BUILDING CIRCULAR CAMPUSES FOR SUSTAINABLE DEVELOPMENT OF HIGHER EDUCATION INSTITUTES – EVIDENCE FROM INDIA

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ABSTRACT

In line with the continuous concerns and furors of ecologists to maintain the globe green and various plans, initiatives, and actions being taken up by many organizations, the education sector, where learning and research originate, also joined hands with them. In India, constitutional bodies like the University Grants Commission (UGC) actively ensure quality education and coordinate and maintain standards in higher education institutes (HEIs). These standards also cover issues related to the environment and green campuses. Several HEIs in India are committed to making their campuses green, eco-friendly, and economical. This study focused on reviewing the views and efforts of HEIs in India. It also studied a real-world case of an HEI. This study looked at different kinds of waste and their management. It also focused on natural resources like water and solar energy and their recycling and renewing. After consolidating the observations, the study developed a holistic framework for making a campus green and circular.

Keywords: Waste Management, Green Campus, Circular Campus, Higher Educational Institutes, Eco-friendly.

INTRODUCTION

According to Gallo et al. (2017), everything in nature has a specific purpose of serving by contributing to maintaining a balance in a closed cycle; hence, nothing can be treated as waste. A material may be a part of another material with a different nature, which may be a part of another. Suppose it is possible to retrieve the earlier material in its original form or as a valuable by-product in another form from a complex material. The whole process can be treated as that material's cycle. As a material, waste can act as a source to derive other important by-product(s) or energy in different ways. Emissions are of three types – Scope 1, Scope 2, and Scope 3 emissions (Goldmark et al., 2023). Scope 1 emissions represent the emissions from fuel combustion; Scope 2 emissions deal with emissions from purchased electricity; and Scope 3 emissions are from waste through food, travel, purchases, and humans. Considering the horrifying impact of waste on the surrounding environment and the health of people roaming there, the organizations or institutes that produce such waste should be responsible for making the surroundings clean and hygienic. Such waste management activities include recycling processes, waste-to-energy techniques, and reduction strategies (Brown and Jones, 2018).

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A cyclic process can be imagined in the case of waste control/reduction and management. Likewise, the water cycle is where the original water used for different purposes can be extracted in its pure or contaminated form and reused in other ways. Harvesting the rainwater, cleaning and reusing the wastewater for various purposes, and controlling water wastage contribute to maintaining good groundwater levels and properly using water resources. The surfaces of ground, soil, and buildings absorb light rays and sun radiation. When they are captured with the help of panels, they can be transformed into valuable energy and power. Even,Wind energy can also be captured through windmills. Solar energy and wind energy come under renewable energy sources, and their proper generation can save considerable expenditures that are incurred on power. All these cyclic processes represent the concept of circular economy (CE) and make the systems clean and hygienic, save a lot of expenditure and water and energy resources, and make the system very economical and eco-friendly. Significant renewable electricity generation can contribute to reducing greenhouse gases and establishing a carbon–neutral society (Mäntymaa et al 2024). Therefore, in a circular economy system, a material can never become waste, but it can be transformed into a different form, like energy or recyclable material that can be used further to save resources and the environment.

A circular economy represents the combination of technological, organizational, and social innovations within and across stakeholder-value networks in a system that efficiently deals with societal sustainability issues (Boons and Lüdeke-Freund, 2013). The concept of circular economy has undergone several modifications. The latest version, codified in 2013, is based on four major areas – using renewable energy sources, declining usage of harmful substances, and seeking to reduce waste through restructuring production and supply processes. Ellen MacArthur Foundation (*https://www.ellenmacarthurfoundation.org/*) is a charity committed to supporting the building of a circular economy. It is based on three essential principles - eliminate waste and pollution, circulate products and materials, and regenerate nature. Higher educational institutes (HEIs) should strictly follow waste management regulations to achieve a circular economy and act as role models in establishing a clean and friendly environment (Ojuriet al, 2024). Any educational institute has students as the largest community, followed by supporting and teaching staff. A prominent higher educational institute can be treated as a model for a small village, town, or city because it accommodates various entities like human beings, buildings and amenities, and food courts. Therefore, significant water and energy consumption would lead to higher wastage than in housing environments.

