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Conceptual Framework for Sustainable Refurbishment of Urban Educational Campus using a Sustainability Assessment Tool

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Abstract

Owing to the rising need for green infrastructure and sustainable universities, many urban educational campuses across India are undertaking sustainable refurbishment of their infrastructure. Pune City is home to many such campuses, of which some are certified and some are in process. Various Sustainability Assessment Tools provided by the Green Building Certification bodies of India aid this transition. While the guidelines exist, there is no structured system devised for prioritizing criteria for implementation. This poses a challenge especially for those campuses that are far behind in their sustainability journey and score very less on initial assessments. The paper proposes a conceptual framework based on a thematic coding that provides a phase-wise approach to carry out the sustainable refurbishment. It also addresses goals like net-zero and net-positive environmental impact. The first step toward sustainable infrastructure is to achieve a Green Building Certification; which this framework attempts to simplify; for decision-makers.

Keywords: *Sustainable Refurbishment, Urban Educational Campus, Green Building Certification, Thematic Coding, Conceptual Framework.*

1. Introduction

India ranks as the world's third largest carbon emitter [1] with approximately 42% of its annual emissions originating from the built environment [2]. One of the first actions taken against global warming in lieu of the Paris Agreement was the green building movement. In India, the Confederation of Indian Industry CII launched the Indian Green Building Council (IGBC) in 2001 to lead this effort [3]. Since then, IGBC, along with US Green Building Council's Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) has promoted sustainable building practices across the country with over 15,000 registered projects in India.

While more than two-thirds of India's building stock is yet to be built, existing buildings still hold significant potential for reducing both resource consumption and emissions [4]. Urban Educational Campuses (UEC) are ideal starting points for sustainable refurbishments due to their mini-city-like setup [5] and mixed-use infrastructure. Located within city limits, they are often well-connected to public transport and building infrastructure. Pune, for example, is one of India's fastest-growing cities, and ranks fourth in the number of colleges, according to the latest AISHE report [6]. These campuses have a great opportunity to adopt sustainability practices, particularly in the context of the emerging concept of the "sustainable university". This paper focuses on developing a conceptual framework for the sustainable refurbishment of existing UECs in Pune with the broader goal of helping them transition toward sustainable university infrastructure.

1.1 Problem Statement

Sustainability Assessment Tools (SAT) provide comprehensive criteria for evaluating the sustainability of built environments. However, there is no structured system followed for prioritizing criteria for implementation. This poses a challenge especially for those UECs that are far behind in their sustainability journey and score very less on initial assessments.

1.2 Aim and Objective

Proposing a conceptual framework and methodology for sustainable refurbishment of Urban Educational Campus using a Sustainability Assessment Tool.

1.3 Scope and Limitation

The focus of the research is on UECs within Pune City that are seeking sustainable refurbishment using an SAT and aiming for a Green Building Certification (GBC). The framework is flexible and can be adapted to different typologies or regional contexts with minimal modifications.

2. Literature Review

As defined by United Nations Environment Programme (UNEP), a sustainable university fosters education and awareness among students and stakeholders on sustainable development, guiding them to adopt responsible practices in their lives and careers [7]. Several Indian campuses, especially IITs, are leading the way in this direction. IIT Bombay, for instance, ranks 118th in the QS World University Rankings, alongside 78 other established Indian universities [8]. Many of them are pursuing goals like net zero waste, carbon, water and energy. However, this represents roughly 8% of universities in India highlighting a wide scope of improvement.

Studies show that nearly 77% of a building's "whole life carbon" is generated during its operations phase, making this the most critical stage for sustainable intervention [2]. Operational expenses; such as utility bills and maintenance; can account for up to 75% of a building's total lifecycle cost, further emphasizing the value of sustainable refurbishment.

SATs play a vital role in both; addressing the infrastructure goals of sustainable universities and reducing the operational and maintenance expenses. The purpose of these tools is to collect and document data for effective decision making during across different phases and provide a structured framework to follow. In the existing research, the most widely accepted urban SATs were reviewed and compared to identify differences and similarities by [9] while [10] performed a systematic review of papers relating to sustainability in campus operations in Higher Education Institutes highlighting their importance in promoting sustainability. [11] compared 12 sustainability assessment tools, studied that functions related to Sustainable University and emphasized the importance of operations and resource management.

