Benchmarking Campus Sustainability: A Case Study of GEM Green Building Principles in Practice

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Abstract: While green certifications in educational institutions remain limited in adoption, the need for sustainable campus development is increasingly urgent. This paper presents a practical case study of JSPM's RSCOE campus, evaluated through the GEM Green Building Rating framework. By benchmarking key sustainability indicators such as water usage, energy efficiency, landscaping, and waste management, the study assesses existing practices against national green building principles. The analysis highlights performance gaps and offers actionable strategies for improvement, aiming to demonstrate how even non-certified campuses can transition toward sustainability in a cost-effective and phased manner. This work serves as a reference for similar institutions seeking to enhance environmental responsibility without formal certification.

Key words: Green Building, GEM Rating, Sustainability in Education, Campus Benchmarking, Environmental Performance.

1. INTRODUCTION

In the face of increasing environmental degradation, resource scarcity, and climate change, the construction industry has been compelled to adopt more sustainable and responsible building practices. One of the most influential mechanisms driving this shift is the application of Green Building Certification systems, which serve as structured frameworks to evaluate and promote environmentally responsible design, construction, and operation of buildings. These systems assess critical sustainability parameters including energy and water efficiency, indoor air quality, material sustainability, and waste management, with the overarching aim of minimizing environmental impacts and enhancing human health and well-being. Certification programs such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), and GEM (Green and Ecofriendly Movement) offer region-specific criteria to guide and assess sustainability in the built environment. These programs not only benchmark sustainability performance but also influence design decisions, operational strategies, and institutional policies aimed at fostering environmental stewardship. As Rehana and Krishna (2023) note, sustainable landscapes and green infrastructure can reduce water use by up to 40%, while enhancing ecological resilience and urban livability. Moreover, certified green buildings offer substantial economic and social benefits. They demonstrate lower lifecycle costs through reduced energy and water consumption, and provide healthier indoor environments through better ventilation, reduced exposure to VOCs, and improved 2 daylighting (EPA, 2024; ASHRAE, 2014). These enhancements are directly linked to improved productivity, reduced absenteeism, and enhanced well-being of occupants. For instance, Izmirlioglu and Sozer (2025) demonstrated that the integration of BIM-based daylight optimization reduced lighting energy use by over 20%, while improving occupant comfort in educational buildings. One of the key players in India's green building movement, the GEM Green Building Certification, focuses on practical, scalable sustainability across diverse typologies, including educational institutions. Its criteria align closely with the UN Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). Studies have shown that interventions such as high-albedo roofing, rainwater harvesting systems, and low-flow fixtures can contribute significantly to energy savings and water resilience, as well as reduce urban heat island effects (Elnabawi et al., 2023; Tota-Maharaj et al., 2025; Arafat et al., 2023).

In this context, JSPM's Rajarshi Shahu College of Engineering (RSCOE) has undertaken a comprehensive sustainability initiative aligned with the GEM certification framework. The institution's pursuit of certification reflects its commitment to reducing its ecological footprint, enhancing resource efficiency, and fostering a healthier learning environment on campus. By incorporating green infrastructure principles and datadriven environmental strategies, RSCOE aims to not only achieve certification but also position itself as a model of sustainable development in the academic sector. 3 This study presents a benchmark-based evaluation of the RSCOE campus using the GEM Green Building framework. It examines the current status of campus infrastructure, highlights strengths and deficiencies, and proposes actionable recommendations for improvement. Through this process, the campus becomes a living laboratory for sustainability — offering students and faculty an opportunity to engage in real-world green practices and policy experimentation. The study further reinforces how institutional adoption of green principles contributes meaningfully to national sustainability goals and global climate commitments.

Literature Review Several studies have emphasized the importance of green campuses in mitigating greenhouse gas emissions and advancing environmentally sustainable infrastructure (EPA, 2022; UNEP FI, 2023). Jain and Kakati (2024) further identified regional barriers to the adoption of green building practices, particularly in Northeast India. Dubey et al. (2023) identified a gap in current rating systems, which often overlook sustainability during the construction phase. Emerging technologies like nano-insulation, BIM-integrated energy simulation, and IoT systems have been proposed for real-time monitoring and optimization of energy use (Ghalandari et al., 2023; Izmirlioglu & Sozer, 2025).

