Comparative study on Indian building assessment tools and its limitations

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Abstract

Construction sector is one of the largest end users of environmental resources and one of the largest polluters of manmade and natural environments around the globe. Economic development, climate change due to greenhouse gas (GHG) emission, energy security and energy access are the primary concerns for India. Sustainable development in energy sector has become a concern for all the people in the world. It satisfies the need of its people without jeopardizing the prospects of the future generation. To minimize these effects, concept of Green Building has been introduced in the construction industry. To asses these building, there are various building assessment tools which have emerged globally. These assessment tools have been developed and used to assist planning and design of sustainable buildings. The aim is to develop complete environmental consciousness among construction specialists towards sustainable performance and to achieve the objective of sustainability in the construction sector. In this study, the assessment approaches towards environmental, economic and social aspects are discussed. The comparative study and analysis on these building assessment tools i.e. LEED-India, GRIHA and IGBC have been made. It is found that there may be inconsistence in the assessment tools and criteria. However, lack of fully integrated assessment tools has resulted in the lack of a holistic assessment approach for the building life cycle.

Keywords: *Energy in building, Pollution, Sustainability, Building Assessment Tools.*

Introduction:

The World is facing the problem of global warming in present situation. Economic development, climate change due to greenhouse gas (GHG) emission, energy security and energy access are the primary concern for India. Sustainable development has become a concern for all the people in the world. Sustainable society is the one which accomplishes growth of economic and damages to its environment in such a way that which cannot be repairable. It satisfies the need of its people without jeopardizing the prospects of future generation. Sustainability is associated with earth's capacity to sustain large human population of 7.2 billion and still rising. Managing the material resources in a sustainable fashion to achieve development goals with minimum or no damage to the environment.

According to World Commission on Environment and Development, sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1986). From a project development point, it is thus concerned with the effective utilization of resources and reducing adverse effects on the natural environment, in order to meet the requirements and needs of current and future generations. Sustainable buildings and sustainable building assessment have therefore gained significant attention in recent times. With the fast growth of sustainable assessment models and tools around the world, some criticisms have arisen as most of these models and tools only consider the environmental aspects and few of them incorporate the assessment to life cycle stages and their impacts. To make the assessment more adequate for the themes of 'sustainability', this research aims to develop an assessment model based on the building life cycle and take three pillars into consideration.

Sustainable development (SD) has drawn the attention of public and researchers since last century. Sustainability represents the interaction of environmental, economic and social aspects. With this concept, the triple bottom line (TBL) emerges from the assessment of environmental, economic and social values. This concept has been widely applied to the building industry. In environmental assessment, the life cycle assessment (LCA) and consumer-based approaches are discussed. In economic assessment, the life cycle costing (LCC) and other forms of cost estimating approaches are discussed. For social assessment, social impact assessment (SIA), social footprint, social benchmarking and other approaches are discussed.

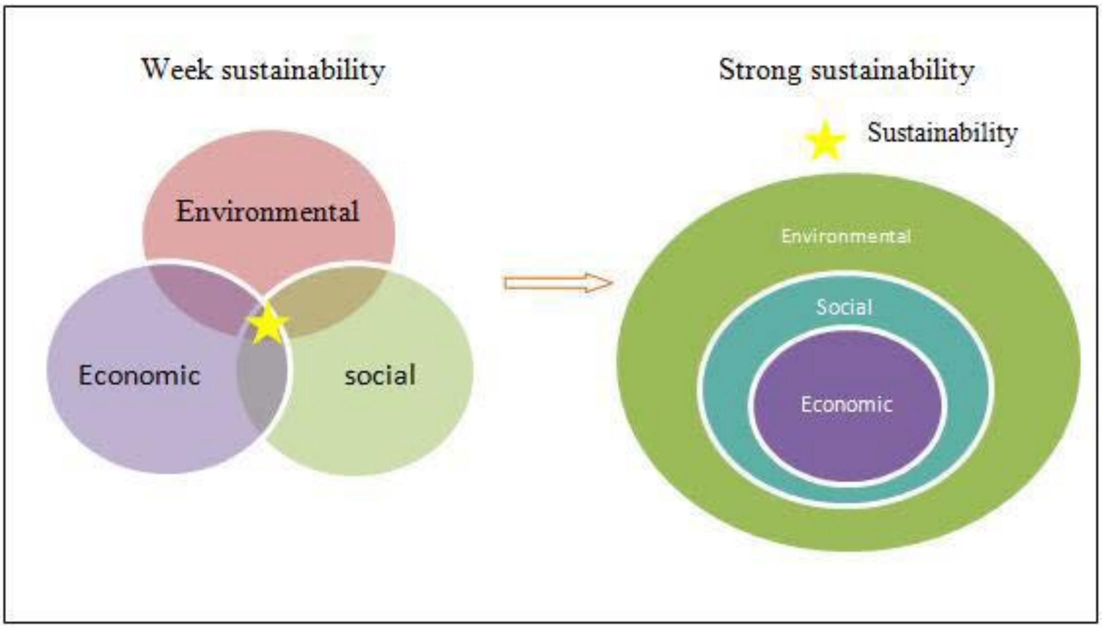
Construction industry is one of the major sources of environmental pollution. The environmental problems caused by construction range from energy and resource consumption to waste production throughout the building life cycle. Sustainable performance of construction projects is an indispensable aspect for a country to attain the goal of sustainable development. With increasing attention being paid to building sustainability performance, numerous environmental assessment tools have emerged worldwide. They have been developed and used to assist planning and designing of sustainable buildings, and help raising overall environmental awareness and achieving the goal of sustainability in the construction sector. In this study, the assessment approaches to environmental, economic and social aspects are discussed. The sustainable building and different building assessment tools are discussed, as well as the specific situation of environmental sustainable development in India.

