

Methodology for Developing Criteria weights for Green Building Rating Tool For Gujarat State

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Abstract - Green buildings play a vital role in the conservation of the environment. However, it has been found that there are many buildings which possess a minimum impact on the environment, yet fail to get certified under the various criteria set by the green building rating tool. Hence there is a need for modified Green Building Rating tool. This research paper presents a methodology on how the weights of the criteria can be determined using AHP technique. These weights shall further be utilized for the development of points for green building rating tool.

Key Words: Green building, GRIHA, LEED, green building rating tools, AHP.

1. INTRODUCTION

A green building is an environmentally sustainable building, designed, constructed and operated to minimize the total environmental impacts. To measure the impact of the building on the environment, rating tools are available. The evaluators evaluate the building with the help of these rating tools and rate the building accordingly. In India, most commonly used rating tools are GRIHA and LEED India.

Here we shall discuss briefly about the two main rating tools used in India. They are

- i. GRIHA
- ii. LEED India
- iii. SB Tool

i. GRIHA

Most of the internationally devised rating systems have been tailored to suit the building industry of the country where they were developed. TERI, being deeply committed to every aspect of sustainable development, took upon itself the responsibility of acting as a driving force to popularize green buildings by developing a tool for measuring and rating a building's environmental performance in the context of India's varied climate and building practices. This tool, by its qualitative and quantitative assessment criteria, would be able to 'rate' a building on the degree of its 'greenness'. The rating shall evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green

building'. The rating system, based on accepted energy and environmental principles, seeks to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period. On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, improving energy security, and reducing the stress on natural resources.

The rating applies to new building stock – commercial, institutional, and residential – of varied functions. Endorsed by the Ministry of New and Renewable Energy, Government of India as of November 1 2007, GRIHA is a five star rating system for green buildings which emphasizes on passive solar techniques for optimizing indoor visual and thermal comfort. In order to address energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within specified comfort limits. A building is assessed on its predicted performance over its entire life cycle from inception through operation.

GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions.

GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors, and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

The GRIHA rating tool consists of 34 various criteria divided under 7 different categories, such as sustainable site planning, health and well being during construction, material management and so on.

GRIHA integrates all relevant Indian codes and standards for buildings and acts as a tool to facilitate implementation of the same.

ii. LEED India

Leadership in Energy and Environmental Design (LEED) was developed and piloted in the US in 1998 as a consensus-based building rating system based on the use of existing building technology.

The rating system addresses specific environmental building related impacts using a whole building environmental performance approach. The Indian Green Building Council has adapted LEED system and has launched LEED India version for rating of new construction. In addition, Indian Green Building Council (IGBC) has launched several other products for rating of different typologies of buildings including homes, factories, among others. The following are key components of the LEED system.

1. Sustainable sites (construction related pollution prevention, site development impacts, transportation alternatives, storm water management, heat island effect, and light pollution)
2. Water efficiency (landscaping water use reduction, indoor water use reduction, and waste water management strategies)
3. Energy and atmosphere (commissioning, whole building energy performance optimization, refrigerant management, renewable energy use, and measurement and verification)
4. Materials and resources (recycling collection locations, building reuse, construction waste management, and the purchase of regionally manufactured materials, materials with recycled content, rapidly renewable materials, salvaged materials, and FSC certified wood products)
5. Indoor environmental quality (environmental tobacco smoke control, outdoor air delivery monitoring, increased ventilation, construction indoor air quality, use low emitting materials, source control, and controllability of thermal and lighting systems)
6. Innovation and design process (LEED accredited professional, and innovative strategies for sustainable design).

iii. SB Tool

The SB method is a generic framework for rating the sustainable performance of the buildings and projects. It may also be thought of as a toolkit that assists local organizations to develop SB Tool rating systems. The SB Method can be used by authorized third parties to establish adapted SB Tool version as rating systems to suit their own region and building types.

It can also be used by owners and managers of large building portfolios to express in a very detailed way their own sustainability requirements to their internal staff or as briefing material for competitors. The system covers a wide range of sustainable building issues, not just green building concerns, but the scope of the system can be modified to be as

narrow or as broad as desired, ranging from 100+ criteria to half a dozen.

SB Method takes into account region-specific and site-specific context factors, and these are used to switch off or reduce certain weights, as well as provide background information for all parties.