Table- 1: GEM Rating System

S.No.	Points scored	GEM levels	GEM
1	All essential requirementsand 40 - 49 points	GEM 1	
2	All essential requirementsand 50 - 64 points	GEM 2	
3	All essential requirementsand 65 - 84 points	GEM 3	
4	All essential requirementsand 85 - 104 points	GEM 4	
5	All essential requirements and 105 points or above	GEM 5	

2. METHODOLOGY

The methodology adopted by team for assessing the sustainability performance of JSPM's RSCOE campus under the GEM Green Building Certification framework was structured into four distinct yet interrelated phases: Planning & Drafting, Field Surveys, Data Analysis & Calculations, and Evaluation Sheet Preparation. Each phase was carefully designed to ensure that the campus's environmental performance was measured comprehensively and systematically, aligned with GEM's sustainability principles.

2.1 Planning and CAD Drafting: The process began with the collection of existing infrastructure layouts and building documentation from college authorities. These were then digitized and redrawn using AutoCAD to create updated, accurate site and building layout plans. These drawings included:

- ❖ **Overall campus site layout**
- ❖ **Block-wise building footprints ϖ Parking zones**
- ❖ **Landscape and vegetation areas**
- ❖ **Water systems and utilities**

These CAD-generated layouts served as the foundation for evaluating spatial aspects such as built-up area ratios, landscape percentages, tree placement, parking facilities, and rainwater harvesting infrastructure.

