Rating of a residential project of a Tier-II city in India to promote green and sustainable construction practices as per guidelines of GRIHA

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The challenges in the construction sector are continuously motivating us to work streamlined with the sustainable development. Thus, we are thrived to adopt the green technologies in our nation. Green Rated Integrated Habitat Assessment (GRIHA) is one of the popular national agencies responsible for providing guidelines for green buildings in India. In terms of number, we are still limited to a few registered (GRIHA) projects, although green construction is not a new technique. There is a numerous advantage of opting green buildings which can be evaluated in terms of electricity savings, proper ventilation, and water conservation. It helps in reducing the Carbon footprint and maintenance costs as well. Along with the savings in the long term, the residents can automatically feel the difference of residing in a green construction project as compared to a conventional residential project. In the present research, one of the conventional residential projects of a Tier-II city Bhopal (M.P.) has been evaluated based on 34 Criteria of GRIHA and the major findings will be to understand how these conventional residential projects can achieve 1–5-star ratings. This research work will be beneficial for the developers of Tier-II cities to access the loop holes in the construction work to be rated as green project, also it will enhance the interest of the stakeholders (buyers) to willingly purchase green residential projects. The project has been evaluated based on guidelines given by GRIHA, and major works to be done in terms of mandatory criteria has been explained.
Keywords: Tier-II city, environmental sustainability, Residential project, sustainable construction, Green rated project

INTRODUCTION

Currently the world is facing severe problems like global warming, climate changes etc. which are a great threat for the existence of human beings. Carbon dioxide emissions have increased a level of 35 billion tones already in 2012. Due to which the gap between the noble cause of reducing CO2 emission and the sources of releasing CO2 in atmosphere is arising rapidly. [1] In the manmade fraternity, buildings are the major source of CO2 emission in any city, accounting to 40% of the energy needs. [2] Green buildings are one of the best solutions to reduce the carbon emissions because the renewable sources of energy are best possibly used. Green buildings promote the usage of natural resources and alternative materials which protects the environment. The climate change issues can be minimized if the green construction practice comes into existence. To promote the concept of green buildings, a case study of a residential project in one of the Tier-II cities namely Bhopal of India has been chosen. Therefore, it is necessary to check where these traditional residential projects which are not green rated stands in terms of GRIHA rating system. This will help in evaluating the status of traditional projects and will provide solutions to these projects falling short in achieving at least 1 star rating prescribed by the guidelines of GRIHA. Also, we will be able to answer that which of the compulsory or partial compulsory criteria are not followed by the traditional residential projects.
The project SAGE Golden Spring (SGS) is located on Ayodhya Bypass Road, Bhopal and comprises of 3, 4 and 5 BHK Bungalows, 2 and 3 BHK luxurious flats with various modern facilities such as rain water harvesting system, swimming pools, jogging tracks, club house, Jain temple and landscaped gardens.

Some of the important statistics related to project are as follows. The details of the residential project undertaken for the study has been shown.

Table 1 Area statement of Bungalows

Unit Type	Accommodation	Plot Size (in Ft.)	Plot Area (sq. ft.)	Built Up Area (sq.ft.)
B	5 BHK	22*60	1320	3560
C	4 BHK	22*50	1100	3000
D	3 BHK	18*50	900	2210

Table 2 Area Statement of Flats

Unit Type	Accommodation	Carpet Area (in Ft.)	Built Up Area (sq. ft.)	Super Built Up Area (sq.ft.)
C1	3 BHK	1080	1184	1515
C2	3 BHK	1080	1184	1515
C3	2 BHK	900	973	1275

Figure 1. Entrance view of SGS

Figure 2. Construction of multi storey Buildings in progress

Figure 3. Construction of Duplexes in progress

Figure 4. Ready Bungalows in campus

Figure 5. Post construction phase

Figure 6. Top view of site under construction (SGS)