The main aim of building assessment tools are:

- To evaluate different aspects of sustainability during the design, operation and demolition phase of building.
- To incorporate the best practices in reducing the negative impact of the building on the environment.

According to (Thomson *et al.*, 2011), increasing sustainability assessment of buildings is required for understanding the social, economic and environmental effects associated with the way that buildings and their support systems are designed, built, operated, maintained and ultimately disposed. However, the lack of fully integrated assessment tools has resulted in the lack of a holistic assessment approach for a building life cycle.

The Relationship of Three Pillars in Sustainable Development



Source: Hart 2000

Factors for assessing the building EES impacts

- Environmental – Energy and resource consumption, emission, land contamination, waste generation, water consumption, transport issue.
- Economic - Life cycle costing (LCC)

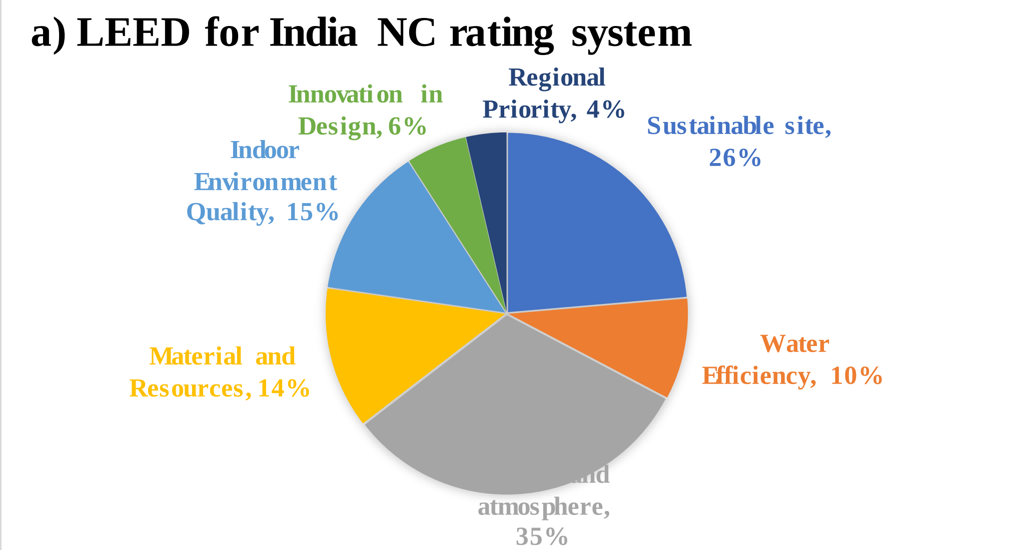
A procedure which facilitates comparative cost analysis and assessments to be made over a indicated span of time, considering account of all relevant economic aspects both in terms of primary costs and future operation costs.

- Social – Quality of the life, health and safety, community satisfaction, culture identity, surrounding environment, facilities.