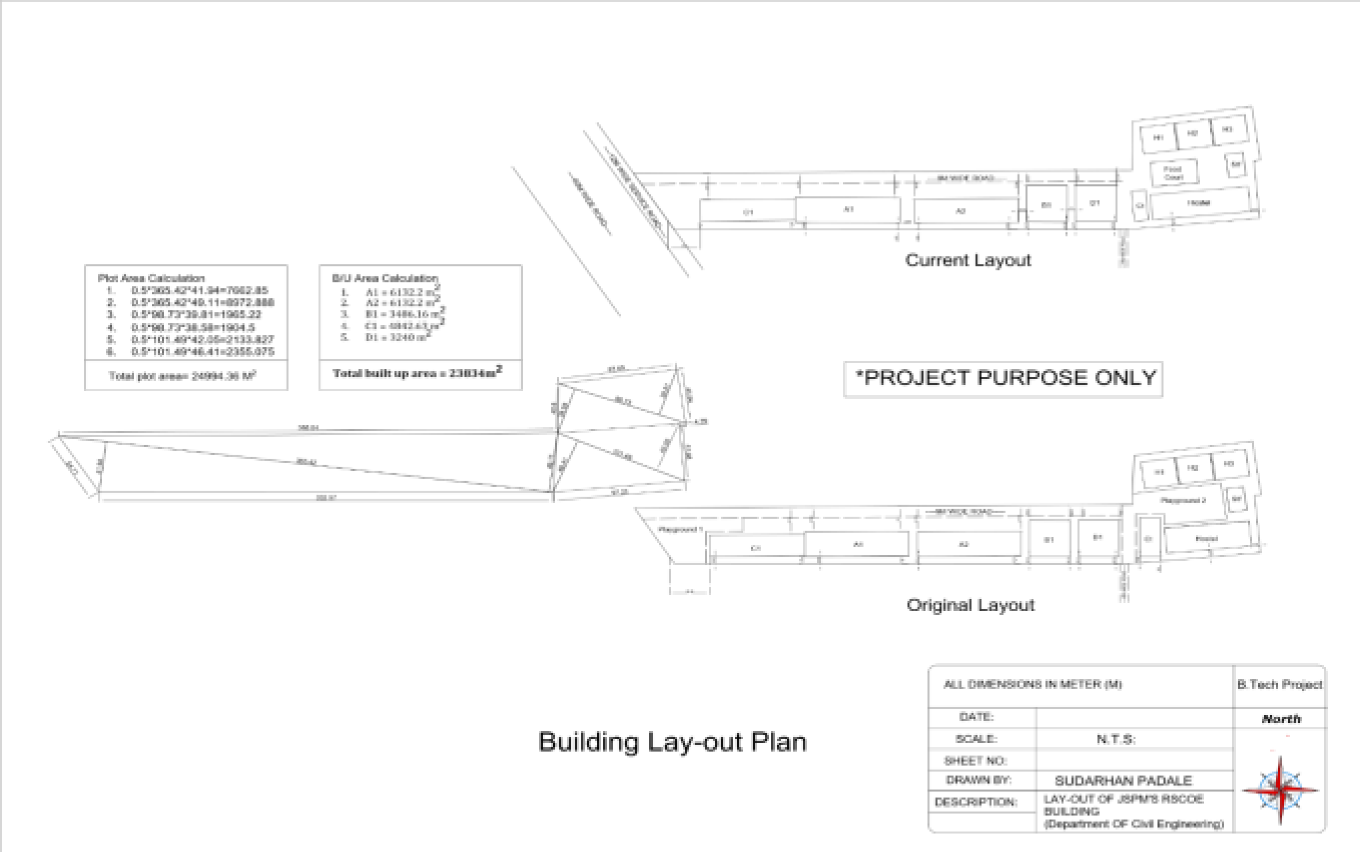

Fig. 1: Building layout plan

Fig. 2: Pedometer map

2.2 On-Site Surveys and Field Measurements

Dedicated field visits were conducted to survey and document existing campus practices related to each principle in the GEM framework. Each survey was carried out using customized checklists, tools, and visual inspection techniques:

- **Water Flow Rate Survey**: Used beakers and timers to measure actual fixture discharge rates (WCs, taps, showers). ϖ Tree Count and Landscaping Survey: Verified count, and coverage using visual inspection.

- ❖ **Parking Area Assessment:** Measured vehicle space dimensions and categorized parking types (Car, 2-wheeler, EV potential).
- ❖ **Roof and Material Surveys**: Evaluated roof reflectivity and material type for albedo calculations.
- ❖ **Waste Management Survey:** Documented bin distribution, signage, segregation practices, and organic waste handling.
- ❖ **Lighting and Ventilation Checks:** Carried out classroom-wise audits for natural lighting and cross ventilation.
- ❖ **Water Source and Reuse Check:** Evaluated plumbing systems, harvesting structures, and wastewater treatment setups.

Each survey was documented using photos, Excel and markups on CAD base plans.