Since educational institutes engage in research and teaching activities, they can create awareness among students about protecting the environment, managing waste, and saving energy resources. They can act as role models to other institutes and systems, surrounding habitats, whole villages/towns/cities, and entire nations by inculcating and establishing sustainable and eco-friendly attitudes and practices. The institutes can adopt various practices like controlling waste, recycling valuable natural resources, and utilizing renewable resources by making the campuses green, sustainable, and circular. Green campuses use existing materials in the campus or nearby community projects for construction and renovation projects, establish energy systems for creating renewable energy and giving surplus production to the grid, make food courts and halls producing zero waste, design grounds and buildings to capture rainwater, and even reduce human and other biological waste for energy or fertilizer for plants in the campus. Goldmark et al. (2023) further imagined the future circular campus with active participation and performance of students, faculty members, and other staff in building climate action, sustainability, circularity, and justice into the curricular courses, campus systems, and operations.

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Based on a review of green campus literature reports related to various general and specific higher educational systems worldwide, and with the help of a detailed study of one HEI in India, this study attempted to develop a holistic framework for circular campuses in HEIs.

Theoretical Background

Zhang et al. (2023) identified critical factors influencing the green consumption behavior of residents and the essential influencing paths using social network analysis (SNA). The factors include green purchase intention, which represents the consumer's green consumption attitude, willingness to pay for green products, risk perception, the feeling of uncertainty to purchase, green product certification, publicity and education, green product price, and green attribute information. Westeret al. (2016) explored the psychological factors affecting the willingness to use recycled water in the USA. They reported that despite giving proper educational awareness guidance, there was not much change in the intention to reuse water. Gao et al. (2019) examined the cognitive factors that influence the use of recycled water in urban areas of China. They presented a framework to emphasize the link and connection of emotion between these cognitive factors and specific behavior. They highlighted favorable and non-favorable emotions among the people and reported that a favorable emotion could increase reuse intention and vice versa.

Educational institutes can play a vital role in educating future generations, undertaking research, and putting in the effort to create, preserve, and reinstate ecosystems. They can extend their role in solving significant sustainability challenges by adopting sustainability concepts in national development programs. Clean and sustainable Campuses can guarantee a healthy, pleasant, and conducive environment for the learners. Several researchers (Ravesteynet al, 2014; Islam, 2015; Hopkins, 2016; Choi et al., 2017; Gallo et al., 2017; Hopff et al., 2019; Mendozaet al, 2019; Smith et al, 2019; Junior et al., 2020; Zhu et al., 2020; Gholami et at, 2020; Bakos et al., 2021; Isa et al., 2021; Anthony Jnr, 2021; Goldmark et al., 2023; Kumdokrub et al., 2023; Zhang et al, 2023; Ojuriet al, 2024)explored the green campus development, opportunities and challenges in educational institutes in different countries.

Based on a real case study of one big university in the UK, Mendoza et al. (2019) developed a methodological framework consisting of three stages - background, foreground, and implementation of the circular economy. It follows an iterative approach of planning, doing, checking, and implementing for efficient resource allocation and management.

Ravesteynet al. (2014) developed a framework by highlighting the collaboration and use of information technology in reducing carbon emissions. They categorized the campus into four themes –smart learning, smart sharing, smart buildings, and smart transport. They reported that 60% of carbon emissions in higher educational institutes were due to the vehicles moving inside. Islam (2015)discussed the activities carried out in HEIs in Malaysia to make the campuses green and emphasized the role of faculties and students. The author suggested various vital steps to follow in the green campus development, which include improvement of energy expenses, use of renewable energy sources, water and waste management, and enhancement of environment quality. The awareness-action-assessment (3A) model was proposed to build a sustainable environment in developing countries.

Hopkins (2016) reviewed significant adoption barriers in green campus development policies, such as lack of awareness among stakeholders, lack of efficiency in green building policy, perception of negative financial impacts, and insufficient monetary support. These factors can be resolved by creating awareness among the students in HEIs, taking their opinions, offering economic benefits, and building an accurate campus roadmap for sustainable campus

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policies. As visiting scholars from Korea, Choi et al. (2017) explored the physical environment of Portland State University, USA, for a green campus. They surveyed to analyze students' knowledge and living practices in the light of green campus and socio-cultural perspective. They reported that the students who studied the sustainability courses or were involved in sustainability-related activities had better knowledge about their university's green campus strategies and plans than others who had not. Based on these observations, they stressed the importance of educating students on green campus practices and developing related programs.
Smith et al. (2019) highlighted three major features of green campuses - the use of renewable energy from sources like solar and wind power, decreasing dependence on fossil fuels, and minimizing carbon footprint. According to them, the HEIs have been focusing on environmental leadership and innovative responsibility, initiating eco-friendly technologies to curb carbon emissions, and nurturing a culture of innovation and conscientious citizenship among scholars.