While many such studies have been performed on correlating the significance of SAT parameters to the Sustainable Development Goals (SDG), very few address the implementation aspect of the tools with respect to resources needed. The research by [12] outlines a detailed journey of a campus toward sustainability as a student-led initiative while other papers like [13] and [14] discuss mainly energy retrofit case-studies in depth. Thus, the review of existing research poses a gap that this paper aims to address.

3. Materials and Methods

3.1 Research Methodology

This study is based on a qualitative research methodology adopted to develop a conceptual framework for the sustainable refurbishment of UECs. The step-by-step process is depicted in Figure 1 and outlined below:

1. Comprehensive literature review: research papers, GBC bodies in India and their SATs.
2. Comparative analysis: SATs from the three identified GBC bodies and selection of appropriate one.
3. SAT analysis: study of structure, sections, criteria and documentation requirements.
4. Thematic Coding: classification and grouping of criteria in a tabular format.
5. Conceptual Framework: designing of a systematic approach to sustainable refurbishment.

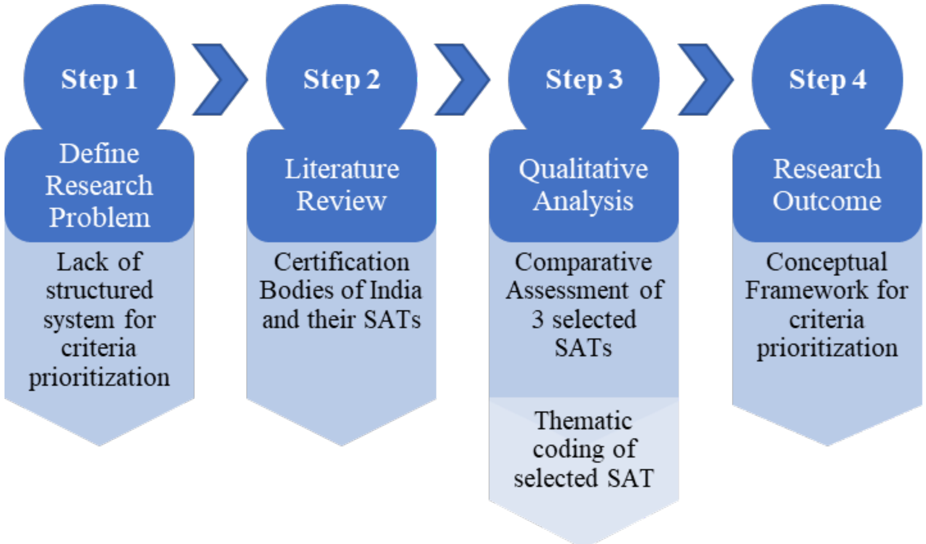

Fig. 1 Flow Chart of Research Methodology.

3.2 Materials

The three leading GBC bodies of India namely LEED, GRIHA and IGBC develop and refine rating systems or SATs for different infrastructure typologies. Thus, the selection of the SAT befitting the type of project undertaken is a crucial step especially in the case of refurbishment. This study evaluated three specific tools from LEED [15], GRIHA [16] and IGBC [17], on the basis of parameters shown in Table 1. Based on the assessment, it is observed that while LEED Campus Guidance (2024) offers global recognition, it poses a financial challenge for UECs in Pune due to its international standard compliance and high certification fee. On the other hand, GRIHA for Large Developments (2015) is deeply rooted in the Indian context and follows local guidelines but has an area limitation of 125 acres and requires a Lifecycle Analysis (LCA) focused study making it less feasible. However, IGBC's Green Campus Rating System (2024) (IGBC GCRS) is strongly relevant to the Indian context, has a rating system specifically targeted for educational campuses, has low certification fee and is comparatively easier to implement making it the most relevant and practical choice.