LITERATURE REVIEW

Utilizing waste in building construction

The Global problem of managing the waste products due to urbanization can also be sort if we outline the standards for sustainable development. In the research focus has been laid on potentially using the waste materials effectively in construction activities. Also, they have gone through the advantages along with the challenges of using waste in construction work by the help of two case studies in India. This way of using the waste in residential projects will help both the agencies i.e. government and private to effectively manage the construction waste and prepare suitable strategies for future. [3,8]

Use of sustainable building materials

The sustainable building materials are the basic requirement for a green construction project. The use of sustainable materials is directly related to the factors like economy, environmental safety, and social equity. If we consider the major components of any green residential project it will involve efficiency related to water and energy parameters, reducing the waste generation on the site, increasing the efficiency of indoor air quality, better HVAC design and extra ordinary site planning. The stages for sustainable development shall also include methods of selecting materials which have no negative environmental impacts. Also these materials shall be recyclable or reuseable. [4,9]

The Concept of Green Building

Due to the energy crisis in 1960's various research has been going on to improve energy efficiencies and simultaneously declining the environmental pollution. Similar problem was being faced by the construction sector, hence to deal with this situation the concept of green building came into the existence gradually. To explain this concept to the world, various rating systems have been developed across the world. Here the researchers have tried to define the green buildings based on the parameters adopted by different countries.

The situation of development is based on two factors, external factor which includes the development of the concerned policies, schemes of certification and economic advantages. Internal factors comprise of technology applications and the way users will interact with these green technologies. Currently more than 48 green building standards have been devised across the world which also includes 18 appraisal systems specified by the experts. To effectively use the green building technologies, it is mandatory to improve the policies and incentive systems by the government.

Simultaneously the quality of professional judgements, technical ability of the workers and employees and relevant consultants' involvement shall be improvised. All these will collectively help in the National development, formulation of accurate policies and will promote the

construction companies to eradicate the obstacles in the path and work for the intensive research for the future. [5]

Low energy green building innovation in the building sector

Research design done on two cities Delhi and Singapore is based on the Innovation Assessment framework and Governance Assessment tool. For collecting the data, interviews of experts were conducted along with participants. The results of the research indicates that the Singapore governance conditions are stronger than that of Delhi. The governance policies and support in Delhi is only moderately supportive for green building innovations. [6,12]

Sustainable construction Practices

Construction industry is equally responsible for degrading the environment in terms of material consumption as well as producing the waste. This extensive urbanization in the country is knocking the door bells of technical officials and professionals of the construction industry to work on sustainable construction projects. So, there is an alarming situation to start working on the resistance factors of adopting the sustainable and green construction practices in our country. [11] For reaching the root level problem, survey based on questionnaire was done on the industry professionals and experts working on the site. So based on the survey data filled by site engineers, project managers, planning engineers, supervisors, trainee students, results were revealed which influences the sustainable construction. The major findings included unavailability of skilled work force, unaware clients, and lack of knowledge amongst the industrial professionals related to green construction technologies. Hence researches are continuously indicating that the collective efforts of all the stake holders will bring success. [7]

An investigation of Green Buildings in India

Green buildings are reducing negative environmental effect by neglecting the use of fossil fuels in development. They also improve the quality of life of the residents by environment friendly initiatives. Although limited research has been done in this field, but still it can be concluded that there is significant growth in this field. Researchers have tried to make conclusions by collecting data of the city like Delhi, the capital city of India. They have bifurcated the results based on age, sex, income, education level etc. This helps in achieving accurate results about the growing use of green infrastructures. It has been proved that knowledge and awareness among the stakeholders is the key reason in promoting green buildings in India. [8,14,15]

CONCLUSION

In the current research work, study of a residential project of a Tier-II city (Bhopal) in India was done to find out the shortcomings of the project to be termed as Green rated. The marks have been awarded as per the compliances given in the GRIHA manual. The rating system of GRIHA has been shown below.