1.1 Need of study

Over the process of rating various projects registered for GRIHA rating, ADaRSH (GRIHA secretariat) carried out a realistic assessment of applicability of GRIHA criteria for various projects. After carrying out this exercise it was recognized that some criteria in the current GRIHA framework may not apply to a particular project due to technical constraints that are specific to the particular project (for example the criteria related to tree preservation and compensatory forestation may not apply to a site that is devoid of trees). It was also recognized that the relative weighting of points within the current framework needs to be reassessed so that green interventions in a project are given points based on its relative advantage to a project. This resulted in modifications to the GRIHA document which have been mentioned below. Criteria have been classified as 'Applicable/Selectively-Applicable'. Certain mandatory clauses have been modified/removed based on the applicability /selective-applicability of the criterion.

The issue with the criteria of these rating tools is that the criteria which are suitable for a particular region may not be suitable for another region with different climatic, geometric and topographical conditions. For example, the criteria suitable for Southern India may not be suitable for northern India because the climatic conditions are different. So the rating tools need to be enhanced for the particular region, as per the geometric and climatic conditions of that particular region or state. Considering the conditions of the Gujarat state, a separate green building rating tool needs to be developed.

1.2 Scope of study

This research article provides a systematic methodology for the development of the criteria weights for the modified green building rating tool for the Gujarat state.

The construction industry will be benefited by using these weights while developing Green Building Rating Tool.

2. METHODOLOGY

To generate the weights, first the criteria have to be decided. In order to do that, rating tools has to be studied and then, the criteria which are suitable for the Gujarat state has to be short listed and then needs to be verified from the

accredited experts of the respective rating tools. Once criteria have been verified, comparison between these criteria has to be made to generate weights according to the relative importance. In order to do that, we shall use the AHP (Analytic Hierarchy Process) technique to make comparison between the criteria.

A questionnaire shall be issued to the respective experts for the comparison and generating relative importance of the criteria. After collecting the data, using the AHP technique, we can generate the weights for the criteria.

3. CRITERIA FRAMEWORK

After studying the rating tools, a criteria framework has to be prepared by selecting the criteria which are most suitable and favorable for the Gujarat state.

41 criteria have been selected under 7 different categories, after studying the rating tools.

The following table number 1 shows a comparative study of the three rating tools under each column. This gives us a brief idea about the criteria covered under each of these rating tools. It also helps us to know which criteria has been missed out under a particular rating tool.

Table 1: List of criteria

Serial number	Criterion Number	Details	Source of criterion
Group A - Sustainable site planning (SSP)			
1	A1	Site selection	GRIHA
2	A2	Preserve and protect the landscape during construction/compensatory depository forestation.	GRIHA
3	A3	Soil conservation	GRIHA
4	A4	Design to include existing site features	GRIHA
5	A5	Reduce hard paving on site	GRIHA
6	A6	Enhance outdoor lighting system efficiency	GRIHA
7	A7	Plan utilities efficiently and optimize on-site circulation efficiency	GRIHA
8	A8	Storm water design	LEED
Group B- Health and well-being (HW) during construction			
9	B1	Provide, at least, minimum level of sanitation/safety facilities for construction workers	GRIHA
10	B2	Reduce air pollution during construction	GRIHA

Group C - Material Management			
11	C1	Utilization of fly-ash in building structure	GRIHA
12	C2	Reduce volume, weight and time of construction by adopting efficient technology, for example pre-cast systems, ready-mix concrete and so on	GRIHA
13	C3	Use low- energy materials in interiors	GRIHA
14	C4	Renewable energy based hot-water system	GRIHA
15	C5	Use of low VOC paints/adhesives/sealants	GRIHA
16	C6	Materials Reuse	LEED
17	C7	Regional Materials	LEED
18	C8	Rapidly Renewable Materials	LEED
Group D – Water			
19	D1	Reduce landscape water requirement	GRIHA
20	D2	Reduce building water use	GRIHA
21	D3	Efficient water use during construction	GRIHA
22	D4	Waste water treatment	GRIHA
23	D5	Water recycle and reuse (including rainwater)	GRIHA
24	D6	Ensure water quality	GRIHA
25	D7	Water use reduction	LEED
Group E – Energy			
26	E1	Optimize building design to reduce conventional energy demand	GRIHA
27	E2	Optimize energy performance of building within specified comfort limits	GRIHA
28	E3	Renewable energy utilization	GRIHA