Table 1: Comparative Analysis of Three Selected SATs

Criteria for Selection	**Sustainability Assessment Tool**					
	LEED Campus Guidance (2024)		**GRIHA for Large Developments (2015)**		**IGBC Green Campus Rating System (2024)**	
Relevance to Indian Context	×	Not tailored to Indian context	✓	Specifically designed for Indian context	✓	Strong relevance to Indian context
Applicability to Educational Campuses	✓	Adapted Guide for Campuses	×	No specific guide for educational campuses	✓	Has a Guide for Educational Campuses
Cost Effectiveness	×	High compliance fee	×	Low compliance fee but requires LCA study	✓	Low compliance fee, cost-effective
Analysis Method	×	Advanced simulation-based analysis needed	×	Complex data requirements, LCA-focused	✓	Simplified calculations and baseline comparisons
Implementation Complexity	✓	Complex, uses international standards, suited for high-end projects	✓	Comprehensive, uses Indian standards, requires more effort	✓	Simpler, uses Indian standards, flexible starting point

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Flexibility and Scalability	✓	No area limitation, adaptable framework	✕	Area limitation of 125 acres	✓	No area limitation, flexible framework
Recognition and Credibility	✓	Globally recognized by US GBC	✓	Supported by MNRE & TERI	✓	Recognized by IGBC, widely accepted in India.
Selection Status	✕	**Not selected**	✕	**Not selected**	✓	**Selected**

4. Analysis and Findings

4.1 Understanding IGBC GCRS

The rating system is divided into eight sections covering a comprehensive range of sustainability criteria. Table 2 provides details of each section, including the section number (SN), section weightage (SW), section name, criteria description, criteria weightage (CW) and type of work. SW represents the relative weightage of the section to the rating system and CW represents the relative weightage of the criteria to the section. Figure A1 offers a visual summary of the sections and criteria using colour coding to highlight the relative importance of each. To emphasize the Mandatory Criteria (M) in the graph, they have been plotted with 15 Credits as a purely indicative measure and is thus not adopted in Table 2. It is observed that the Site Planning and Management section carries the highest weightage followed by Energy Efficiency and Water Conservation. The type of work required to implement each criterion, written in the 'Type of Work' column, support the thematic coding approach covered in Section 3.3.

Table 2: Breakdown of IGBC GCRS

SN	SW	Section Name	Criteria Description	CW	Type of Work
1	25%	Site Planning and Management	Green Features in Campus Buildings	M	Retrofit
			Soil Erosion Control Policy	M	Policy Development
			Enhanced Green Features in Campus Buildings	48%	Retrofit
			Basic Amenities	4%	Documentation
			Green Cover	16%	Retrofit
			Heat Island Reduction	24%	Retrofit
			Outdoor Light Pollution Reduction	4%	Retrofit
			Universal Design	4%	Retrofit
2	7%	Sustainable Transportation	Pedestrian Network with Illumination	29%	New Installation
			Bicycle Network with Illumination	29%	New Installation
			Access to Sustainable Transportation	43%	Documentation
3	20%	Water Conservation	Rainwater Harvesting	M	Validate
			Enhanced Rainwater Harvesting	30%	Retrofit
			Sustainable Landscape	10%	Validate
			Management of Irrigation Systems	10%	New Installation
			Wastewater Treatment and Reuse	30%	New Installation
			Water Performance Monitoring	20%	New Installation
4	24%	Energy Efficiency	Eco-Friendly Refrigerants	8%	Retrofit
			Enhanced Energy Efficiency	33%	Retrofit
			Green Power	42%	Validate
			Energy Performance Monitoring	17%	New Installation
5	8%	Material and Resource Management	Segregation of Waste	M	Retrofit
			Use of Green Products and Equipment	38%	Practice

			Dry Waste Management	13%	Retrofit
			Organic Waste Management	50%	New Installation
6	6%	Health and Well-Being	Tobacco Smoke Control	M	Policy Development
			Daylighting	50%	Validate
			Control Indoor and Outdoor Pollutants	17%	Retrofit
			Health and Well-Being Facilities	33%	Documentation
7	3%	Sustainable Operations and Maintenance	Green Audit (Water and Energy)	67%	Policy Development
			Green Education	33%	Policy Development
8	7%	Innovation in Design	Innovations in Design Process	57%	New Installation
			GHG Inventorization And Mitigation Measures	29%	Practice
			IGBC Accredited Professional	14%	Practice
	100%	← Total SW for 8 sections	Total CW for 8 sections →	800%	