Green Building Assessment Rating Systems in India – An Overview

LEED-2011 for India NC Rating System

The Leadership in Energy and Environmental Design (LEED) building assessment tool has been developed by the U.S. Green Building Council (USGBC) in 2000. The LEED India green building assessment tool was developed by IGBC (Indian Green Building Council) in October 2006. The LEED-2011 for India NC rating system is categorized into water efficiency- 9.1%,indoor environmental quality-13.63%, energy and atmosphere-31.82%, sustainable sites-23.63%, innovation in design -5.45% materials and resources-12.73%, and regional priority -3.64 %. The LEED assessment tool is developed for existing buildings, new construction, core and shell, school, commercial interiors, homes, community development and retail. This tool awards assessment of buildings as platinum, gold, silver and certified. It has a very simple checklist to assess the performance of building.



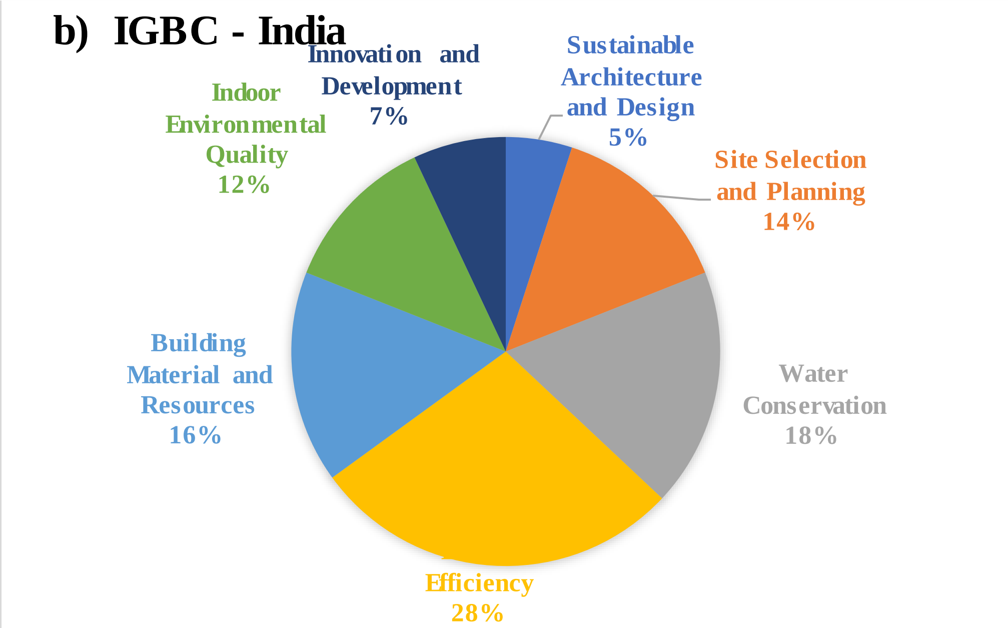
The assessment tool includes one criteria, indoor environment air quality (IAQ) management during building construction that clearly addresses safety and health of construction worker at site. The intention of this criteria is to prevent and protect the building workers and building occupants from indoor air quality problems throughout the process of construction or renovation process. On fruitful formulation, implementation and execution of an IAQ management policy, the project gets the LEED-NC certification, which is minor and thus underscores the minimum consideration that the assessment tool gives to safety and health of the construction worker. It should be consider and noted that other criteria within the assessment tool which are directed to improve the building workers health and safety and also for the end-user, such as the use of low- carbon emitting materials, may benefit the construction workers safety and health as well.

LEED is one of the most popular and worldwide recognized green building certification systems. Developed by the U.S. Green Building Council (USGBC) it includes a set of assessment for the plan, design, execution and control, operation, and maintenance of green buildings.

Leaders around the world have made LEED the most widely used third party validation for green buildings, with around 1.85 million SQF being certified daily. LEED India rating, which is for commercial buildings, forms about 25 per cent of total built-up area registered with IGBC for green building projects in India.

IGBC

The IGBC (Indian Green Building Council) part of the Confederation of Indian Industry (CII) was formed in the year 2001. It has setup the green new building core committee to develop the rating system. This committee comprised of stakeholders, developers architects, consultants, builders, manufactures , owners, institutions, and industry representatives. IGBC is categorized into energy efficiency -28%, building materials and resources -16%, water converation – 18%, site selection and planning -14%, indoor environment quality -12%, sustainable architecture and design 5% and innovation and development -7%. The main aim of the commitee is to facilitate a sustainable built environment for all and enable India to be one of the world leaders in the sustainable built environment by 2025.