Table 4 Evaluation system of GRIHA (GRIHA Manual 2019)

S. No.	Points scored	Rating
1	50-60	One star
2	61-70	Two stars
3	71-80	Three stars
4	81-90	Four stars
5	91-100	Five stars

The selected project is falling short of 1 star rating by 7 marks which can be recovered by taking suitable measures as specified by GRIHA. The major drawbacks and the remedial measures have been highlighted below. The table below gives the Marking scheme under GRIHA checklist, for Sage Golden Spring project, evaluated based on the same.

Table 3 Marks gained by SGS as per 34 criteria of GRIHA (GRIHA Manual 2019)

Criteria			Sagar Green Hills	
S. N.	Clause	Points	Applicable	Committed
1. Selecting the site	Partly Mandatory	1	1	1
2. Landscape protection during construction/compensatory depository forestation.	Partly Mandatory If applicable	5	5	4
3. Conserving soil (post construction)	-	2	2	2
4. Designing while including existing site features	-	4	4	2
5. Reduction in hard pavements on site	Partly Mandatory	2	2	1
6. Uplifting external lighting system efficiency		3	3	1
7. Sustainable planning of utilities and optimizing on-site circulation efficiency		3	3	2
8. Providing basic sanitation/safety facilities to the construction workers	Mandatory	2	2	1
9. Minimizing air pollution while constructing	Mandatory	2	2	1
10. Reducing the water requirements of landscape		3	3	1
11. Minimizing the use of water in building		2	2	1
12. Utilizing water efficiently during construction		1	1	1
13. Designing building to reduce demand of non-renewable energy	Mandatory	8	8	3
14. Utilizing the building energy performance under specified limits of comfort	Partly Mandatory	16	16	4

15. Consumption of fly-ash in building structure		6	6	5
16. Ways of reducing construction time by utilizing technologies like pre-cast construction, RMC etc.)		4	4	2
17. Using material having lower energy in interior of buildings		4	4	2
18. Utilizing renewable energy in construction	Partly Mandatory	5	5	0
19. using hot- water system based on renewable energy		3	3	0
20. Arrangements of treating waste water		2	2	1
21. Recycling & reusing water (even rainwater)		5	5	1
22. Ways of minimizing construction waste		1	1	1
23. Segregating the construction waste		1	1	0
24. Storing and disposing construction wastes		1	1	1
25. Ways of recovering resources from waste		2	2	0
26. Using paints and products having low VOC.		3	3	2
27. Minimizing substances causing ozone depletion	Mandatory	1	1	0
28. Ways of maintaining water quality	Mandatory	2	2	1
29. Maintaining noise in interior and exterior		2	2	0
30. Neglecting use of Tobacco and smoke	Mandatory	1	1	1
31. Providing accessibility for persons with disability		1	1	1
32. Conducting audit of energy, waste and water.	Mandatory	-	-	-
33. Protocols for Operating and maintaining electrical and mechanical equipment's	Mandatory	2	2	0
34. Adopting innovative methods (beyond 100)		4	4	0
TOTAL		104	104	43