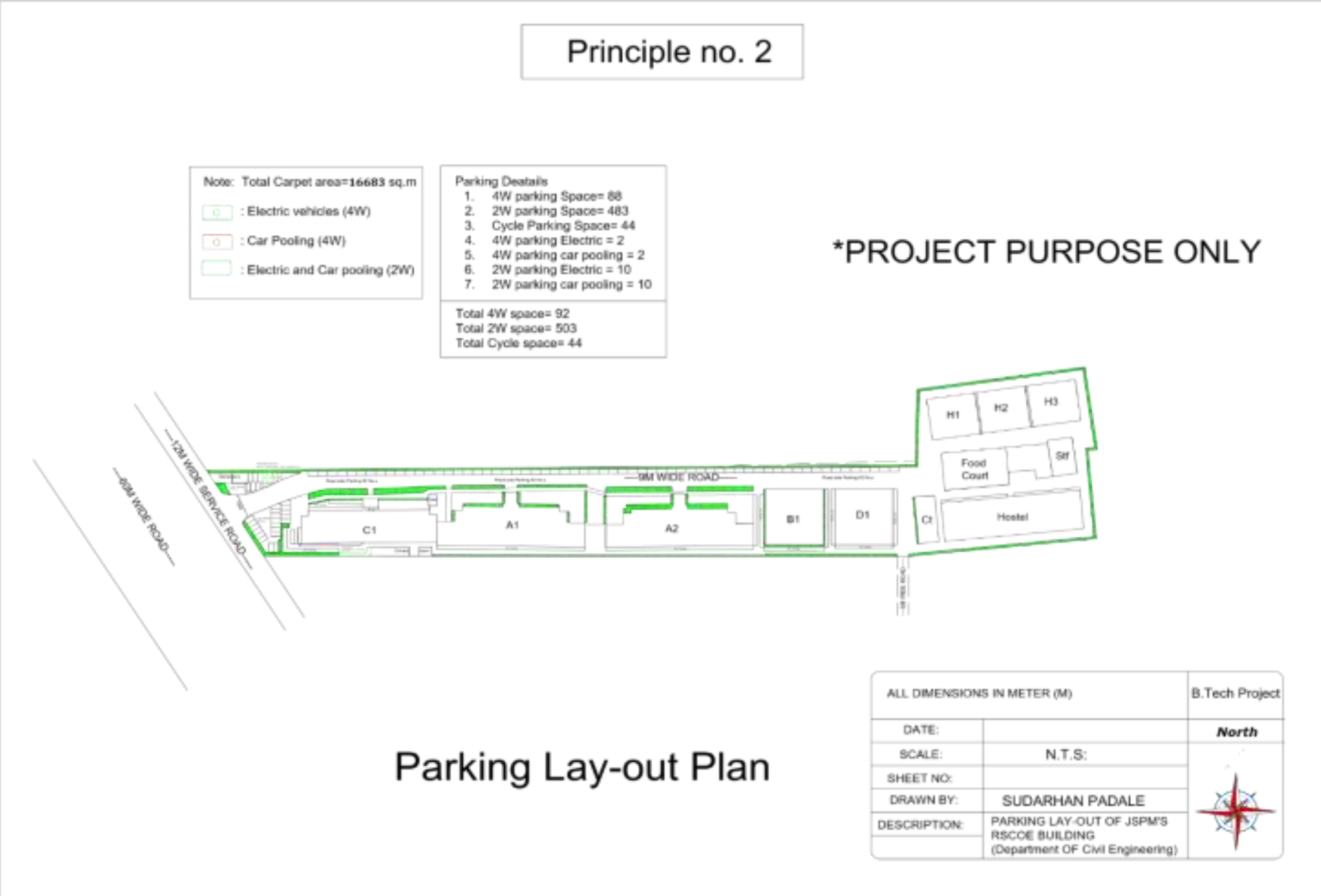

Fig. 3: Parking layout plan

2.3 Data Analysis and Calculations

After completing the physical surveys, the collected data was processed and analyzed through a series of quantitative and qualitative methods.

Key calculations and benchmarking analyses included:

- ❖ **Landscape Ratio and Green Coverage:**
  %Calculated using measured landscape areas over site layout drawings. The landscape ratio indicates the proportion of the site dedicated to vegetated, permeable surfaces which aid in reducing the urban heat island effect and promoting biodiversity. High landscape coverage contributes positively to microclimate regulation and ecological balance within the campus.

- ❖ **Parking Space Analysis**
  Evaluated based on the designated parking areas marked in the site layout. The analysis considers the surface area used for two-wheeler and four-wheeler parking, and its proportion to the total site area. This helps assess impervious surface coverage, vehicular load, and opportunities for incorporating sustainable alternatives like shaded or green parking.

❖ **Tree Number Density**
Tree number density is assessed by calculating the number of trees per unit area of open space. It serves as an indicator of urban greening. Additionally, contribution to air purification, shading, and carbon sequestration.

❖ **Rainwater Harvesting Volume**
Estimated using the rooftop catchment areas in conjunction with local annual rainfall data. The theoretical volume of rainwater that can be harvested provides insight into the site's potential for water conservation, recharge, and nonpotable use. This contributes to reducing the dependency on external water sources and promotes sustainable water management practices.

❖ **Water Fixture Discharge**
Analysis Compared measured flow rates of water fixtures such as taps and flushes against GEM benchmarks to evaluate water efficiency. This analysis aids in identifying high discharge fixtures and recommending retrofits like aerators or low-flow systems to optimize water usage within the facility.

❖ **Daylight Availability**
Daylight access is evaluated based on building orientation, window-to wall ratio, glazing types, and interior layouts. Effective daylighting reduces the need for artificial lighting during daytime hours, thereby conserving energy and enhancing occupant comfort and productivity.

❖ **Natural Ventilation**
Natural ventilation is assessed through the design of openings (windows, ventilators), cross ventilation potential, and building orientation. Good ventilation contributes to indoor air quality, thermal comfort, and energy 7 savings by reducing the reliance on mechanical ventilation systems. Wherever applicable, national standards and GEM thresholds were used as reference points to establish performance benchmark