Indian Green Building Council (IGBC) presently said over 2 billion SQF area of green building projects has been registered till now and is targeting to have 10 billion SQF by 2022. It has been various categories of consruction like IGBC Green Homes, IGBC Green Townships,IGBC Green New Buildings, IGBC Green SEZ , IGBC Green Factory Buildings, IGBC Green Schools, IGBC Green Landscaping,IGBC Existing Buildings and IGBC Green Mass Rapid Transit System. This tool awards rating of building as certified, silver, gold, platinum and super platinum.

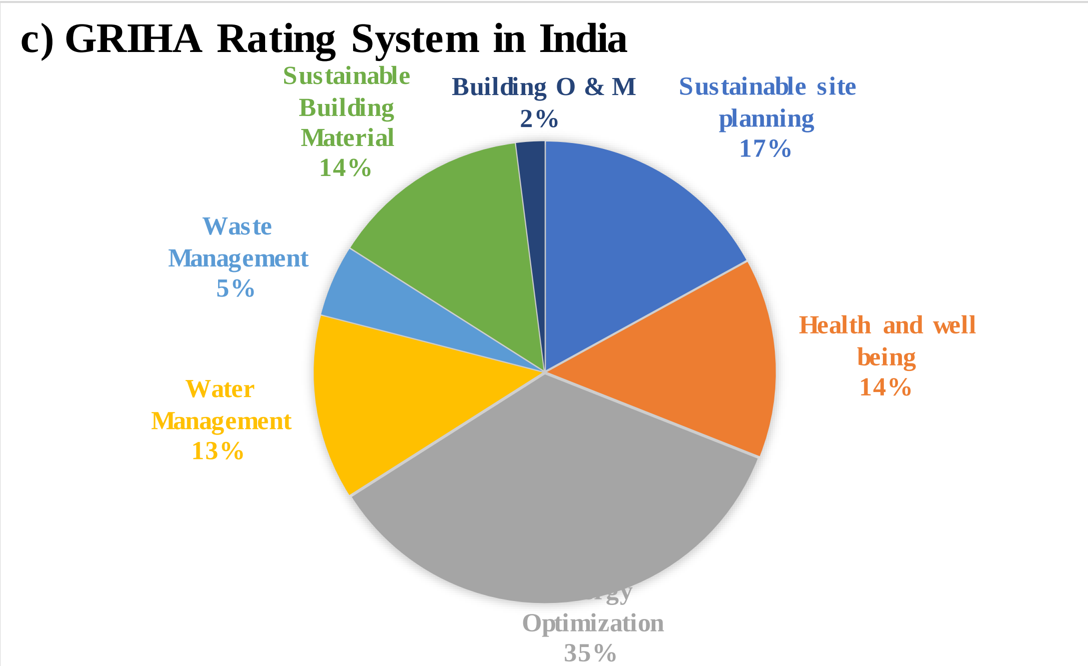
With this background, the(IGBC) Indian green building council has launched ‘IGBC green new building assessmenyt system to address the national priorities. This assessment program is a tool which allows the designer to adpot the green technological aspects and reduce the environmental impacts that are quantifiable. The assessment program covers implementation methodologies to cover varied climatic zones and varying lifestyles.

IGBC has setup the green new building core committee to develop the assessment program. This committee consist of stakeholders, including planner, architects, builders, consultants, developers, owners, institutions, manufactures and industry representatives.