4.2 Criteria Organization using Thematic Coding

Thematic coding is a qualitative analysis technique used to categorize items based on common themes or characteristics. In this study, it was applied to organize the criteria of IGBC GCRS according to the type of work required for implementation as shown in Table 2. The Criteria Classification (CC) is explained below:

- CC1: New Installation – Credits requiring installation of new systems or infrastructure.
- CC2: Retrofits – Credits for upgrading or improving existing infrastructure.
- CC3: Policy Development – Credits for policy development and basic documentation.
- CC4: Practice – Credits for change in management and occupant-level behaviors.
- CC5: Validate – Credits for verification of existing systems through calculations.

Table 3: CC1 - CC5 Classification Distribution Across All Sections of IGBC GCRS

S. No.	Section Name	Criteria Numbers	Criteria Classification 1 - 5				
			CC1	CC2	CC3	CC4	CC5
1	Site Planning and Management	8	0%	75%	25%	0%	0%
2	Sustainable Transportation	3	67%	0%	33%	0%	0%
3	Water Conservation	6	50%	17%	0%	0%	33%
4	Energy Efficiency	4	25%	50%	0%	0%	25%
5	Material and Resource Management	4	25%	50%	0%	25%	0%
6	Health and Well-Being	4	0%	25%	50%	0%	25%
7	Sustainable Operations and Maintenance	2	0%	0%	100%	0%	0%
8	Innovation in Design	3	33%	0%	0%	67%	0%
	Total Criteria Weightage	34	200%	217%	208%	92%	83%
	Relative Criteria Weightage	100%	**25%**	**27%**	**26%**	**11%**	**10%**
	Impact Assessment:		CC1	CC2	CC3	CC4	CC5
	Space		✓✓✓	✓✓	×	×	×
	Time		✓✓✓	✓✓	✓	✓	✓

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	Cost	✓✓✓✓	✓✓	✕	✓	✕
	Resources (Material/Machinery/Manpower)	✓✓✓	✓✓	✓	✓	✓
	Administration Processes	✕	✕	✓	✓	✓

Legend: ✓ = Low Impact, ✓✓ = Medium Impact, ✓✓✓ = High Impact, ✓✓✓✓ = Very High Impact, ✕ = No Impact

