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Waste Management for Zero Liquid and Solid Waste in Campus Buildings

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Abstract: ***The population is growing fast, the economy is thriving, and urban development and occupational expansion is leading to an increase in the production of liquid and solid waste in buildings. Zero liquid and solid waste is an innovative approach for addressing the waste issues in our society. The three precepts of "reduce," "reuse," and "recycle" (3R) were adapted to make the goal of zero waste a more valuable and efficient choice for sustainable creation. It is also expected that by 2030, India will be water-stressed, and solid waste generation statistics show an increase of 165 million in the municipal solid waste.***

Developing countries such as India lag behind developed countries in the waste management of zero liquid and solid waste. These countries employ advanced technologies and efficient management techniques. The primary causes of liquid and solid waste include lack of awareness and knowledge regarding issues with water scarcity, on-site liquid waste water treatment and improper solid waste disposal strategies. If the current waste management situation is allowed to continue, environmental sustainability and quality of life is bound to decline rapidly. There is a need to act immediately to protect the environment and its resources for future generations and to help the poor live better lives. The objective of this study is to conduct a pilot study that aims to provide valuable insights for the implementation of sustainable practices in various types of campuses, including commercial, institutional, and residential campuses.

The focus of this study is to investigate the existing challenges pertaining to internal waste management in campus buildings within the Punjab region. Through the implementation of a pilot study, practical and feasible solutions will be identified and proposed to attain the objective of achieving zero waste in these campus buildings. By incorporating the methodologies and strategies outlined in this study, campus buildings can effectively plan and execute efficient waste management practices. Furthermore, by addressing issues related to water scarcity, liquid waste, and solid waste on campus, significant environmental benefits can be realized, including the reduction of CO2 emissions and greenhouse gas (GHG) levels, conservation of water resources, and the establishment of a campus environment that generates no liquid or solid waste.

Keywords: Zero liquid and solid waste, Sustainable development, Waste management, Campus buildings, Resource consumption.

I. INTRODUCTION

India, with around 18% of the global population, faces a significant water resource challenge as it comprises only 4% of the world's total. The growing population has led to a surge in the demand for raw water consumption throughout the country. Unfortunately, this demand has resulted in the excessive exploitation of water resources, intensifying the need for sustainable water management practices. Currently, approximately 80% of domestic water in India is sourced from groundwater reserves, which heavily rely on annual replenishment primarily through monsoon precipitation. Given the limited availability of water, it has become crucial to adopt measures that encourage water conservation, efficient usage, and recycling. Rainwater harvesting provides an effective solution to conserve water and can be utilized to meet various non-potable water requirements, including HVAC equipment, flushing, and irrigation. Embracing the principles of Zero Liquid Waste, it is imperative for campuses to meet their water demands through alternative resources. Zero-waste water campuses focus on reducing water consumption, relying on alternative water sources, minimizing wastewater generation, and returning water to its source.

Zero solid waste campuses aim to conserve resources by reducing waste generation, responsibly utilizing materials, promoting recycling, and avoiding harmful disposal methods. These approaches contribute to sustainable water management, efficient resource utilization, and environmental preservation. In summary, addressing water scarcity and waste management challenges is of utmost importance for campuses in India. Embracing the principles of Zero Liquid and Solid Waste offers a pathway to sustainable practices, promoting water conservation, efficient usage, and responsible waste management. Through these initiatives, campuses can play a pivotal role in conserving resources, safeguarding the environment, and ensuring a better future for generations to come.

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II. ADOPTED METHODOLOGY

The objective of this study is to conduct a pilot study that aims to provide valuable insights for the implementation of sustainable practices in various types of campuses, including commercial, institutional, and residential campuses. This study involves a comprehensive investigation into the prevalent practices of liquid and solid waste generation and management in campus buildings. Through data collection and analysis, various waste management practices in campus buildings will be assessed in terms of their effectiveness. This pilot study will incorporate practical and sustainable strategies to efficiently manage and minimize waste generation, contributing to a cleaner and more environmentally friendly campus environment.