GRIHA Rating System

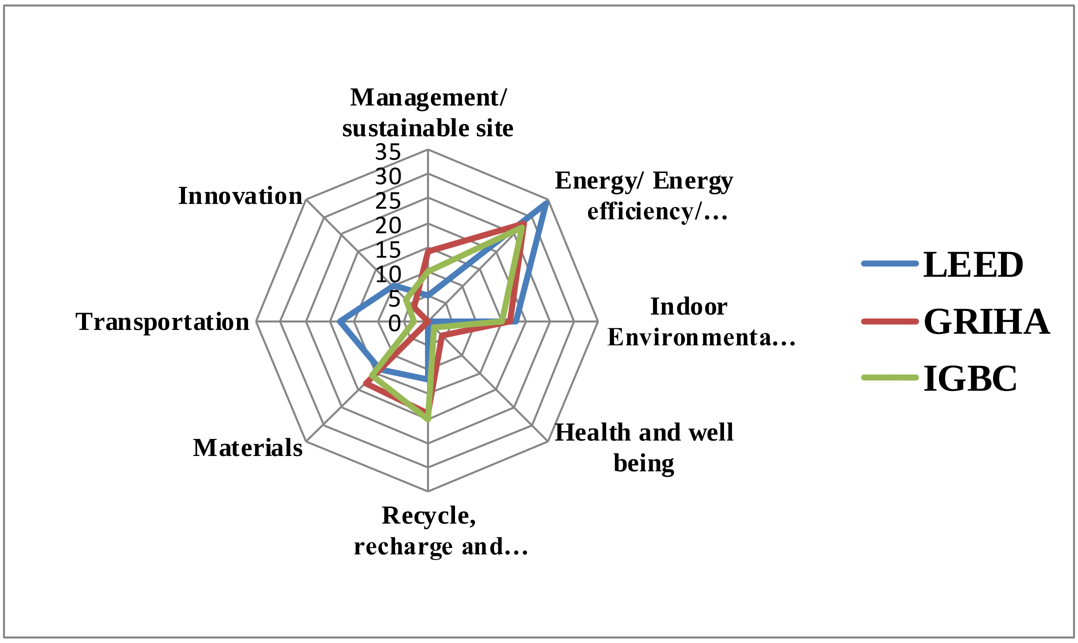
GRIHA (Green Rating for Integrated Habitat Assessment) is the Indian national green building rating system. It was developed by TERI (The Energy and Resources Institute) in 2007. This rating system is divided into: energy end use-36.5%, sustainable site planning-21.2%, building planning and construction-7.7%, health and wellbeing- 9.6%, energy: renewable- 7.7%, innovation points-3.9%, recycle, building operation and maintenance-1.9%, waste management-4.8%, and recharge and reuse of water-6.7%. The GRIHA rates the buildings for 100 points for above 90, from 81-90, 71-80, 61-70, and 50-60, five star, four star, three star, two star and one star respectively. A building project is assessed based on its anticipated performance over its complete life cycle from inception to operation. The phases of the project life cycle that have been recognized for evaluation are: pre-construction, building design, and construction, and building O & M (operation and maintenance). The issues that are assessed in these phases are as follows.

- Pre-construction stage (intra- and inter-site issues)
- Building planning and construction stages (issues of resource conservation and reduction in resource demand resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well-being). The prime resources that are considered in this section are land, water, energy, air, and green cover.
- Building O&M stage (issues of O&M of building systems and processes, monitoring and recording of consumption, and occupant health and well-being, and also issues that affect the global and local environment).



GRIHA was conceived by TERI and developed with Ministry of New and Renewable Energy, is a national rating system for green buildings in India. GRIHA is a rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks. About 650 projects registered consist of almost 250 million sq. ft. build up area.

Comparison of Building Assessment Tools in India



Graphical Represential of Different Criteria Adopted in India Rating system

COMPARATIVE ASSESSMENT OF BUILDING ASSESSMENT TOOLS

Sl no	Category	LEED		GRIHA		IGBC	
		Applicability	Points available	Applicability	Points available	Applicability	Points available
1	MANAGEMENT / SUSTAINABLE SITE						
a)	Site selection/ reuse of land / reclaimed land / sustainable construction	Y	1	Y	1	N	0
b)	Preserve and protect the landscape during construction / preserve top soil / existing vegetation	Y	1	Y	5	Y	3
c)	Soil conservation/top soil laying and stabilization/hard landscaping and boundary protection	N	0	Y	2	Y	0
d)	Brownfield re-development	Y	1	N	0	N	0
e)	Design to include existing site features / maximize open space	Y	2	Y	4	Y	2
f)	Building and site operation and maintenance	N	0	Y	2	N	0
g)	Universal design	N	0	N	0	Y	1
h)	Integrated design approach	N	0	N	0	Y	1
i)	Passive architecture	N	0	N	0	Y	2
j)	Project management	N	0	N	0	N	0
k)	Green building guidelines	N	0	N	0	Y	1
2	ENERGY / ENERGY EFFICIENCY / ENERGY USE						
a)	Renewable energy utilization	Y	7	Y	8	Y	8
b)	Minimum energy performance/Optimize energy performance	Y	19	Y	16	Y	15
c)	Fundamental building commissioning / Measurement and verification / Energy monitoring /Metering and monitoring	Y	4	Y	0	Y	2
d)	Ozone depletion	N	0	Y	1	Y	1
e)	Additional commissioning	Y	2	N	0	Y	2
f)	Energy Improvement / Green power	Y	2	Y	3	N	0