With the help of interpretive structural modeling (ISM), Gholami et al. (2020) examined the operational barriers to developing green campuses for Universities. They identified the barriers by reviewing literature reports and creating an interaction model to judge the relationship among various identified barriers. The study concluded that out of 18 barriers identified, eight (8) factors - lack of awareness, lack of knowledge, resistance to change, insufficient communication, lack of legal regulations, large size of institutions, lack of top management support, and complex bureaucracy were found as the prominent ones that hinder the operations. Based on green campus initiatives taken up by several universities in Malaysia, Isa et al. (2021) analyzed different strategies and challenges in implementing such initiatives in the case of one university, UiTM. Challenges related to finance, awareness, and knowledge were found to be significant barriers to developing green campuses, and appropriate actions should be taken to overcome these barriers.

Gallo et al. (2017) explored campus waste detection and prevention at the University of Genova, Italy. They used a circular economy methodology in their project, which was meant to diminish the impacts of pollutants derived from waste management recovery and recycle high-quality materials. They suggested that management and local waste management companies develop a business model to achieve the circular economy goal. Hopff et al. (2019) attempted to associate three crucial subjects - campus environment, area development, and circular economy. They explored various dimensions of a circular campus in Dutch universities. They reported institutional issues, less complex design, unique policies, and sufficient knowledge as critical dimensions to develop a circular campus.

Junior et al. (2020) examined the green practices implemented in HEIs in Malaysia to explore significant factors that lead to sustainability there. Twenty-one critical factors were identified, which include control of pollution, protection and safety of society, management of carbon emissions, energy and waste, transport management, biodiversity conservation, and rainwater harvesting. They analyzed primary and secondary data collected from questionnaire responses, Green documents, and other related prior studies.

Researchers like Ravesteynet al. (2014), Islam (2015), Zhu et al. (2020), and Goldmark et al. (2023) focused on the concept and development of a framework or model for a circular campus. Zhu et al. (2020) analyzed the sustainable development goals in green campus construction and accommodated them among three major factors: (i) introduction of energy supply and demand, water and land, waste management, and construction materials; (ii) evaluation of sustainable tracking and assessment methods with Stanford University; and (iii) relationship with the local community. They added that more benefits could be possible from this

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triangular circular framework. Goldmark et al. (2023) reported the development of a circular campus framework by Barnard's College in New York City, USA. The framework focuses on five major areas – (iv) Reuse and sustainable purchasing; (ii) Design, Construction, and Deconstruction; (iii) Waste; (iv) Food and Dining; and (v) Green spaces. The framework was intended to reduce emissions, waste, and costs, transform consumption patterns on campus, increase access and affordability for students, and support the transition to a sustainable economy. They presented three case studies that deal with the themes of *reuse, renovation, and reallocation.*

With the help of an exemplary case study in India, Bakos and Shiano-Phan (2021) attempted to develop a practical framework for a circular campus with tangible benchmarks, particularly in designing and constructing buildings on the campuses of higher education institutes. They proposed a bioclimatic and regenerative building design to demonstrate more efficiency and sustainability, environmentally friendly and economical by making the asset withstand against climate change. Kumdokrub et al. (2023) studied various ways to maintain carbon neutrality in one USA university campus and stressed the need to shift towards renewable energy.

Anthony Jnr (2020) studied the existing green practices implemented in higher educational institutes in Malaysia. The study used the archived sustainability documents of sixteen Malaysian universities and related literature reports to derive green indicators and understand their variation from one university to another. Based on these indicators, the author developed a green policy framework comprising the three essential sustainability dimensions.
From a detailed study of solid waste management in a Nigerian federal government University, Ojuri et al. (2024) stressed the need to optimize waste collection points, install separate color-coded bins to segregate different kinds of waste, and promote their upcycling and recycling. They recommended collaborating with recycling firms and making policies for waste management and robust business models.