III. DATA ANALYSIS AND COMPILATION

A. *Analysis Of Various Practices For Liquid And Solid Waste Management In Campus Buildings In Terms Of Effectiveness Of Waste Management Based Upon Griha Rating System And Solid Waste Management Rules 2016*

By evaluating campus buildings against the GRIHA solid and liquid waste management criteria and the Solid Waste Management Rules of 2016, the analysis aims to identify areas where improvements can be made in waste management practices. It helps to assess the effectiveness of waste management systems in place, identify any non-compliance issues, and suggest measures to enhance waste management efficiency, reduce environmental impact, and promote sustainability within the campus buildings.

B. *Analysis Based On Solid Waste Management Rule 2016*

The analysis conducted based on the Solid Waste Management (SWM) Rules of 2016 focuses on assessing and improving waste management practices. The analysis aims to ensure compliance with the SWM Rules, promote sustainable waste management practices, and create a cleaner and healthier living environment. A comprehensive assessment was conducted, utilizing a set of 15 key parameters derived from the Solid Waste Management (SWM) 2016 regulations. These parameters served as the foundation for developing an expert-based checkpoint table, which facilitated the evaluation of the existing waste management practices and measures implemented.

The following points have been considered as parameters forming the basis for developing an expert-based checkpoint table:

1) Waste segregation at source
2) Biodegradable waste segregated from non-biodegradable waste
3) Domestic hazardous waste segregated properly
4) Waste generators providing segregated waste to waste collectors
5) Processing of organic waste through composting or vermicomposting
6) Setting up recycling facilities for non-biodegradable waste
7) Prohibition of open burning of waste
8) Proper disposal of waste in landfills as per norms
9) Reduction, reuse, and recycling of plastic waste
10) Collection, segregation, and disposal of plastic waste as per regulations
11) Adoption of measures for rainwater harvesting and water conservation.
12) Implementation of water metering and monitoring
13) Compliance with regulations for the treatment and disposal of liquid waste.
14) Innovation in waste management
15) Implementation of measures for the management of liquid waste, including sewage and effluents

These points serve as fundamental considerations in the development of an expert-based checkpoint table for assessing waste management practices.

C. *Analysis Based On Griha Rating System*

Waste management practices play a crucial role in sustainable development, particularly within institutions. The GRIHA rating system provides a framework to assess and promote effective waste management strategies. This analysis aims to evaluate the prevalent waste management practices implemented in an institution through the lens of the GRIHA rating. Different points are provided by GRIHA for water management and solid waste management system and on basis of that credit points are given by GRIHA, following point are given below: -

1) Water Management Criterion (Total Credit Point :16)

This criterion evaluates factors such as water demand reduction; wastewater treatment; rainwater management; water quality and self-sufficiency. The analysis assesses the implementation of measures like rainwater harvesting, water-efficient fixtures, and wastewater treatment systems

a) Water Demand Reduction: The goal of this criterion is to reduce the project's overall building and landscape water demand. (Maximum Point :4)

b) Wastewater Treatment: The goal of this criterion is to encourage grey-water and black-water separation and treatment on-site in order to reduce the project's reliance on freshwater. (Maximum Point :2)

c) Rainwater Management: The goal of this criterion is to efficiently manage rainwater in order to reduce project runoff. (Maximum Point :5)

d) Water Quality and Self Sufficiency: The goal of this criterion is to assess both the quality and quantity of water available to a project in order to push it towards self-sufficiency (net zero) and reduce reliance on municipal or ground water sources. (Maximum Point :2)

2) Solid Waste Management Criterion (Total Credit Point :6)