Table - 2: Daylight Calculations

Daylight C1 Building

Sr no.	Description	Measurement of room		Floor Area (Sq.m)	Window Direction	Measurement of window			Head Height	No. of Windows	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	Total daylight area (Sq.m)	Day Lighting (Percentage)
		Length	Width			Width	Height	Sill						
1	Class Room	9	7.5	67.5	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	91%
2	Class Room	9	7.5	67.5	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	91%
3	Class Room	9.15	7.5	68.625	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	90%
4	Principle Cabin	8.17	7.07	57.7619	North	1.6	1.12	0.915	2.035	2	5.698	3.6	41.0256	71%
5	Office	9.15	7.5	68.625	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	90%
6	Office	9	7.5	67.5	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	91%
7	Class Room	9	7.5	67.5	North	1.6	1.12	0.915	2.035	3	5.698	3.6	61.5384	91%
8	Staff Room	4.5	5.2	23.4	South	1.6	1.12	0.915	2.035	1	4.477	3.6	16.1172	69%
9	Comp Lab	14.96	7.5	112.2	South	1.6	1.12	0.915	2.035	5	4.477	3.6	80.586	72%
10	Class Room	9	7.5	67.5	south	1.6	1.12	0.915	2.035	3	4.477	3.6	48.3516	72%
11	Class Room	9	7.5	67.5	south	1.6	1.12	0.915	2.035	3	4.477	3.6	48.3516	72%
12	Library	14.96	7.5	112.2	south	1.6	1.12	0.915	2.035	5	4.477	3.6	80.586	72%
13	Staff Room	4.5	5.2	23.4	South	1.6	1.12	0.915	2.035	1	4.477	3.6	16.1172	69%
	Average Day Lighting													80%

DATA	
Latitude > 15 degrees (For PCMC)	
Shading with PF<4 (Projection/Height of window)	
VLT>3 (Assumed)	
DEF	
North	2.8
South	2.2
East	1.1
West	0.7

Summary		
Building	Daylight.	Average
C1	80%	62%
A1	66%	
A2	65%	
B1	52%	
D1	48%	

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Table - 3: Natural Ventilation Calculations

Natural Ventilation C1 Building														
Sr no.	Description	Measurement of room		Floor Area (Sq.m)	Measurement of door		Area of door (Sq.m)	Measurement of window			No. of Windows	Window Area (Sq.m)	Net Openable Area	Ratio
		Length	Width					Width	Height	Sill				
1	Class Room	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
2	Class Room	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
3	Class Room	9.15	7.5	68.625	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
4	Principle Cabin	8.17	7.07	57.7619	1.92	1.12	2.1504	1.6	1.12	0.915	2	3.584	5.7344	10%
5	Office	9.15	7.5	68.625	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
6	Office	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
7	Class Room	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
8	Staff Room	4.5	5.2	23.4	1.92	1.12	2.1504	1.6	1.12	0.915	1	1.792	3.9424	17%
9	Comp Lab	14.96	7.5	112.2	1.92	1.12	2.1504	1.6	1.12	0.915	5	8.96	11.1104	10%
10	Class Room	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
11	Class Room	9	7.5	67.5	1.92	1.12	2.1504	1.6	1.12	0.915	3	5.376	7.5264	11%
12	Library	14.96	7.5	112.2	1.92	1.12	2.1504	1.6	1.12	0.915	5	8.96	11.1104	10%
13	Staff Room	4.5	5.2	23.4	1.92	1.12	2.1504	1.6	1.12	0.915	1	1.792	3.9424	17%
													Average	12%

Summary		
Building	Ventilation	Average
C1	12%	11%
A1	10%	
A2	10%	
B1	13%	
D1	8%	

2.4 Preparation of Evaluation Sheets

Following analysis, each sustainability principle was documented using a standardized Evaluation sheet format, which included:

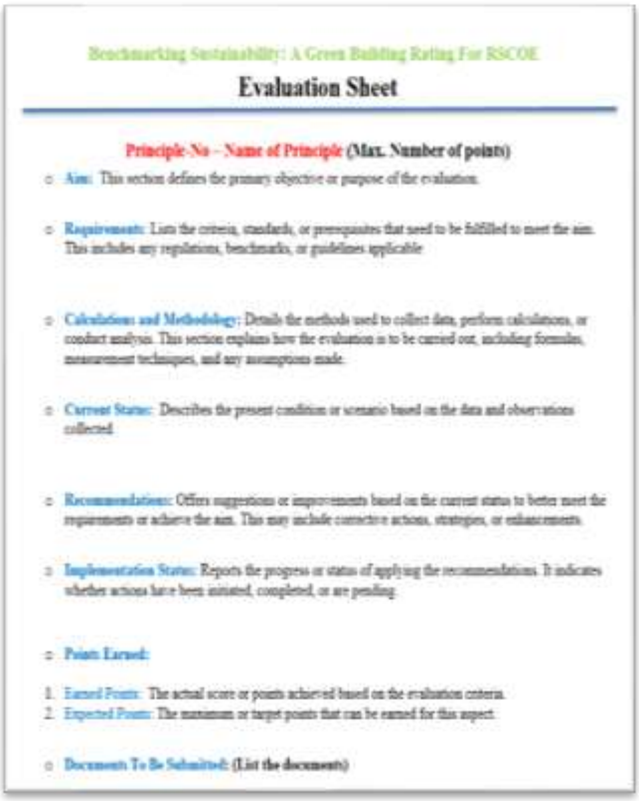
Current Scenario: A factual description of the existing infrastructure or practices.