Indian Scenario of Making HEIs Green/Circular

According to Nandy (2023), even though India demonstrated low per capita carbon footprints well below the average of 4 to 5 tons per person due to its large population, it stands as the third largest producer. Direct emissions from fossil-fuel combustion, heating, and transportation significantly contribute. Both central and state administrations have been creating awareness among the people to adopt green practices in various activities like cooking, warming, commuting, and safeguarding individual and societal care and health. In this regard, several schemes are being promoted to extend financial help to the people and impoverished families. Apart from these efforts, governments have also been encouraging educational institutes to modify the curricula at the school level, undergraduate, and graduation level by including topics and courses related to environmental education, sustainability, and security.

There are various accreditation bodies like AICTE (All India Council of Technical Education), NAAC (National Assessment and Accreditation Council), NBA (National Board of Accreditation), BCI (Bar Council of India), and UGC (University Grants Commission) to support such initiatives in Indian HEIs. Indian Green Building Council (IGBC) is another agency that has designed and developed a rating system for green campuses for both existing and new campuses to help educational institutes reduce water and energy consumption, improve air quality, and promote biodiversity. Since 2015, India has declared its commitment to the UN2030 Agenda for Sustainable Development Goals (SDGs), and most of the accreditation agencies have

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started directing the HEIs to promote green and sustainable campuses. For example, NAAC included a criterion related to environmental sustainability in their accreditation process so HEIs can adopt green practices and sustainable development. On similar grounds, UGC developed a framework called SATAT to guide HEIs in achieving a green and sustainable campus environment. It provides overall directions to the HEIs in adopting relevant policies and practices to achieve SDGs and motivates them to include sustainability concepts in their curricula and research programs. It covers several sectors like campus planning, designing and development, resource optimization, landscapes and biodiversity, campus building design, energy and water management, transportation, procurement, waste management, green catering, and event organization. In this process, many HEIs in India have adopted innovative pedagogical techniques for integrating environmental education into curricula to make the students eco-conscious (Chugh and Ruhi, 2019). They treated it as their prime duty to align their activities and priorities around the SDGs.However, India's schemes and certifications only revolve around sustainable green campuses. Even though there is a buzz on circular campuses, efforts to develop the related indicators and benchmarks are still at an immaturity level.

HEIs in India are aggressively initiating and adopting green practices. Those that are in the row include several Indian Institutes of Management (IIMs), Indian Institutes of Technology (IITs), Indian Institutes of Information Technology (IIITs), Universities like Mangalore University and Dibrugarh University, business schools like Universal Business School of Mumbai andInstitute of Financial Management and Research of Andhra Pradesh, and colleges like St. Teresa College of Kerala state. These institutes and many more HEIs are progressing and competing with their green and circular campus strategies and practices. Some HEIs that are deemed to be Universities are also in the race. Examples include the Manipal Academy of Higher Education of Karnataka state and the Kalasalingam Academy of Research and Education (KARE) of Tamil Nadu state. HEI under study is also deemed a university accredited by NAAC and UGC and is highly committed to green campus initiatives and practices.

METHODOLOGY

This study started with a detailed review of various literature reports published on green campuses and the circular economy, which helped to understand the concepts of green campus and circular economy and the practices to be adopted to achieve and maintain them in HEIs. In addition, it discussed the efforts and initiatives of several HEIs in India to make their campuses green and circular.

In order to examine the real-world scenario of the efforts taken or being taken by higher educational institutes, this research work planned a detailed case study. For this, a private university located in Hyderabad was selected. Interactions were planned with different wings involved in making the campus green. This attempt would give a clear picture of framing, upgrading, and evaluating the practices in an ideal HEI and their adoption in other environments.

Based on the outcomes of the literature review and real-world case study, this research work intended to develop a holistic framework by envisaging the different dimensions representing the intentions, efforts, and actions to be taken by the stakeholders in keeping their campuses green and circular.

Case Study

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The private university under study is in Hyderabad, Telangana state, India. It runs different colleges related to science and engineering, management, humanities, and law. These schools handle undergraduate, graduate, and doctoral programs. Student strength is around 10,000, whereas faculty strength is around 400. Other support staff will also be around 400, covering different divisions like administration, academics, labs, security, and housekeeping. Therefore, there are about 11,000 habitats in the university. Of them, there may be around 5,000 students in residential programs; the support staff related to hostels and security may be around 200; all these people should continue their stay on campus.

The campus is spread across 40 hectares of land, with 20% of the land occupied by campus infrastructure, including buildings and roads. A good number of trees and plants occupy the remaining part. There is a parking place for staff personnel vehicles, buses to bring students to campus from distant places, visitor vehicles, and material-carrying trucks.