The analysis conducted by the GRIHA solid waste management criterion assesses the efficiency and effectiveness of waste management practices in campus buildings. It evaluates factors such as waste segregation, collection, transportation, treatment, and disposal methods

a) Waste Management: The intent of this criterion is to provide the necessary infrastructure to future occupants of the project so that they can sustainably manage on-site solid waste during the operation phase and comply with the statutory norms for disposal in a way that augments resource recovery (Maximum Point:4)

b) Organic Waste Treatment: The intent of this criterion is to divert organic waste from landfill sites by adopting strategies for treating it (preferably on-site otherwise off-site) and thereby mitigating its adverse effects on the surrounding environment. (Maximum Point:2)

D. Case Study Of Prevalent Practices Of Liquid And Solid Waste Generation And Management In Campus Buildings

This research focuses on campus buildings under the IGBC Green Campus Rating System, covering diverse categories like administrative, educational, healthcare, and hospitality. New Buildings, including offices, malls, and hospitals, are evaluated separately from residential buildings and other specific types. The case study examines waste management approaches and measures implemented by a Commercial Campus, a Residential Campus, and an Institutional Campus to achieve zero liquid and solid waste.

TABLE III Comparison Of Case Studies

Sr. No.	Description	Parameter Details / Remarks	Parameter Details / Remarks	Parameter Details / Remarks
1	Region	Punjab, India	Punjab, India	Punjab, India
2	Total Built Up Area	39325 sqm.	92205.87 sqm.	71246.568 sqm
3	Type of Campuses	Institutional	Commercial	Residential
4	Total Quantity of SW Generation	494Kg/day	1491 kg/day	850 kg/day
5	Total Water Requirement KLD	126KLD	402 KLD	318 KL/day
6	Solid Waste Management Practices Done in Premises	Uses of Dross Magic Machine to convert Solid waste into Compost and RDF	Organic waste composter, In-organic waste collector by vendors	Organic waste composter, In-organic waste collector by vendors and municipal corporation
7	Remarks Of Waste Management Practices Done According to SWM Rules 2016	Yes (80%) / No (20%)	Yes (87%) / No (13%)	Yes (67%) / No (33%)
8	Points Obtained According to GRIHA Water Management Criterion	Water Management Points Obtained 16 Out of 10 Points	Water Management Points Obtained 16 Out of 13 Points	Water Management Points Obtained 16 Out of 11 Points
9	Points Obtained According to GRIHA Solid Waste Management Criterion	Solid Waste Management Points Obtained 6 Out of 6 Points	Solid Waste Management Points Obtained 6 Out of 4 Points	Solid Waste Management Points Obtained 6 Out of 4 Points

IV. RESULT

A. Based On SWM (Solid Waste Management Rule) Rules 2016

In the realm of waste management practices, it is essential to evaluate the extent to which different types of buildings adhere to regulatory guidelines. Specifically, this analysis focuses on comparing the level of compliance with SWM (Solid Waste Management) rules 2016 among commercial, institutional, and residential buildings.