3	**INDOOR ENVIRONMENTAL QUALITY**						
	Optimize building design to reduce the conventional energy demand / Naturally ventilated design / Localized ventilation	Y	1	Y	8	Y	1
	Day lighting and views / Visual comfort / Day lighting / External Views / Artificial lighting Minimisation / Interior lighting normally specify	Y	2	Y	3	Y	3
	Reduced heat island effects / Thermal comfort / Thermal insulation / Thermal performance of building	Y	5	N	0	Y	4
	Low emitting / Indoor chemical and pollutant source control / CO2 monitoring and control / Hazardous material / Indoor air pollutants / ETS control / tobacco and smoke control	Y	6	Y	3	Y	4
	Minimise ozone depleting substance / HCFC and CFC free HVAC / Low and zero carbon technology / construction indoor air quality management plan	Y	4	Y	1	Y	3
	Acceptable indoor and outdoor noise levels / Acoustic performance / Background noise	N	0	Y	2	N	0
4	**HEALTH AND WELL BEING**						
	Minimum level of sanitation / Safety facilities for construction workers	N	0	Y	2	Y	1
	Reduce air pollution during construction	N	0	Y	2	N	0
	Occupant wellbeing facilities	N	0	N	0	Y	1
5	**RECYCLE RECHARGE AND REUSE OF WATER**						
	Water consumption / Water monitoring / Water meter / Water usage monitoring	Y	4	Y	7	Y	7
	Waste water treatment	Y	1	Y	2	Y	5
	Water recycle and reuse	Y	1	Y	5	Y	5
	Minimise waste generation / Water segregation / Storage and disposal / Recovery from waste	N	0	Y	3	N	0
	Water efficient landscaping	Y	4	N	0	Y	3
	Innovative waste water technologies / Strom water management / Water recycling effluent discharge to foul sever	Y	2	Y	2	N	0
6	**MATERIALS**						
a)	Building reuse / Reuse of façade / Reuse of structure	Y	6	N	0	N	0
b)	Conservation and efficient utilization of resources	Y	0	Y	0	N	0
c)	Utilization of fly ash in the building structure	N	0	Y	6	N	0
d)	Storage and collection of recyclables / Construction water management / Resource reuse / Recycled content / Construction Waste management / Recycled aggregates / Recycled content of concrete /Recycled content of steel / Recycled content of reused product & materials	Y	2	Y	3	Y	3
e)	Reduce volume , Weight and time of construction by adopting an efficient technology	N	0	Y	4	Y	5
f)	Use low energy materials in the interiors	Y	2	Y	4	N	0
g)	Sustainable procurement / Recycling waste storage / Sustainable construction / Sustainable products / Adaptability and deconstruction / Sustainable products / Waste recycling facilities / Waste management	Y	2	Y	1	Y	8
h)	Local or regional materials	Y	2	N	0	N	0
7	**TRANSPORTATION**						
a)	Alternative transportation / Public transport accessibility / Commuting mass transport / Green transport / Local transport / Vehicular access	Y	8	N	0	Y	1
b)	Alternative transportation / Cyclist facilities / Alternative transportation / Travel plan / Fuel efficiency transport	Y	4	N	0	Y	1
c)	Pedestrian route / Local transport	Y	1	N	0	N	0
d)	Proximity to amenities / Neighborhood amenities / amenities features	Y	5	N	0	Y	1
8	**INNOVATION**						
a)	Innovation in design	Y	5	Y	4	Y	4
b)	Accredited professional	Y	1	N	0	Y	1
	Optimization in structural design	N	0	N	0	Y	1
9	**Regional priority**	Y	4	N	0	N	0
	Total		**110**		**104**		**100**

The critical and prominent stages of life cycle have been compared by various rating tools. Following are the highlights about the consideration of LEED, GRIHA and IGBC in assessing the green building.