Water Consumption and Recycling

The average daily consumption of water on the campus is around 1,350-kilo liters and average. At present, bore water is drawn from 300 to 1000 feet deep into the ground, and the water supplied by municipal agencies meets the water requirement throughout the campus. The share of municipal water supply is about 30% of total water consumption; the remaining is groundwater. The campus is trying to get more supply from the Municipal Corporation to meet future demand. The campus uses electricity to draw bore water from the ground and municipal sources and distribute the collected water to various consumption points. Of course, this expenditure on power is relatively less than that incurred for lighting, running air conditioners, fans, geysers, lifts, computers, and various machines meant for water purification and other purposes.

The institute under study initiated a water recycling process. For this, the concerned authorities arranged to collect the used water from various points and places on the campus for purification. The campus uses two phases of purification. The first phase deals with removing hard materials through an iron strainer, and the second phase involves mixing proper chemicals to purify water by removing or diluting any pollutants and pungent odors. Such purified water will be diverted for watering plants and filling flush tanks on campus. This way, water recycling is happening on the campus regularly, saving huge quantities of water. The RO plants, which generate purified water for drinking purposes, filter out the impurities, chemicals, and other pollutants in the form of wastewater. Such waste water coming out from the RO plants will be directed for gardening purposes. Therefore, the efforts of the campus in recycling water have saved a lot of expenditure in buying and drawing water and made the process of watering all the plants spread across the campus economical.

Energy Economics

The HEI under study has been heavily using electricity to run the campus. The student hostels are the ones that consume the most electricity. Classrooms, office rooms, faculty rooms, and other facilities like washrooms and corridors run on electricity during working hours. The institute deployed some supervisors to watch unnecessary electric power and water waste. After classes, in the evening, all the lighting and power systems will be shut down in time, and corridor lights will be dim. The institute has been trying to the maximum extent to save energy consumption. Since faculty members are also important stakeholders and have a good awareness

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of green practices, they can expect considerable energy consumption savings. However, it is also the institute's responsibility to regularly alert and motivate all the habitats about the economical consumption of energy and water.

The campus started the process of installing solar panels to generate electric power. This power is used to light the lamps at night. This way, the campus has begun its move towards renewable energy resources. The wind power mechanism has not yet been initiated.

In the campus circular economy, energy, food waste, and construction materials play a vital role and need to be analyzed as part of material flow analysis (Kumdokrub et al. 2023). The campus recently started building bio-gas plants to generate energy from bio-wastes and food wastes, which are accumulating continuously and becoming a threat to the hygienic environment of an organization.

Calculation of Carbon Footprint on the Campus

A carbon footprint represents the total quantity of greenhouse gasses, including carbon dioxide and methane, and is measured in units of carbon dioxide equivalents. In HEIs, high use of personal vehicles by faculty members and other employees and campus buses by students commuting from long distances to campus impact the organization's environment in terms of carbon footprint by contributing to more than 50% of total harmful carbon emissions (Ribeiro and Fonseca, 2022). The mode of transport selected by the users depends upon several factors: the cost of commuting to campus, availability of parking space to park vehicles on campus, and policies of the organization, such as who can use personal and private vehicles and campus transport facilities. On the campus under study, there are about 10 buses for faculty members and about 50 buses for students who commute to the campus. In addition to these buses, the parking space also accommodates about 100 two-wheeler personal vehicles and about 200 four-wheeler employees' vehicles. Half of the 200 four-wheeler vehicles may use diesel, and the remaining half use petrol. The emissions are in the form of oxides of carbon and nitrogen. In addition, particulate matter composed of microscopic solid or liquid droplets will be emitted, causing serious health problems by penetrating the lungs and bloodstream.

As per the carbon footprint of travel per kilometer data forthe year 2022 (ourworldindata.org/grapher/carbon-footprint-travel-mode), the approximate carbon print per day by the above modes of travel into the campus has been calculated, as shown in Table 1. It has been assumed that each vehicle would cover an average distance of 1 kilometer inside the campus on a daily basis. Based on this assumption, the approximate total carbon emissions from vehicles moving inside the campus has been calculated as 51,320 grams, which means about 51 kilograms per day. From comparing the air pollution of different kinds of vehicles, we can see that cars contribute the most.

