete negligence of economic aspects surrounding a green building manifests the equal importance of the three pillars of sustainability in a green rating system.

Data Availability Statement

All data, models, and code generated or used during the study appear in the submitted article.

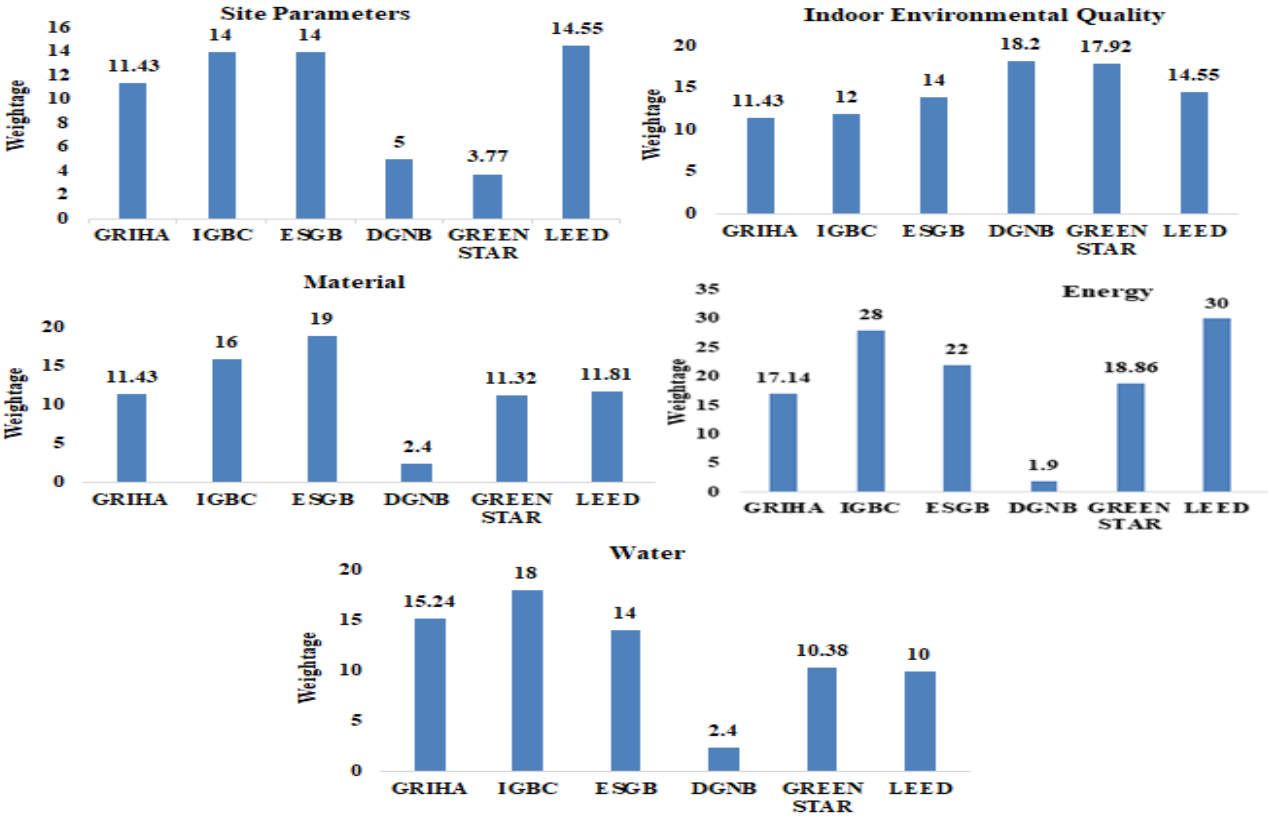

Fig. 3. Key standard criteria for comparison of rating systems

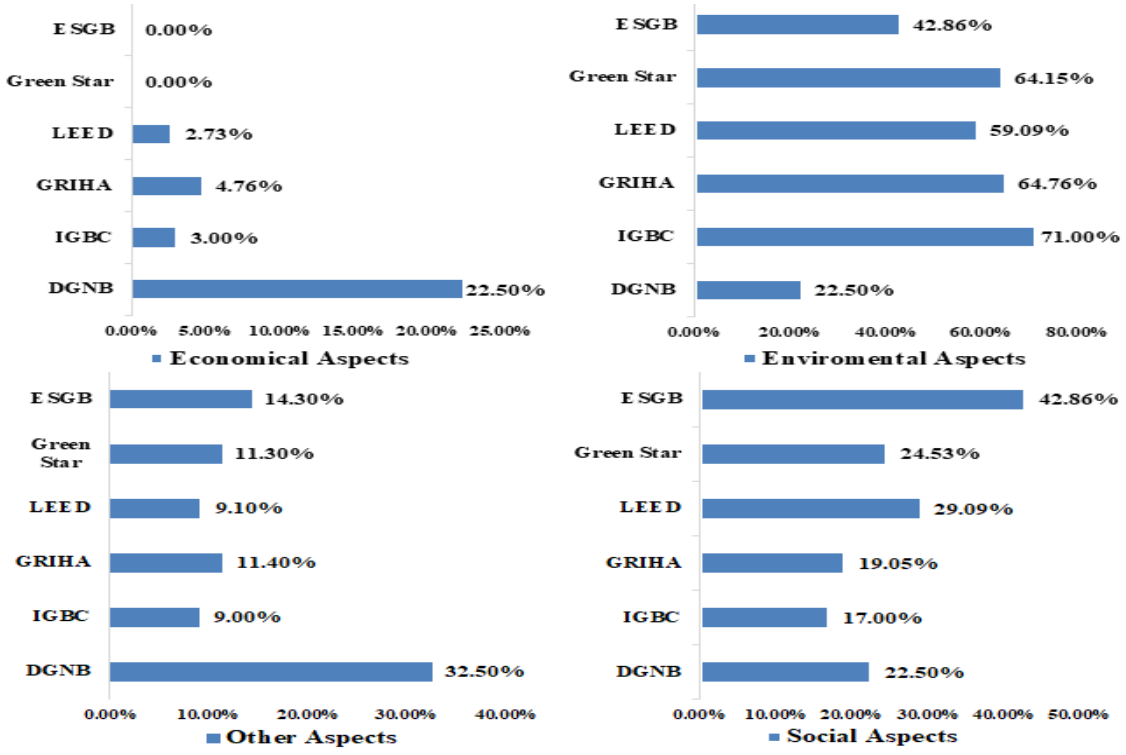

Fig. 4. Comparison of rating systems based on triple-bottom-line

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors Contribution

Rohini C. Kale: Data curation, Methodology, Writing – original draft. Mayur Shirish Jain: Conceptualization, Supervision, Writing - review & editing.

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References

Ahmed, M., Abul Hasan, M., Mallick, J. 2019. World Green building rating systems: a comparative study. In International conference CUM exhibition on building utilities, New Delhi, India.,Vol 8 Retrieved from https://www.researchgate.net/publication/315516234_World_Green_Building_Rating_Systems_A_Comparative_Study . (Accessed on 23 February 2022)

Basiago, A. D. 1998. Economic, social, and environmental sustainability in development theory and urban planning practice. Environmentalist *19*(2), 145-161. https://doi.org/10.1023/A:1006697118620

Brown, M. A., Southworth, F. 2008. Mitigating climate change through green buildings and smart growth. Environ. Plan A, 40(3), 653-675.

CARB's. 2021. Research on Green Buildings. Retrieved from https://ww2.arb.ca.gov/research/research-green-buildings (accessed on 18 February 2022).

Centre for Science and Environment. 2021. Green Building Rating: Overrated https://www.cseindia.org/green-building-rating-overrated-4009. (accessed on 18 February 2022)

DGNB e.V. 2020. Sustainable building gains momentum: another successful year for the DGNB – despite Covid-19. Retrieved from https://www.dgnb.de/de/aktuell/pressemitteilungen/2021/dgnb-successful-2020. (accessed on Jan 20 2022)

Doan, D. T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A., Tookey, J. 2017. A critical comparison of green building rating systems. Build Environ, 123, 243-260. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0360132317302937 (accessed on 15 January 2022)

Flower, D. J., Sanjayan, J. G. 2007. Green house gas emissions due to concrete manufacture. Int J LCA, 12(5), 282-288.

GRIHA V. 2019 A GRIHA Council Publication Volume 1 Introduction to National Rating System - GRIHA An evaluation tool to help design, build, operate, and maintain a resource-efficient built environment.