- All these rating tools (LEED, IGBC and GRIHA) have given the most important portion to 'Energy Efficiency/ Use', allotting the maximum score for the complete project life cycle in assessment of green rating.
- In these rating tools 'Indoor Environment Quality' plays moderate role, however it obtains a similar avarage score by all the LEED, IGBC and GRIHA.
- 'Recycle, Recharge and Reuse of Water' have been considered equally by GRIHA and IGBC but LEED has given lesser score to it comparitively in rating the building.
- LEED has considered 'Transportation' as a moderate contribution factor whereas GRIHA and IGBC have given negligable score to it.
- All the rating tools have considered 'Materials' as a moderate contribution factor equally.
- 'Health and Well Being' have negligable considerations by all these Indian Tools.
- Similarly 'Innovation' has obtained minimal scores by all the three tools.
- GRIHA has considered 'Magement/Sustainable Site' in the moderate category while LEED & IGBC have given less score to the same.

However it is proven that energy efficiency and enery utilization has a major important role in impacting the environment in all the aspects. Sustaibable assessment is considered to be complete when all the aspects such as environmental , economic and social are integrated. However the currently available rating tools have concentrated more towards environmental which is appriciated but givng less importance to economic and social aspectd leads to incomplete in the sustainable assessment of building performance. Hence these rating tools may not be completely successful in assessing sustainablity since assessin sustainablty is a complex phenomina.

Conclusion

Construction sector is one of the important sector, where every country should be concentrated for the growth of economy. From past decade construction industries moving towards the change in practice from conventional building to green buildings. Developed and developing countries are practicing their own or one of the popular rating system to assess the building. All the aspects of sustainability has significant impact in assessment of building and it should be integrated. Economic and Social aspects are having some deficient and inadequate in many assessment tools in measuring sustainability. Existing assessment tools are focused towards environmental assessment rather than sustainable assessment. Existing assessment tools are not taken into consideration of regional and functional aspects, which also plays a significant role in assessment of building performance. The building assessment should be carried out for complete project, from initiation phase to demolition phase. The continuous revision and updates on existing assessment tools should happen, to meet the current challenges in construction. EAT are condemned as being fruitless and incompetent in presenting the sustainable measures with respect to building performance. One issues for regional adaptation is that, indicators vary from one region to another region. Sustainability is like a three legged chair, any leg missing from the sustainability chair will cause unsteadiness, because the three components are interlinked together. The most of the assessment tools have been established nationally to measure environmental impact and consider the problems, as they appear. Economy is the most a important factor in any developing countries, so considering is very much necessary to analyse ans assessproject cost for the life cycle of the building, which is not taken into account in the GRIHA. GRIHA and LEED-India gave more importance to environment aspects rather than social and economic aspects. Sustainable building assessment have strong regional differences and the application of the international tools in India, will still have some shortcomings. GRIHA is not sufficiently focused on sustainability issues in building life cycle. Project life cycle has not received necessary attention in building assessment process.

Most Green Building Rating systems available today are criteria based. Whole building process are categorized into several criteria and credited with points – Normalizing them into Star Ratings or other nomenclature. They are good to streamline the processes but do not accurately measure the impact of Building Energy on Natural Environment. None of the systems include properties of materials and integrate them in the assessment process. This lacunae calls for development of a New Sustainability Indicator, applicable for entire Built environment with ease. Sustainability is complex phenomena having too many variables with lack of dependable data has limitation in existing assessment tools.

References

1. Ng, S. T., Chen, Y., and Wong, J. M. (2013). Variability of building environmental assessment tools on evaluating carbon emissions. *Environmental impact assessment review*, *38*, 131-141.
2. Sovacool, B. K., and Brown, M. A. (2010). “Twelve metropolitan carbon footprints: A preliminary comparative global assessment”. *Energy policy*, *38*(9), 4856-4869.
3. Scheuer, C., Keoleian, G. A., and Reppe, P. (2003). “Life cycle energy and environmental performance of a new university building: modeling challenges and design implications”. *Energy and buildings*, *35*(10), 1049-1064.
4. WCED (ed.) 1987, *Our common future,* Oxford University Press, Oxford.
5. Junnila, S., and Horvath, A. (2003). “Life-cycle environmental effects of an office building”. *Journal of Infrastructure Systems*, *9*(4), 157-166.
6. Muga, H., Mukherjee, A., and Mihelcic, J. (2008). “An integrated assessment of the sustainability of green and built-up roofs”. *Journal of green building*, *3*(2), 106-127.
7. Liu, J. J., Ding, G. K., and Samali, B (2011). “Quantifying and assessing impacts of building processes in a ‘triple bottom line approach”.