29	E4	Energy audit and validation	GIRHA
Group F – Health and well-being (HW) post construction			
30	F1	Minimize ozone depleting substances	GRIHA
31	F2	Acceptable indoor and outdoor noise levels	GRIHA
32	F3	Tobacco and smoke control	GRIHA
33	F4	Universal accessibility	GRIHA
34	F5	Operations and maintenance protocol for electrical and mechanical equipment	GRIHA
35	F6	Thermal comfort	LEED
36	F7	Daylight and views	LEED
Group G – Waste Management			
37	G1	Reduction in waste during construction	GRIHA
38	G2	Efficient waste segregation	GRIHA
39	G3	Storage and disposal of waste	GRIHA
40	G4	Resource recovery from waste	GRIHA
41	G5	Construction waste management	LEED

4. INTRODUCTION TO AHP

Analytic Hierarchy Process (AHP), since its invention, has been a tool at the hands of decision makers and researchers; and it is one of the most widely used multiple criteria decision-making tools. Many outstanding works have been published based on AHP: they include applications of AHP in different fields such as planning, selecting a best alternative, resource allocations, resolving conflict, optimization, etc., and numerical extensions of AHP.

The speciality of AHP is its flexibility to be integrated with different techniques like Linear Programming, Quality Function Deployment, Fuzzy Logic, etc. This

enables the user to extract benefits from all the combined methods, and hence, achieve the desired goal in a better way.

Analytic Hierarchy Process is a multiple criteria decision-making tool. This is an Eigen value approach to the pair-wise comparisons. It also provides a methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative performances. The scale ranges from 1/9 for least valued than, to 1 for equal, and to 9 for absolutely more important than covering the entire spectrum of the comparison. Some key and basic steps involved in this methodology are:

1. State the problem.
2. Broaden the objectives of the problem or consider all actors, objectives and its outcome.
3. Identify the criteria that influence the behavior.
4. Structure the problem in a hierarchy of different levels constituting goal, criteria, sub-criteria and alternatives.
5. Compare each element in the corresponding level and calibrate them on the numerical scale. This requires $n(n-1)/2$ comparisons, where n is the number of elements with the considerations that diagonal elements are equal or 1 and the other

elements will simply be the reciprocals of the earlier comparisons.

6. Perform calculations to find the maximum Eigen value, consistency index CI, consistency ratio CR, and normalized values for each criteria/ alternative.
7. If the maximum Eigen value, CI, and CR are satisfactory then decision is taken based on the normalized values; else the procedure is repeated till these values lie in a desired range.

AHP helps to incorporate a group consensus. Generally this consists of a questionnaire for comparison of each element and geometric mean to arrive at a final solution. The hierarchy method used in AHP has various advantages.

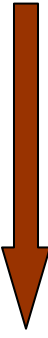
5. DEVELOPMENT OF QUESTIONNAIRE SURVEY

A survey questionnaire has to be developed based on AHP method. This step of the methodology requires the criteria identified to be weighted against one another. In an AHP model, researchers can assume that although there might be multiple criteria when making a decision, not all the criteria may have the same impact on the final decision. It is then the task in this step to determine the criteria weights as perceived by the respondents.

A comparison between the two criteria has to be made over a scale on 1 to 9. This scale is known as Saaty scale.

The following table number 2 shows what the score on the saaty scale mean. By studying the table, the expert respondent can mark the relative importance of the category and its criteria.

Table 2: The comparison scale

Value	Meaning	Importance
1	Equal	
2	Between Equal to moderate	
3	Moderate	
4	Between Moderate to strong	
5	Strong	
6	Between Strong to Very strong	
7	Very strong	
8	Between Very strong to Extreme	
9	Extreme	

An example is shown below to give a clear understanding of the comparative method of the criteria.

Sustainable site planning Health and well being during construction

9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
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Similarly a comparison has to be made of the subcriteria.

Site selection Preserve and protect landscape during construction

9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
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Like wise the questionnaire shall contain a comparison between all the 7 main categories and then comparison between the subcriteria shall also be made on saaty scale to determine their relative importance on the saaty scale of 1-9.

After getting the responses from the experts, matrices shall be generated and the weights of each criteria, based on the relative importance, could be generated. These weights shall be utilized for the development of score points for the Green Building Rating Tool for Gujarat.

6. CONCLUSION

This article states the need for the modified Green Building Rating Tool for the Gujarat, with clear, logical reasons that different regions or different states need different criteria for the green building rating tool as per their geographic and climatic conditions.

Further, this research article provides a systematic methodology for the generation of the criteria for the Gujarat state and then the procedure for the development of the criteria weights based on the responses of the experts. These weights can be utilized for the development of Green Building Rating Tool for Gujarat. AHP technique is suggested for weight development.

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