Indian Green Building Council. 2019. Indian Green Building Council Anuual Review 2018- 2019. Retrieved from https://igbc.in/igbc/html_pdfs/IGBC%20Annual%20Report%202019%20_.pdf (accessed on 19 February 2022).

International Energy Agency and the United Nations Environment Programme. 2018. Global Status Report: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/27140/Global_Status_2018.pdf (accessed on 27 March 2022)

Jain, M. S. (2021). A mini review on generation, handling, and initiatives to tackle construction and demolition waste in India. Environ. Technol. Innov., *22*, 101490.

Leadership in Energy and Environmental Design for India (2011). Green Building Rating System: For New Construction and Major Renovations. Retrieved from http://www.indiaenvironmentportal.org.in/files/LEED2011forIndia-NC.pdf#:~:text=The%20Indian%20Green%20Building%20Council%20%28IGBC%29%20is%20coordinating,buildings%20that%20deliver%20high%20performance%20inside%20and%20out. (accessed on 22 February 2021).

LEED (2021). Retrieved from https://www.usgbc.org/leed/v41. (accessed on 23 February 2022)

Mattoni, B., Guattari, C., Evangelisti, L., Bisegna, F., Gori, P., Asdrubali, F. 2018. Critical review and methodological approach to evaluate the differences among international green building rating tools. Renew. Sustain. Energy Rev, 82, 950-960.

Mitchell, L. M. 2010. Green Star and NABERS: learning from the Australian experience with green building rating tools. Energy Efficient Cities: Assessment Tools and Benchmarking Practices, The International Bank for Reconstruction and Development/The World Bank, Washington, DC, 93-124.

Parikh, P. R., 2016. Developing Green building concept in India. Int. J. Eng. Res. Appl, 4(1), 77-80.

Qadir, G., Haddad, M., Hamdan, D., 2019. Potential of energy efficiency for a traditional Emirati house by Estidama Pearl Rating system. Energy Procedia, 160, 707-714.

Roderick, Y., McEwan, D., Wheatley, C., Alonso, C. 2009. Comparison of energy performance assessment between LEED, BREEAM and Green Star. In Eleventh International IBPSA Conference (pp. 27-30).

Roy. K V, 2015. Sustainable Engineering. Kollam,kerala,India: Pentex.

Varma, C. S., Palaniappan, S., 2019. Comparison of green building rating schemes used in North America, Europe and Asia. Habitat Int., 89, 101989.

Zhou, Y., 2014. Comparison of Chinese Green Building Standard with Western Green Building Standards.

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