Assuming a total of around 11 months and around 23 days per month as working duration per year, the total carbon footprint from the vehicles moving on the campus will be around 13 tons per year. Then, the per capita carbon footprint per year will be approximately 1.2 grams per person. This aggregate figure may be treated as negligible, but the whole production and spread of emissions is within the limited area of the campus and may affect the people who are in close proximity. To avoid such a direct effect on the habitats, the campus has created separate spaces to park the vehicles by maintaining a considerable distance from the habitations, which accommodate classrooms, hostels, and different office spaces. This way, the campus will put all efforts into maintaining a green campus.

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Table 1
APPROXIMATE CALCULATION OF TOTAL CARBON EMISSIONS PER DAY IN THE CAMPUS

Type of vehicle	**Total number**	**Carbon emission** *(in grams)*	**Total carbon footprint** *(in grams)*
Buses	60	97	5,820
2-wheeler	100	114	11,400
4-wheeler (Diesel)	100	171	17,100
4-wheeler (Petrol)	100	170	17,000
Total carbon emissions:			51,320 grams

Holistic Framework to Make an HEI Campus Green/Circular

As part of creating a circular economy, the Ellen MacArthur Foundation pronounced four necessary R's - Reduce, Refurbish, Reuse, and Recycle. They stressed the importance of resource efficiency, careful selection of products and materials, and their regular and optimum usage. They also highlighted the significance of regenerating natural systems. Goldmark et al. (2023) proposed 3 R's - Reduce, Reuse, and Recycle - for the circular campuses. They treated reuse and repair as similar cases that require the support of a wide variety of visible, identifiable, resourced, and scaled logistical and economic systems. Cheshire (2016) examined a hierarchy of six 'R's – Recycle, Remanufacture, Reclaim/Reuse, Refurbish, Refit, and Retain - in a circular construction industry. They reported Retain, Refit, and Refurbish as the most desired and resource-efficient options in the case of the foundation and structure of the building. They also emphasized that recycling could add more value.

The case study found that educational institutes still need to develop awareness among all stakeholders and users about green practices, circular economy, sustainability, and making the environment eco-friendly. That means all the institute's stakeholders should realize the importance of these concepts and their objectives and advantages. In addition, they should also feel responsible for maintaining the campus hygienic and eco-friendly. By consolidating all the necessary ingredients for shaping an HEI green and circular campus, the present work came out with a framework, as shown in Figure 1, consisting of six R's with clear demarcation, meaning, and focus. Depending on the significance and objectives of each R, the associated actor(s) have been identified along with their actions or roles. The six R's include Realize, Respond, Reduce, Reuse, Recycle and Renew. The framework is just like a model for holistically greening a HEI.

Realize: All the campus habitats should be cautious and realize the dangerous/hazardous impacts of waste and its accumulation and continuation. When institutes initiate collaborative efforts related to sustainability and green campus among the faculty members and students, proper knowledge about environmental pollution and protection can be acquired and suitable development practices adopted. They should be conscious, identify the prominent spots and places that pollute the environment, and initiate or report for rectification. Therefore, the realization among the habitats about their environment is foremost in the agenda of the green/circular campus action plan of HEIs. Students may have interdisciplinary subjects, and faculty members may teach them how to deal with environmental education, but they, along with others, should take part in developing awareness and perception of ecological issues among themselves and others. The housekeeping staff should also commit to keeping the campus clean and hygienic. They should even be equipped with the skills required to adopt the appropriate practices for sustainable development. The top management should also contribute to this mission and extend all the support to teach awareness and consciousness about green and circular campus practices. They should maintain a feedback system to identify waste-prone areas and also resolve complaints.

Respond: The top management, administrative, and engineering departments should be responsible for identifying unresolved environmental issues, areas that accumulate further waste, and resources that are under-used and being wasted. The concerned authorities should regularly survey the campus, note the places creating problems and

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opportunities for improvement, and take appropriate actions to reduce the accumulation and continuation of waste. Even other habitats may be aware and committed to acting as responsible people who support reducing waste. A proper monitoring system should review and analyze these issues and provide alerts to take appropriate decisions and actions. The top management and administration department should have a regular vigil and notify the engineering department to take appropriate actions by allocating the budget and approving the timely release of funds for the services. It is their responsibility to analyze any complaints received from others and be proactive to avoid any types of imminent threats and havoc from waste accumulation/continuation and inactions.