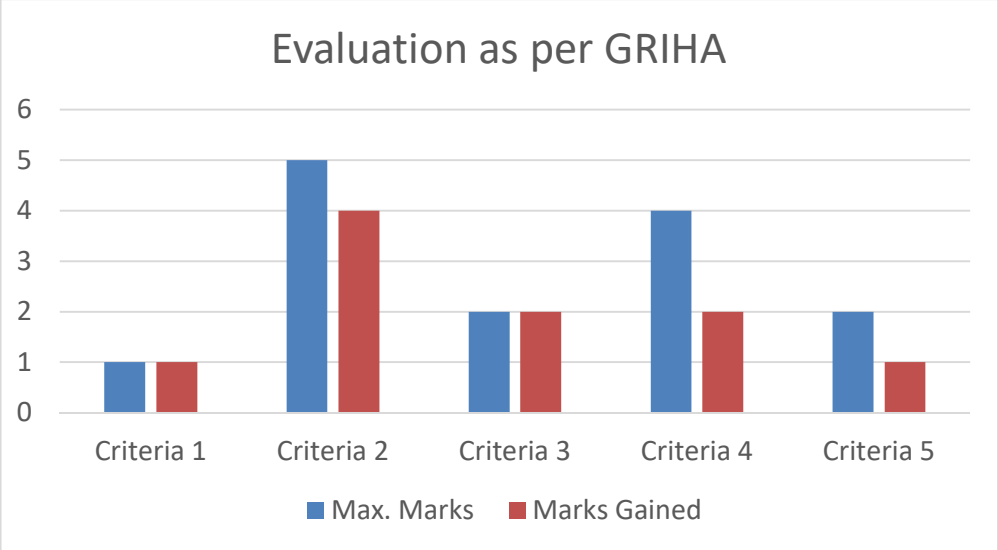

Figure 8 Comparative analysis of criteria 1-5 as per GRIHA for SGH

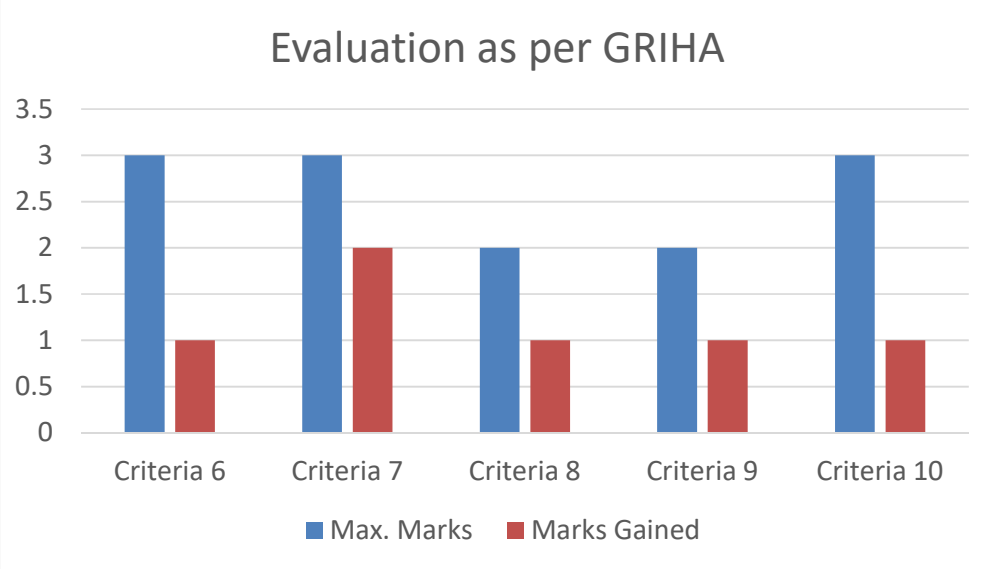

Figure 9 Comparative analysis of criteria 6-10 as per GRIHA for SGH

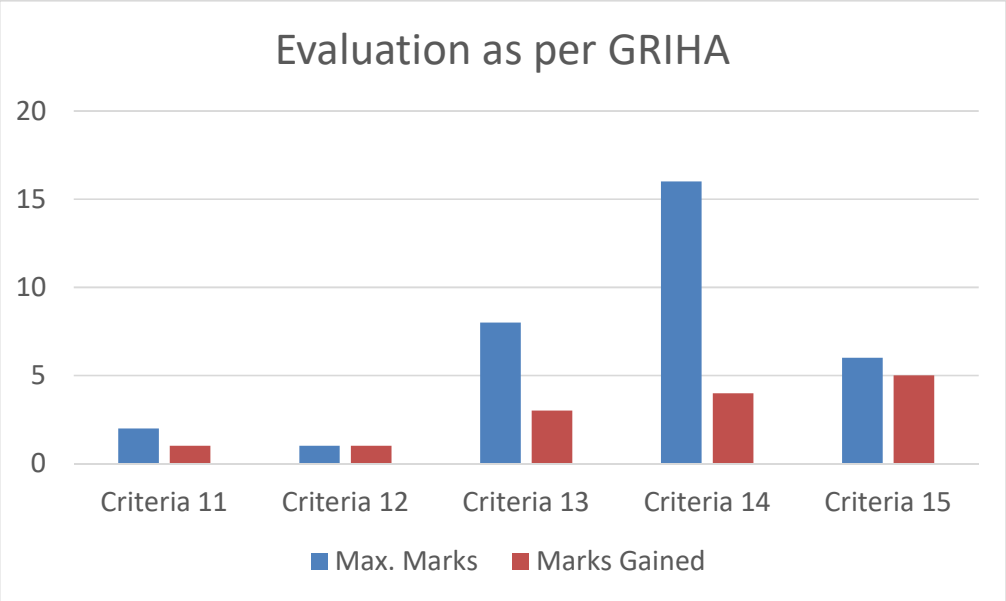

Figure 10 Comparative analysis of criteria 11-15 as per GRIHA for SGH

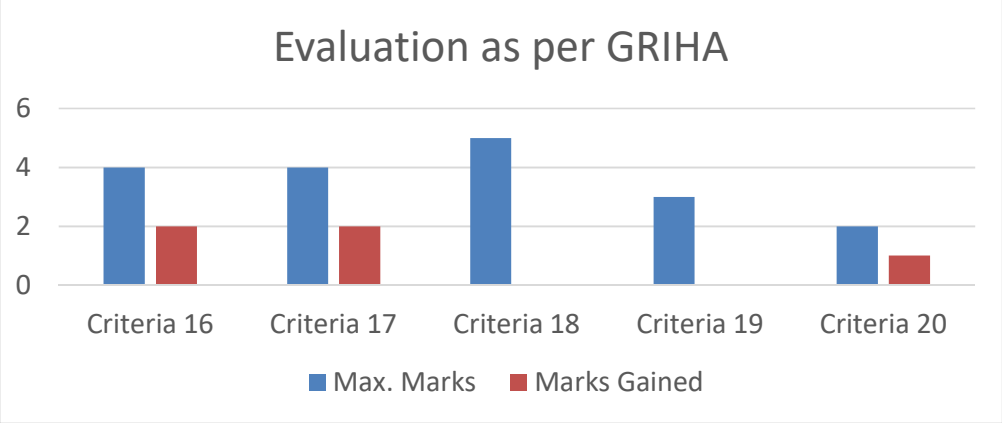

Figure 11 Comparative analysis of criteria 16-20 as per GRIHA for SGH

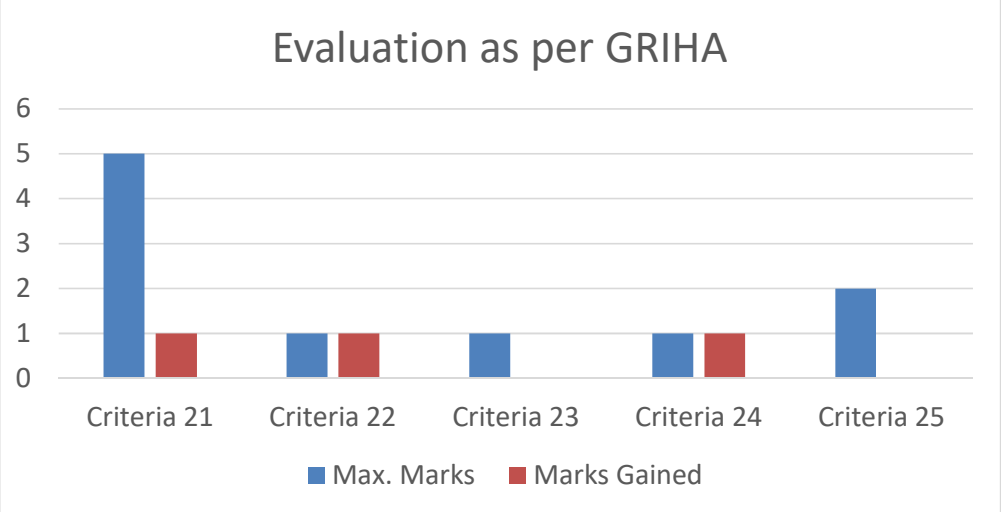

Figure 12 Comparative analysis of criteria 21-25 as per GRIHA for SGH

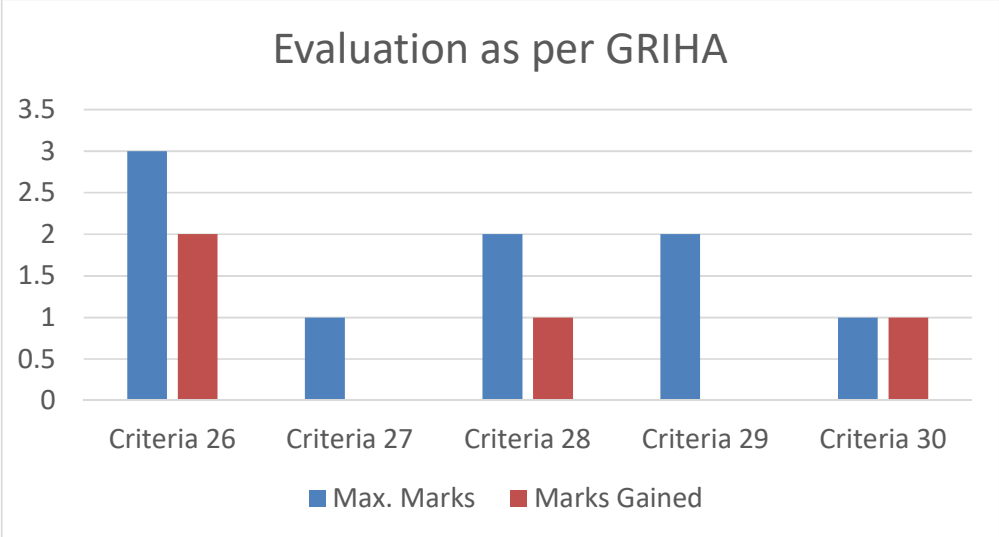

Figure 13 Comparative analysis of criteria 26-30 as per GRIHA for SGH

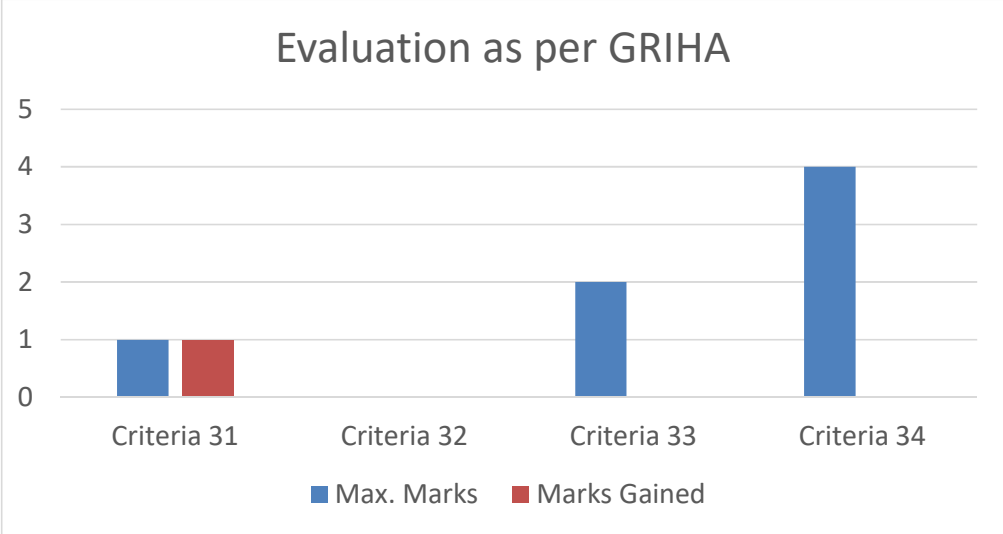

Figure 14 Comparative analysis of criteria 31-34 as per GRIHA for SGH

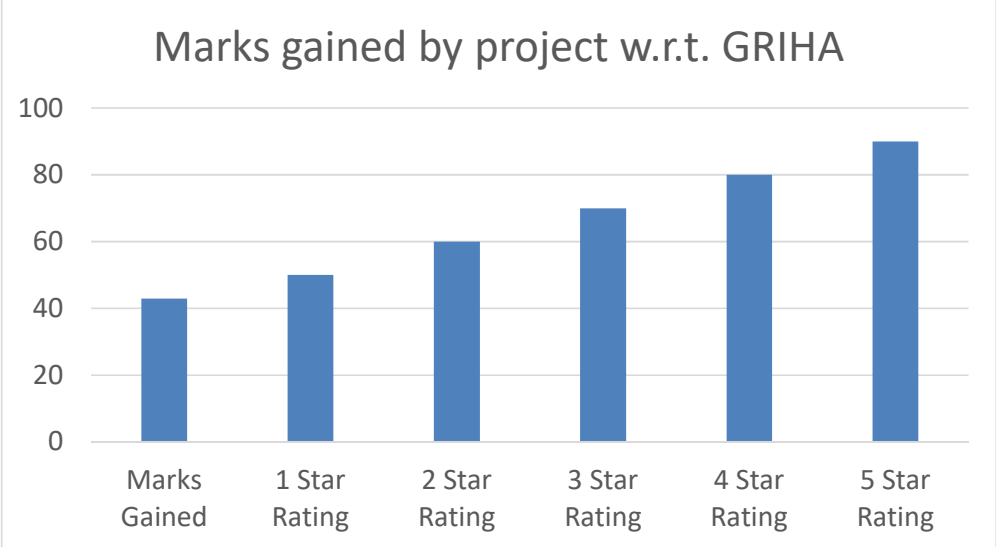