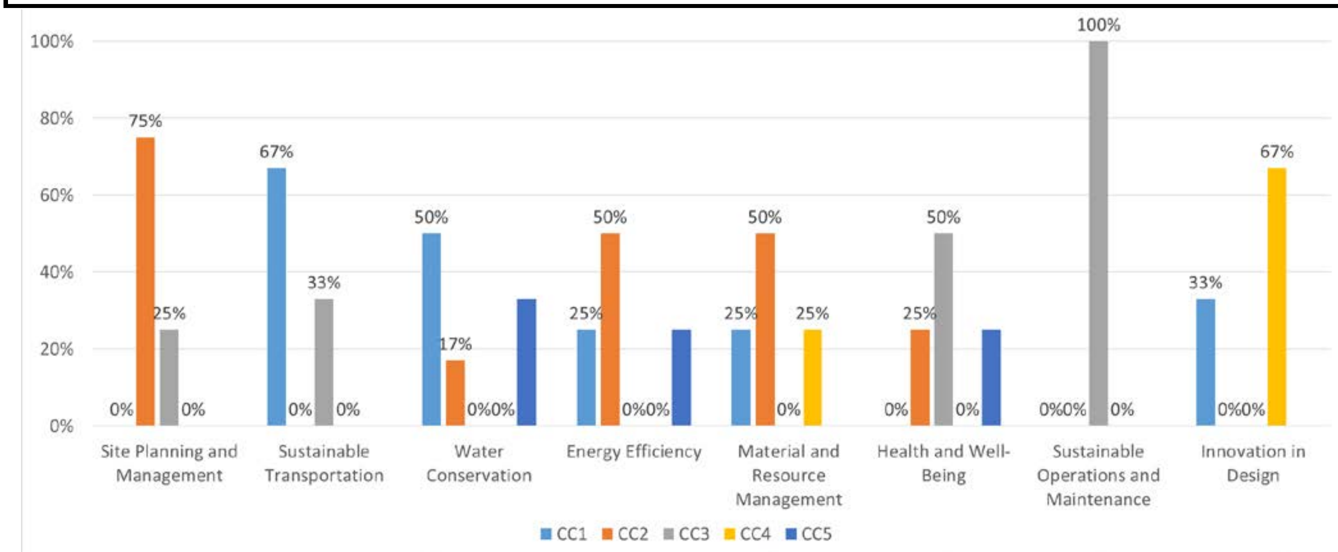

Fig. 2 Visual Depiction of Classification Distribution Across Various Sections of IGBC GCRS

Table 3 shows the distribution of CC1 to CC5 across all sections with the highest values marked in red. Figure 2 illustrates the data in a graphical format for clarity. Figure 3 illustrates that by attempting CC2 to CC4, nearly 75% of the criteria can be addressed, indicating that progress is achievable through retrofits, policy upgrades and behavioral shifts without immediately moving to major installations. CC1: New Installations on the other hand makes up only 25% of the criteria reinforcing the analysis that IGBC GCRS is easy to implement especially for campuses at the start of their sustainability journey. It can be noted from Table 3 and Figure 3 that CC2: Retrofits have the highest share of criteria overall. This is closely followed by CC3: Policy Development, which is less resource-intensive and easier to implement. CC4: Practice and CC5: Validate account for only 11% and 10% respectively, but when combined with CC3: Policy Development, they constitute 47% or nearly half of the criteria. Table 3 also shows the impact assessment over space, time, cost, resource and administration processes for all the sections giving a broad picture of the achievability of each of the CCs. It is important to note here, that addressing 75% of the criteria does not guarantee achieving 75 out of 100 credits, as not every credit may be fully attained for each criterion. Nonetheless, targeting these ensures a minimum score of 50, which is sufficient to achieve the certified status. According to the rating system, following are the recognitions awarded on the basis of credits achieved out of 100:

- 50-59% = Certified, Best Practices
- 60-69% = Silver, Outstanding Performance
- 70-79% = Gold, National Excellence
- 80-100% = Platinum, Global Leadership

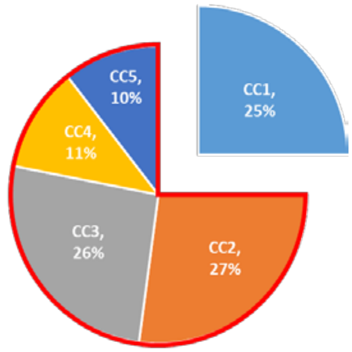

Fig. 2 Criteria Classification Distribution

4.3 The Conceptual Framework

Figure A2 shows the conceptual framework developed on the basis of the thematic coding classification explained above. It provides an implementation strategy for the criteria in a phase-wise manner. The criteria are placed on the basis of a logical sequence; starting from retrofitting existing systems to policy development and behavioral change; and eventually complex new installations. This approach enables decision makers to gradually approach campuses refurbishment and achieve a certification. The framework emphasizes maintaining and optimizing existing systems before planning for larger, more complex systems classified into the CC1: New Installations category. This aligns with IGBC's three-year certification cycle which ensures that the systems installed are maintained in sustainably. Beyond this, the framework also addresses larger sustainable infrastructure goals of net-zero and net-positive environmental impacts.

5. Conclusion and Recommendations

The research attempts to address the urgent need for sustainable refurbishment of UECs in Pune by proposing a framework to support informed decision-making. This framework encourages a phase-wise approach to the project by classifying the criteria on the basis of the type of work required for implementation and then prioritizing them for execution. Achieving green campus certification is the first milestone on the journey toward a "Sustainable University" because sustainability is an ongoing process, not a fixed destination. The paper aims to simplify this process for campuses by providing a structured approach. The goal of certification is to serve as a launchpad for long-term sustainable strategies like net-zero and net-positive environmental impacts.