Recommendations: Practical, tailored strategies for improving compliance or performance.

Implementation Status: Notes on feasibility and progress (existing, proposed, under consideration).

Points Earned: Points awarded based on GEM's official scoring matrix.

These evaluation sheets formed the backbone of the certification readiness report, guiding the prioritization of short-term improvements and long-term interventions. The final set of evaluation sheets served as a decision-support tool for institutional stakeholders.


Benchmarking Sustainability: A Green Building Rating For RSCOE

Evaluation Sheet

Principle-No – Name of Principle (Max. Number of points)

- Aim: This section defines the primary objective or purpose of the evaluation.
- Requirements: Lists the criteria, standards, or prerequisites that need to be fulfilled to meet the aim. This includes any regulations, benchmarks, or guidelines applicable.
- Calculations and Methodology: Details the methods used to collect data, perform calculations, or conduct analyses. This section explains how the evaluation is to be carried out, including formulas, measurement techniques, and any assumptions made.
- Current Status: Describes the present condition or scenario based on the data and observations collected.
- Recommendations: Offers suggestions or improvements based on the current status to better meet the requirements or achieve the aim. This may include corrective actions, strategies, or enhancements.
- Implementation Status: Reports the progress or status of applying the recommendations. It indicates whether actions have been initiated, completed, or are pending.
- Points Earned:

1. Earned Points: The actual score or points achieved based on the evaluation criteria.
2. Expected Points: The maximum or target points that can be earned for this aspect.

- Documents To Be Submitted: (List the documents)

Fig. 4: Evaluation sheet

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3.RESULTS AND DISCUSSION

The assessment of JSPM's Rajarshi Shahu College of Engineering (RSCOE) campus was conducted using the GEM Green Building Certification framework, comprising 27 sustainability principles. Each principle was evaluated through field surveys, document analysis, and performance benchmarking to determine current point achievements and future potential based on implementable recommendations.

3.1 Overall Certification Performance

• Maximum Attainable Points: 130
• Current Points Earned: 47
• Expected Points
-Post-Implementation: 92
This positions the RSCOE campus in the GEM 2 Star category under current conditions and projects it toward a GEM 3 Star rating upon successful execution of recommended measures.

3.2 Principle-Wise Scoring Summary

Out of the 27 GEM principles assessed, 22 were fully evaluated and marked as complete, while 2 principles (Energy Management Best Practices and Efficient Electric Equipment and System) remain under implementation. Three principles, including VOC control and use of imperishable energy, scored zero due to current infrastructural limitations. Notably, the campus performed strongly in key areas such as rainwater harvesting (4/4), tree plantation (2/2), universal design (5/5), campus amenities (6/6), and local material sourcing (6/6).

These results reflect strong institutional efforts in water management, landscaping, accessibility, and local procurement—all key sustainability areas in academic infrastructure.