Figure 15 Comparative analysis of marks gained by SGH as per GRIHA star ratings

RESULTS

The above statistics shows that the chosen residential project is falling short of 1-star green rating by 7 marks as per GRIHA. Following are the shortcomings of the project and these remedial measures can be adopted for achieving at least 1 star rating.

1) To reduce the air pollution and improving air quality on the site no specific measures were taken. Therefore wheels of the vehicles entering or leaving the site shall be cleaned properly to reduce air pollution.
2) While loading the demolished waste or unloading the construction materials on the site, fresh water must be sprinkled to reduce air pollution and gain marks for criterion 9.
3) To gain marks under criterion 13, and reducing the use of conventional energy sources the portion of infrastructure's receiving extra sunlight can be shaded or covered by some external arrangements or devices.
4) For achieving marks under criterion 27, better fire fighting arrangements can be provided in the multi storeyed buildings such as automatic sprinkler system which functions on generation of heat. Also, the equipment's such as air conditioning and refrigeration which are the major sources of CFC shall be minimized.
5) For satisfying criterion 28 the water quality testing reports can be obtained from local municipal corporation authorities who will ensure that the water quality standards are maintained as specified in Indian Standard code 10500
6) For gaining marks under criterion 30, awareness can be brought among the stakeholders about not to consume tobacco and smoking. For this worker can be provided with a workshop and sign boards can be installed in the campus, indicating "Ban on Tobacco & No smoking zone." The smoking zone shall be provided separately.
7) The lacking behind in criterion 32 can be fulfilled by undergoing Energy Audit, water quality Audit and Solid waste audit of the site by the help of experts within two years of occupancy.
8) To avoid wastage of water and score marks under criterion 33, water meters need to be installed along the supply mains to notify and control the wastage of water.
9) These recommendations and changes will help in satisfying the mandatory criteria of GRIHA and will help in gaining at least 1-star rating.
10) Similar studies can be done on other traditional projects and a consolidated report can be submitted to government bodies to mandate the green construction practices in the developing Tier-II cities of India which can protect us from environmental losses.

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