8. Vyas, G. S., and Jha, K. N. (2016). "Identification of green building attributes for the development of an assessment tool: a case study in India". *Civil Engineering and Environmental Systems*, *33*(4), 313-334.
9. Cole, R. J. (2005). "Building environmental assessment methods: redefining intentions and roles". *Building Research and Information*, *33*(5), 455-467.
10. Cole, R. J., and Larsson, N. K. (1999). "GBC'98 and GBTool: background". *Building Research and Information*, *27*(4-5), 221-229.
11. Ding, G. K. (2008). "Sustainable construction—The role of environmental assessment tools". *Journal of environmental management*, *86*(3), 451-464. Haapio, A., and Viitaniemi, P. (2008). "A critical review of building environmental assessment tools". *Environmental impact assessment review*, *28*(7), 469-482.
12. Ng, S. T., Chen, Y., and Wong, J. M. (2013). Variability of building environmental assessment tools on evaluating carbon emissions. *Environmental impact assessment review*, *38*, 131-141.
13. Sachin, V. G., and Jha, K. N. (2012). "Comparative study of rating systems for green building in developing developed countries". In *Third International Conference on Construction in Developing Countries (ICCIDC–III), Paper* (pp. 4-6).
14. Smith, R. M. (2015). "Green" building in India: a comparative and spatial analysis of the LEED-India and GRIHA rating systems". *Asian Geographer*, *32*(2), 73-84.
15. SANDE, M. I. I., and PHADTARE, M. (2015). "Comparative study of LEED and GRIHA rating system".
16. Castanheira, G., and Bragança, L. (2014). "The Evolution of the Sustainability Assessment Tool: From Buildings to the Built Environment". *The Scientific World Journal*, *2014*.
17. Liu, J., Ding, G. K., and Samali, B. (2013). "Building Sustainable Score (BSS)—A Hybrid Process Approach for Sustainable Building Assessment in China". *Journal of Power and Energy Engineering*, *1*(05), 58.
18. Tam, V. W., and Zeng, S. X. (2013). "Sustainable performance indicators for Australian residential buildings". *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *5*(4), 168-179.
19. Ding, G. K., and Shen, L. Y. (2010). "Assessing sustainability performance of built projects: a building process approach". *International Journal of Sustainable Development*, *13*(3), 267-279.
20. Cabeza, L. F., Rincón, L., Vilariño, V., Pérez, G., and Castell, A. (2014). "Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: A review". *Renewable and Sustainable Energy Reviews*, *29*, 394-416.
21. Debnath, A., Singh, S. V., and Singh, Y. P. (1995). "Comparative assessment of energy requirements for different types of residential buildings in India". *Energy and buildings*, *23*(2), 141-146.
22. Kaatz, E., Root, D. S., Bowen, P. A., and Hill, R. C. (2006). "Advancing key outcomes of sustainability building assessment". *Building Research and Information*, *34*(4), 308-320.
23. Forsberg, A., and Von Malmborg, F. (2004). "Tools for environmental assessment of the built environment". *Building and environment*, *39*(2), 223-228.
24. Poveda, C. A., and Lipsett, M. G. (2011). "A review of sustainability assessment and sustainability/environmental rating systems and credit weighting tools". *Journal of Sustainable Development*, *4*(6), 36.

25. Sev, A. (2011). “A comparative analysis of building environmental assessment tools and suggestions for regional adaptations”. *Civil Engineering and Environmental Systems, 28*(3), 231-245.
26. Shen, L. Y., and Tam, V. W. (2002). “Implementation of environmental management in the Hong Kong construction industry”. *International Journal of Project Management*, *20*(7), 535-543.
27. Shen, L. Y., Wu, M., and Wang, J. Y. (2002). “A model for assessing the feasibility of construction project in contributing to the attainment of sustainable development”. *Journal of Construction Research*, *3*(02), 255-269.
28. UNEP (ed.) 2003, *Sustainable building and construction*, Industry and Environment.
29. Vanclay, F. (2004). “The triple bottom line and impact assessment: How do TBL, EIA, SIA, SEA and EMS relate to each other?”. *Journal of Environmental Assessment Policy and Management*, *6*(03), 265-288.