- **Reduce**: A proper monitoring and execution system is required to keep the campus green and circular. In this regard, the engineering department should be more proactive. Air pollution due to vehicles should be reduced to the maximum extent. The parking space should be considerably far from the buildings where routine curricular, administrative, residential, and other activities run. Wastes are two types – valuable waste meant for recycling and useless waste to be handed over to public waste collection units. Such separation bins should be placed in important places. The waste for recycling should be collected and moved to processing facilities. Further filtering occurs, producing more useless waste that can be thrown out of the campus. Some biological wastes can be transferred to compost processing plants, from where the end products are distributed to plantation areas.

The campuses having hostels do not maintain a stock of beds to be distributed to the students. They may keep cots without beds and bedsheets in the hostel rooms. When students complete their courses on campus and stay in the hostel, they treat them as waste and leave them there along with books, stationery, used utensils and clothes, and other materials. The incoming students may reuse some of them but naturally look at acquiring new items. Therefore, it is a challenge and routine practice for the hostel administration to collect all that junk from the rooms vacated by students and dispose of them as waste. Likewise, but not frequently, there will be waste to be removed from buildings in the form of damaged furniture, debris, dismantled materials, and used stationery. Food courts and dining spaces continuously generate waste of unused and wasted food and other accompanying materials. Campuses may maintain dumping yards to dump damaged furniture and other materials like plastic, metal, and alloy-based items.

Reuse: Damaged machinery, equipment, and furniture should be collected and checked for repair and reuse. Repair or refurbishment can also be considered for some items. Some dormant office spaces and buildings can be adequately renovated to be used for any additional campus activities. In consultation with the administrative and engineering departments, the top management should think about the possibilities and feasibility of bringing back some damaged items and dormant spaces and buildings. Wherever economics work, proper execution should take place. Therefore, all the concerned authorities should look at the under or over-used and damaged items, collect them for adequate refinement, and distribute or divert the refined items to the points where they can be utilized effectively and economically, and the same process can be applied to dormant and spoiled spaces and buildings.

Taking into consideration the serious environmental impacts of frequent and massive disposal of used furniture, Parikka-Alhola (2008) proposed the concept of green furniture. While in use, any furniture shows the less environmental impact, but during manufacturing and disposal, it shows greater impact on the environment and health (Xu et al, 2020). The green furniture concept involves eco-friendly design and usage of recyclable and reusable materials for production. Liang et al. (2024) examined the influence of environmental awareness, health consciousness, and demographics on purchasing green furniture using the theory of planned behavior (TBP). They reported that psychological attitudes, perceived social pressure, personal control, environmental and health consciousness, and consumers' basic personal conditions need to be considered while promoting green consumption behaviors.

Recycle: Educational campuses should provide proper sanitation facilities for all habitats and transform themselves into hygienic and conducive environments. Water and power resources should be appropriately and economically used. Voluntarily or involuntarily, water may be misused in toilets and other places. When diverted to purifying plants and thereafter to plants, this water can save a lot of consumption and power meant for watering the plants and also increase the groundwater level. Rainwater harvesting is also helpful. Recycling or regenerating the water enormously saves natural resources and ultimately saves nature. The engineering department should play a vital role in this case. They should find different ways and means for saving, capturing, and making economical use of water that is going to waste. Water resources should be safeguarded and recycled with proper mechanisms.

Renew: India is a tropical country with a more extended coastal area. Educational campuses spreading across huge areas will have good exposure to solar radiation and wind power, both of which are renewable. The engineering department should identify the spots where such natural energy can be captured to the maximum extent across the campus and check the technical and financial feasibility of establishing a proper mechanism to generate energy from those sources. Solar photovoltaic systems to generate electricity and solar thermal systems to generate heat can be planned and established. Windmills can also be erected, but they are more expensive and less economical when

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compared to solar energy systems. In addition, bio-gas plants may be built at the right places to capture the bio-waste in different forms and generate bio-gas that can be used as fuel wherever needed.