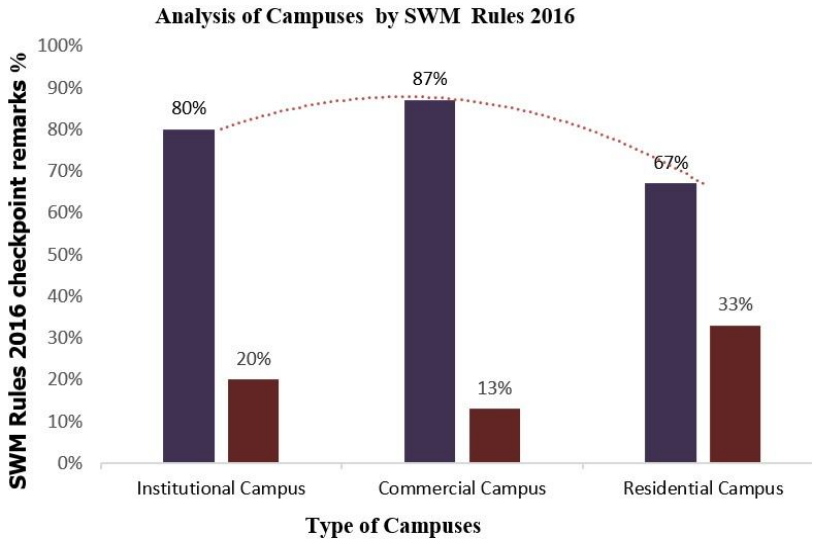


Fig. 1. Analysis of Different Type of Buildings According to SWM 2016 Rules

Commercial Campus exhibit a stronger adherence to SWM Rules 2016 waste management rules compared to Institutional and Residential Campuses, as indicated by the trendline intersecting with the Commercial Campus column on the chart.

B. Based on GRIHA Water Management and solid waste management Criterion

In the context of evaluating water and solid waste management practices, this analysis focuses on comparing the performance of different entities based on a set of criteria. The results of the assessment highlight the achievements and areas for improvement in water and solid waste management.

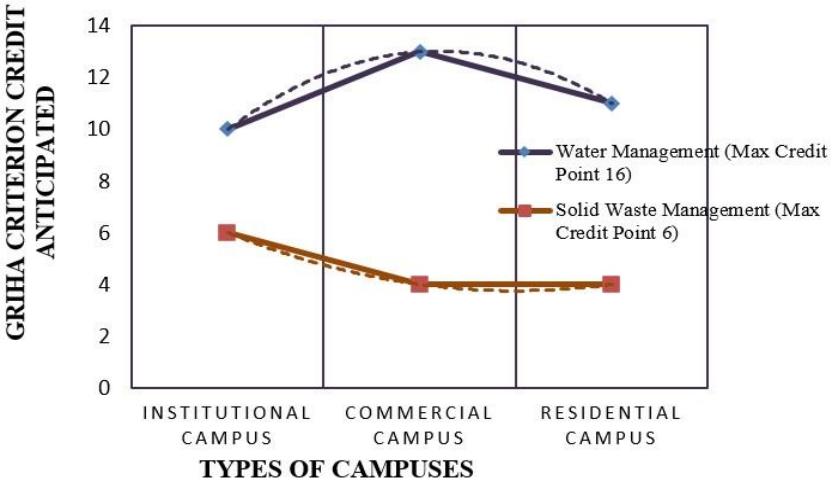


Fig. 2. Analysis of Different Type of Buildings According to GRIHA Water Management and Solid Waste Management

Based on the above Line Chart, the analysis reveals the following results:

Commercial Campus excelled in water management practices, showcasing a strong commitment to efficient usage and conservation. Institutional campus demonstrated exemplary solid waste management practices, emphasizing effective waste segregation and treatment. Residential Campus, however, has room for improvement in water and solid waste management practices. These results highlight the varying degrees of success in water and solid waste management among the mentioned entities, providing insights into their performance in adhering to relevant regulations and sustainable practices.