Table - 4: GEM rating system score card

GEM Rating System Score Card					
Principle	**Principle decription**	**Max Points**	**Current points**	**Expected Points**	**Status**
1	Government Approved Plans	E	E	E	Complete
2	Parking for Building Occupants	2	0	2	Complete
3	Landscape Best Practices	4	2	4	Complete
4	Preserve and Plant Trees Onsite	2	2	2	Complete
5	High Albedo Materials - Roof and Non-roof	6	2	4	Complete
6	Rainwater Harvesting - Recharge and/ or Reuse	4	4	4	Complete
7	Install Low Flow Water Fixtures	7	0	4	Complete
8	On-site Treatment of Grey & Black Water & Reuse for Flushing	6	0	6	Complete
9	Irrigation Best Practices	3	2	3	Complete
10	Measurement of Energy and Water Consumption	6	0	6	Complete
11	Post-occupancy Waste Management	4	2	4	Complete
12	Onsite Conversion of Organic Waste	4	0	4	Complete
13	Amenities for fundamental needs and daily commute	6	6	6	Complete
14	Best Practices for Universal Building Design	5	5	5	Complete
15	Reduced Exposure to VOC	3	0	0	Complete
16	No Use of Halogenated Hydrocarbons	2	0	2	Complete
17	Sustainable Development of Construction Engineering	12	8	8	Complete
18	Local Sourcing of Construction Materials	6	6	6	Complete
19	Judicious use of hard wood and soft wood	4	0	0	Complete
20	Energy Management Best Practices	12	0	0	In progress
21	Efficient Electric Equipment and Systems	5	0	0	In progress
22	Use of Imperishable Energy Resources	6	0	4	Complete
23	Optimal Use of Natural Light	6	2	4	Complete
24	Healthy Indoor Air Quality	6	6	6	Complete
25	Training and Capacity Building of Project Team	2	0	2	Complete
26	Activities for Corporate Social Responsibility	2	0	2	Complete
27	Going the Extra Miles	5	0	4	Complete
	Total Points	130	47	92	

3.3 Areas Needing Improvement

Table - 5: Zero Score Principles

Principle	Max Points	Current Score	Remarks
Low Flow Water Fixtures	7	0	Existing fixtures exceed GEM limits
Grey & Black Water Treatment	6	0	No current reuse infrastructure
Energy & Water Submetering	6	0	No smart metering systems installed
Energy Management	12	0	Under development
VOC Control	3	0	High-VOC materials still in use
Efficient Electric Equipment	5	0	Traditional systems still dominate

Several principles scored low or zero, indicating substantial room for improvement: These gaps, if addressed, can yield an additional 45 points, pushing the total from 47 to 92 significantly enhancing the certification level and sustainability profile of the campus.

3.4 Certification Projection Based on GEM's point thresholds:

Table - 6: Expected levels for GEM system

GEM Level	Points Required	Status at RSCOE
GEM 1	≥ 40	Achieved
GEM 2	≥ 60	Pending (with improvements)
GEM 3	≥ 80	Projected
GEM 4	≥ 100	Not achievable without systemic upgrades
GEM 5	≥ 120	Not in current scope

The project's structured approach and documented evaluations support a realistic transition from **GEM 1 to GEM 3**, showcasing measurable campus sustainability improvement.

4. RECOMMENDATIONS

To enhance the sustainability performance of JSPM's RSCOE campus and achieve higher GEM certification levels, several focused improvements are recommended. In terms of energy efficiency, smart submetering systems and energy-efficient equipment should be introduced, alongside the development of a formal energy management policy. For water conservation, retrofitting high-flow fixtures and implementing a grey and black water treatment system for reuse in flushing and irrigation is essential.

To improve indoor environmental quality, future construction should use low-VOC materials and enhance natural ventilation. Waste management can be strengthened by introducing composting units, ensuring classroom-level waste segregation, and conducting awareness programs. The adoption of imperishable and renewable energy sources, such as solar power, should be prioritized wherever feasible. Additionally, high-reflectance roofing and optimized daylight design should be adopted to reduce heat gain and energy load.

For principles related to materials and construction, increased use of locally sourced and certified sustainable materials, along with responsible timber use, is advised. Lastly, strengthening efforts in training, CSR activities, and continuous monitoring will help maintain long-term sustainability and stakeholder engagement. Collectively, these interventions will bridge existing gaps and support the institution's transition toward a more resource-efficient, resilient, and environmentally responsible campus

5. CONCLUSION

In conclusion, this evaluation has provided a comprehensive assessment of the current status against the established green building principles and sustainability benchmarks. The analysis clearly highlights areas where the campus meets or exceeds the required standards, as well as aspects that need improvement. By following the recommended actions and systematically implementing the proposed measures, the institution can significantly enhance its sustainability performance and move closer to achieving the desired certification goals.

The structured methodology and rigorous calculations used in this assessment ensure that the findings are reliable and actionable. Continuous monitoring and timely implementation of recommendations will be crucial for maintaining progress and realizing long-term benefits in resource efficiency, environmental impact reduction, and overall campus sustainability.

Ultimately, this evaluation not only serves as a benchmark but also as a roadmap guiding the institution towards greater ecological responsibility and operational excellence. With commitment and collaboration among all stakeholders, the campus can establish itself as a model for sustainable development in academic environments.

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