While the framework is adaptable to other refurbishment projects, contexts and campus typologies, this study is limited to UEC refurbishment projects in Pune. It does not address rural educational campuses with different infrastructure challenges, nor does it cover campuses of non-educational typologies. Additionally, since the framework is built specifically around IGBC GCRS, minor modifications may be required for applicability to SATs by LEED or GRIHA. Testing the framework for applicability on real-life UEC projects in Pune will help identify lacunae and uncover practical limitations. Further research could focus on introducing timelines to the framework and developing financial models to support budgeting by leveraging savings generated through retrofits. These additions would further improve the frameworks usability for project planning and implementation.

Appendix A

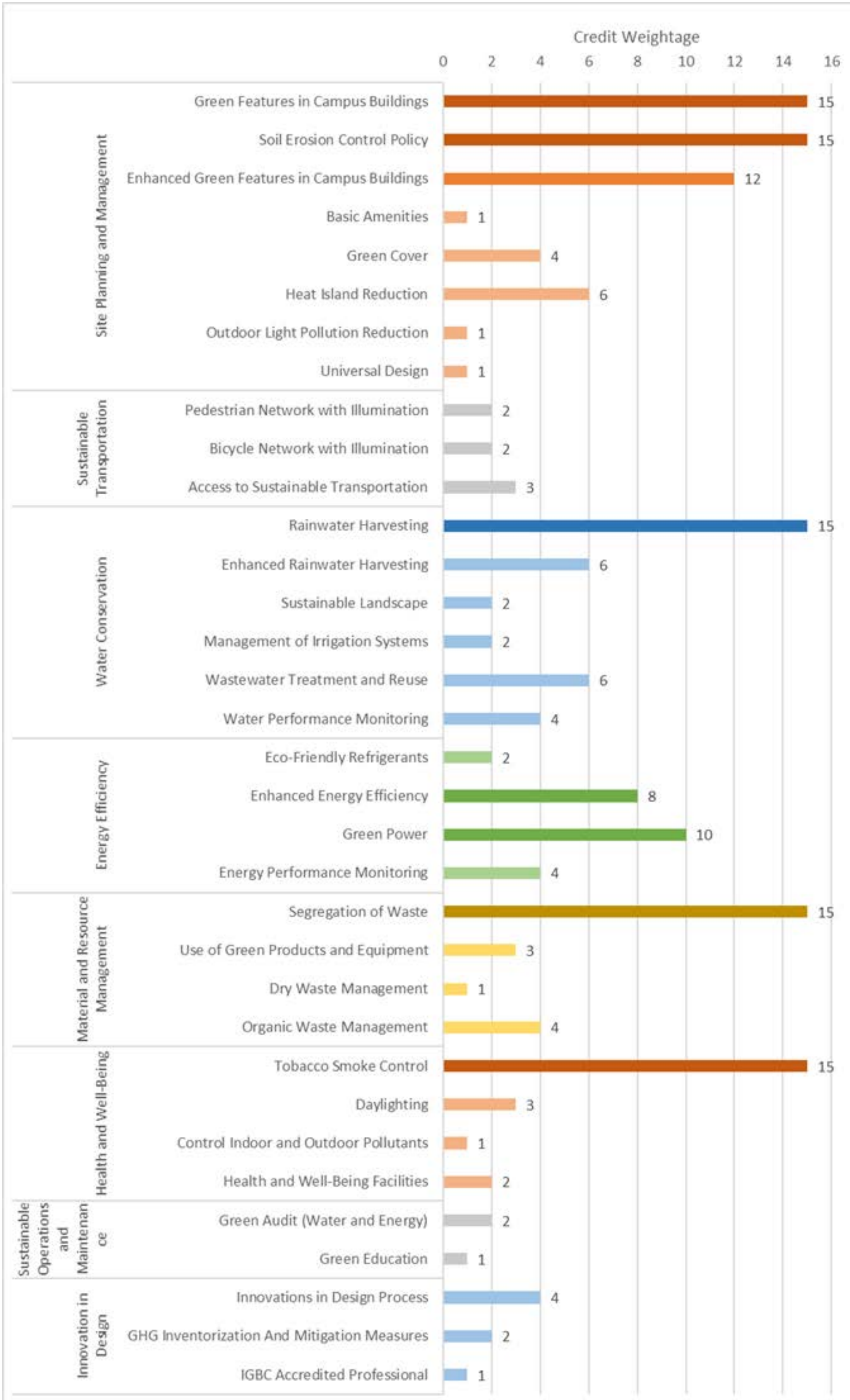

Fig. A1 Color-coded Summary of IGBC GCRS

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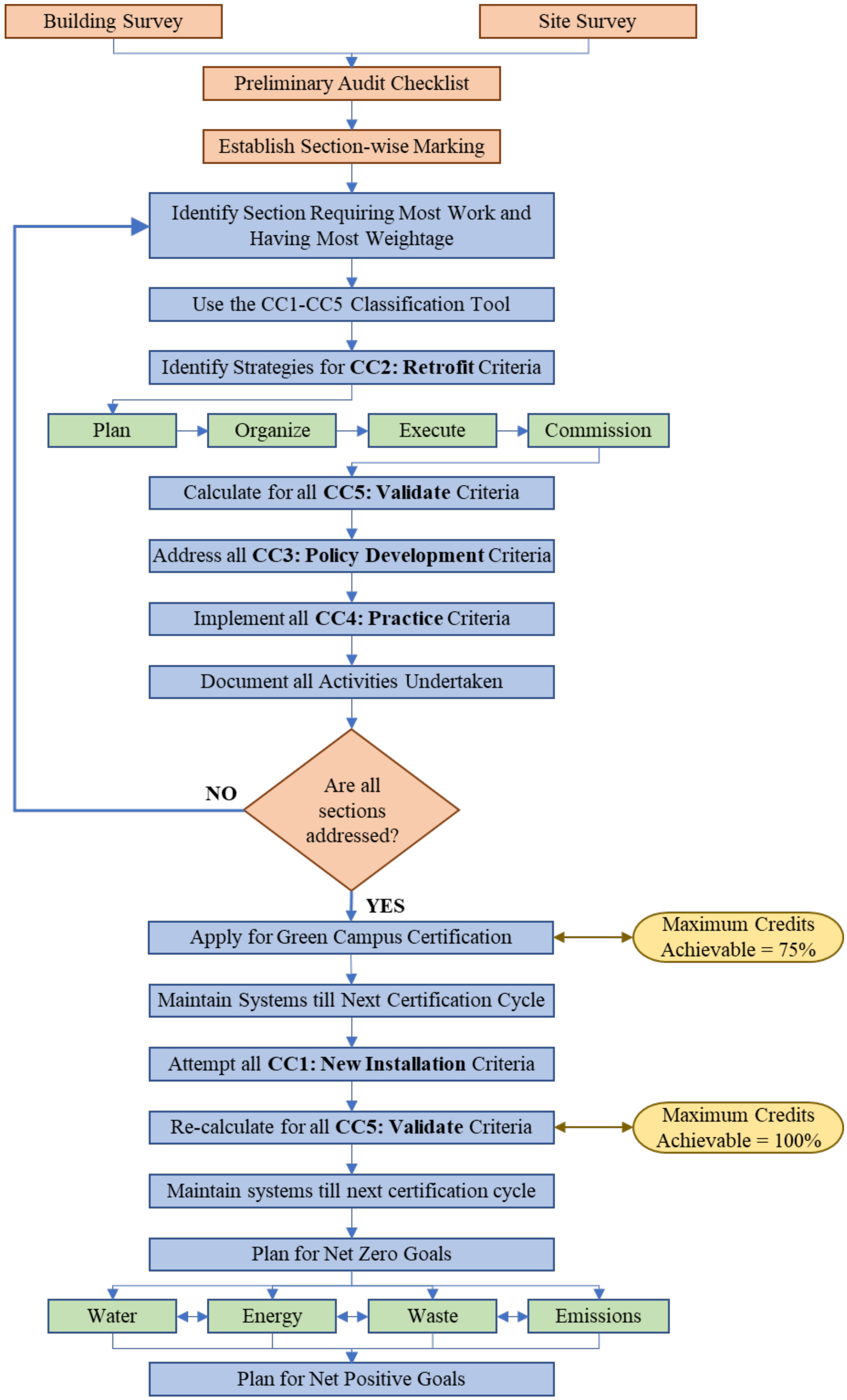

Fig. A1 The Conceptual Framework

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