V. CONCLUSION

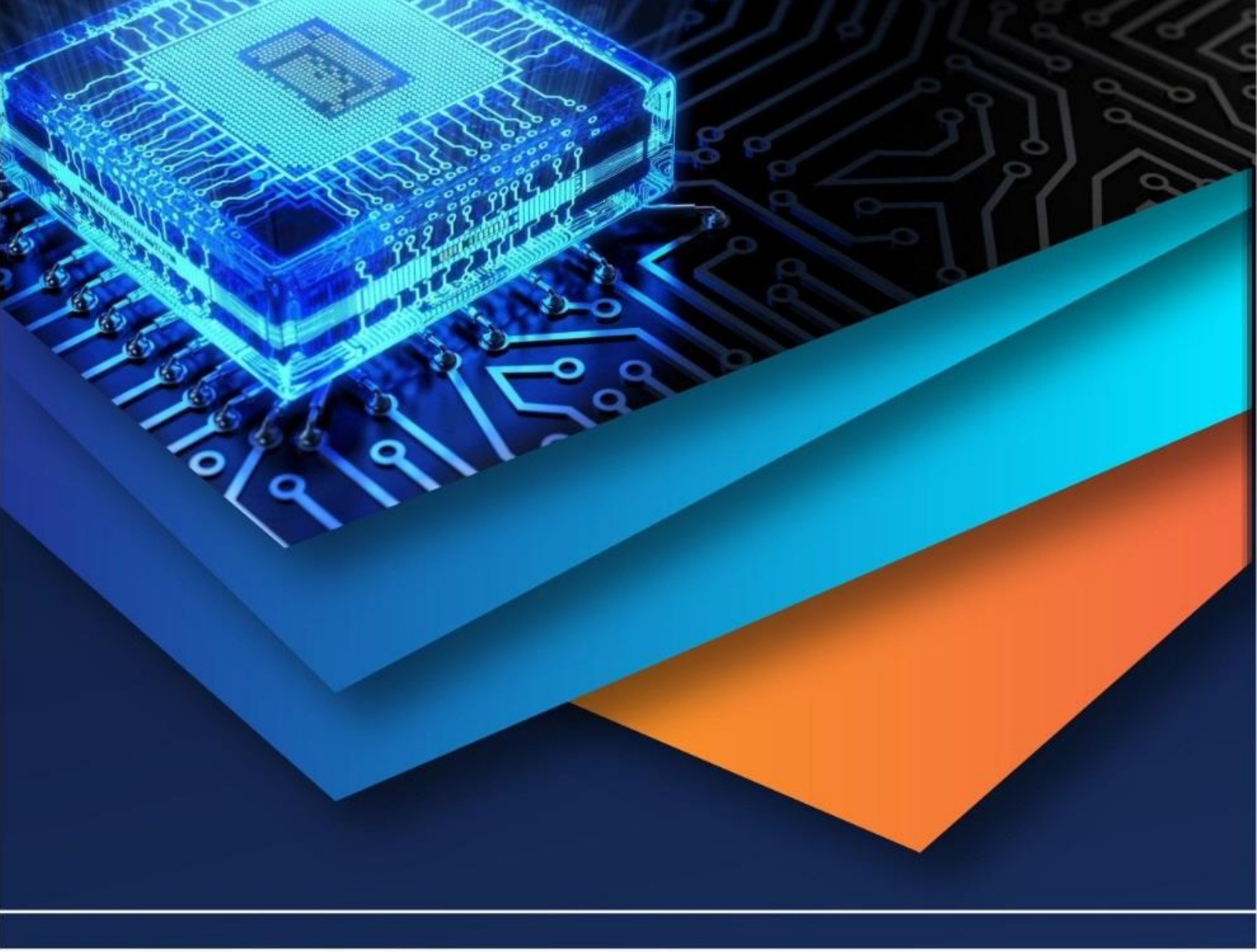
1) Commercial campus excelled in water management, achieving a score of 13 out of 16 points, demonstrating their commitment to efficient water usage and conservation.
2) Institutional campus demonstrated exemplary solid waste management practices, earning a perfect score of 6 out of 6 points, showcasing their dedication to sustainable waste management.
3) Residential campus received fewer points, indicating potential shortcomings in their water and solid waste management practices, emphasizing the need for improvement.
4) Commercial buildings exhibit a stronger adherence to SWM Rules 2016 waste management rules compared to institutional and residential buildings.
5) The chart clearly displays the higher compliance of commercial buildings with SWM Rules 2016 waste management practices.

In conclusion, the primary objective of this study serves as a guiding framework for conducting a pilot study. The findings and insights obtained from this pilot study can greatly facilitate the successful implementation of the proposed strategies within diverse Campuses, including commercial campus, institutional campus, and residential campus. This approach holds significant potential for effective and efficient integration into various campus environments, enabling informed decision-making and fostering positive outcomes.

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