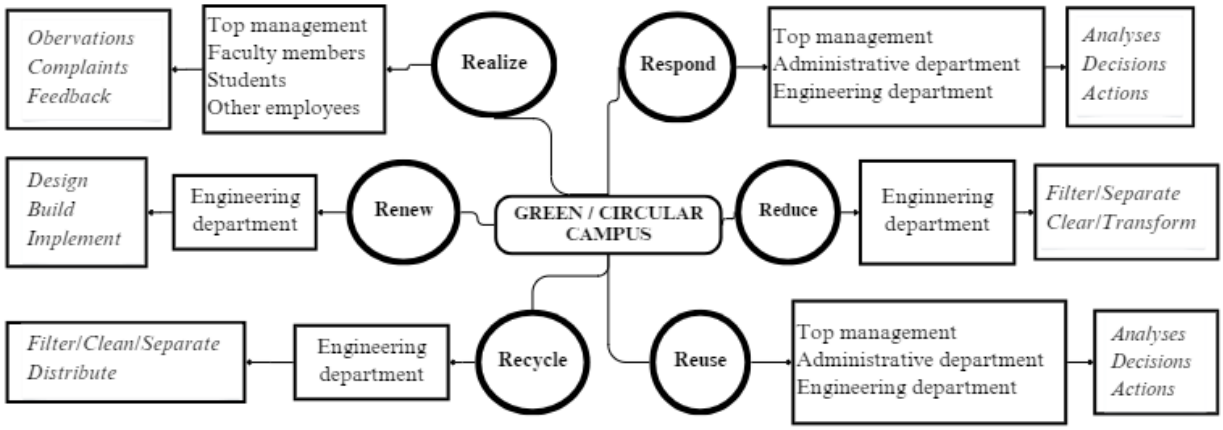

FIGURE1
HOLISTIC FRAMEWORK FOR A GREEN/CIRCULAR CAMPUS

CONCLUSIONS AND IMPLICATIONS

India is a developing country with a considerable population and occupies a smaller area than developed countries like the USA and China. Despite these limitations, India has been keen and conscious about protecting the environment and saving energy resources. However, these efforts are concentrated in academia and some committed corporate sectors. Therefore, academia should play a vital role in initiating green/circular campus practices, implementing them inside, and even covering the neighborhood society. They can be role models for society and provide places to nurture the practices of sustainability and eco-friendliness.

Material, fuel, and power waste lead to adverse health effects and higher energy demands. The initiatives of HEIs to become green or circular campuses are oriented towards restoring, sustaining, or improving the campus' natural resources and capacities. This study explicitly examines the green initiatives of various international and national HEIs for conservation and environmental management. It brings together some helpful contemporary strategies and practices to bring required changes in the HEIs' environment, enabling them to move towards becoming green campuses. This study comprehensively analyses greening initiatives and evaluates their effectiveness in reducing the challenges posed by accumulating and continuing wastes of different kinds. It is intended to provide deeper awareness and insight for the concerned people to establish a green economy.

When students at the school level develop awareness about the environment, its sustainability, eco-friendliness, and green practices, they can be conscious about their environment and society, as well as their health and sustainability at every level of education and in their real life. This needs curricula aligned with those concepts and practices. Faculty members should have thorough awareness and knowledge to teach and train them. Management support should be there. Once green campus thoughts and practices are firmly established, thinking about a circular campus would be easy. Of course, circular campus practices may lead to more standardization in the form of recycling and renewing activities. Actually, education for children starts from their parents and homes, and therefore, there would also be an onus on the

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parents to inculcate eco-friendly awareness and practices in their children. Then, it will be easy for the schools and, thereafter, the colleges and universities to directly initiate them by briefly reminding them and providing additional content in the curricula.

Given the above, future research shall focus on studying the existing efforts and commitment to green/circular campus practices of primary and secondary education schools and colleges engaged with undergraduate programs. If any gaps and constraints are observed during that study, suitable roadmaps and frameworks may be developed to help the institutes plan and build eco-friendly systems for their campuses. This study may have several limitations, the most important of which is the geographical area limiting to India, particularly to a part of India and certain types of institutes. Future studies may start from the same ground but may advance further by initially enhancing the geographical area, number, and kind of institutes. Therefore, the study wants to focus on educational institutes dealing with primary, secondary, collegiate, and higher education. After a detailed, reliable, and in-depth study and analysis and satisfactory results, future research would consider the scope of targeting some selected countries neighboring India and also members of the same continent, that is, Asia.

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Received: 22-Jan-2025, Manuscript No. AMSJ-25-15647; **Editor assigned:** 23-Jan-2025, PreQC No. AMSJ-25-15647(PQ); **Reviewed:** 28-Jan-2025, QC No. AMSJ-25-15647; **Revised:** 22-Feb-2025, Manuscript No. AMSJ-25-15647(R); **Published**: 16-Mar-2025

Citation Information: Urkude, S., & Jigeesh, N. (2025). Building circular campuses for sustainable development of higher education institutes – evidence from india. *Academy of Marketing Studies Journal, 29*(3), 1-13.