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Innovative Sustainability Initiatives: A Case Study of the Polytechnic School of Chimborazo in Ecuador

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Abstract. Escuela Superior Politécnica de Chimborazo (ESPOCH), a higher education institution located in the central region of Ecuador, is one of the largest universities in the area, serving a student population of 19,349 and employing 1,091 teachers and 588 staff members. In 2022, the university was recognized for its sustainability efforts and ranked 386th in the UI GreenMetric World University Rankings.

To further improve the university's sustainability indicators, the institution has prioritized initiatives related to energy and climate change, water management, and transportation. In order to reduce the university's carbon footprint, the first initiative involves implementing hybrid systems in campus buildings that utilize both photovoltaic energy and energy from the national electricity grid. Additionally, measures to increase energy efficiency and savings are being taken.

For water management, the university is implementing a system to monitor water distribution for possible leaks, as well as devices to ensure efficient water use. A campaign promoting good environmental practices will also be launched. Lastly, to improve transportation, the university plans to implement an efficient transport management system within the campus, optimize the use of institutional vehicles, and encourage the use of environmentally friendly transportation options.

ESPOCH is dedicated to placing sustainable initiatives at the forefront of its priorities while also decreasing its environmental impact. The institution utilizes both factfiles and experiences gained from participating in the UI World University Rankings as essential tools in guiding its efforts to improve the areas where it is weakest in terms of sustainability.

Keyword:

Sustainability, Climate Change, Carbon Footprint, Photovoltaic Energy, Environmentally Friendly Transport

1. Introduction

Escuela Superior Politécnica de Chimborazo (ESPOCH), a higher education institution located in the central region of Ecuador, is one of the largest universities in the area, serving a student population of 19,349 and employing 1,091 teachers and 588 staff members. In 2022, the university was recognized for its sustainability efforts and ranked 386th in the UI GreenMetric World University Rankings and 4th in Ecuador.

The urgency of addressing global environmental challenges has led to increased attention on the role of higher education institutions in promoting sustainability. Universities are essential players in achieving the Sustainable Development Goals (SDGs) through their teaching, research, and campus operations. This paper focuses on the Polytechnic School of Chimborazo (ESPOCH) in Ecuador, which has recently been evaluated in the UI GreenMetric World University Rankings. The UI GreenMetric ranking assesses the sustainability performance of universities worldwide, providing a benchmark for continuous improvement [1].

The main objectives of this paper are to: i) analyze the current sustainability performance of ESPOCH, with a focus on low-scoring indicators in the UI GreenMetric ranking. ii) Propose innovative sustainability initiatives to address these weaknesses and improve the university's overall sustainability performance. iii) Offer insights and guidance for other higher education institutions seeking to enhance their sustainability efforts.

Section 2 presents the results and discussions of the analysis of ESPOCH's sustainability performance based on the UI GreenMetric ranking. Section 3 details a carbon emission reduction action plan for the university, focusing on specific initiatives to address low-scoring indicators. Section 4 offers concluding remarks and future recommendations.

2. Results and Discussions

The UI GreenMetric ranking evaluates university sustainability across six categories: Setting and Infrastructure, Energy and Climate Change, Transportation, Waste, Water, and Education. ESPOCH's overall score in the 2022 ranking was 66.00%, with varying performance across the categories. This section presents an analysis of the low-scoring indicators within each category as shown in Figure 1, which serve as the basis for the proposed sustainability initiatives.

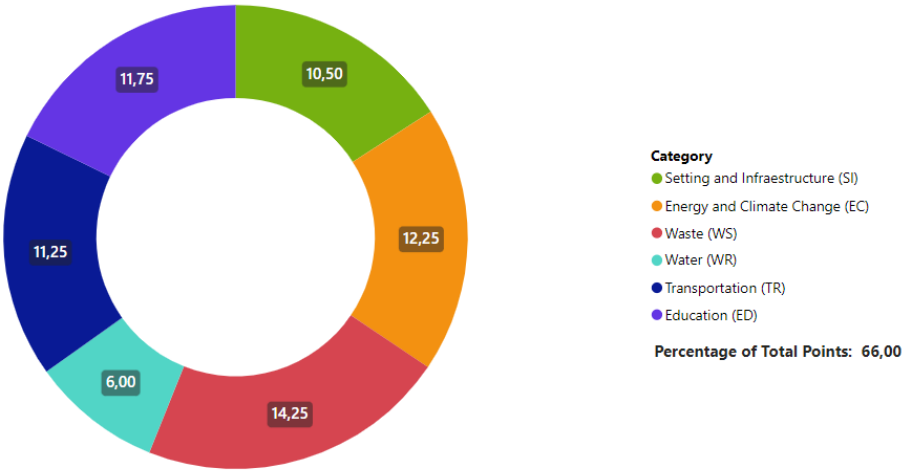

Figure 1. Score Obtained by ESPOCH in the UI Greemetric Evaluation (2022)

2.1 Analysis of the 2022 Factfile for ESPOCH

In our analysis of the 2022 UIGreenMetric report for ESPOCH, we have identified several indicators with the lowest evaluations across various categories. These indicators include the extent of campus vegetation coverage, university budget allocations for sustainability efforts, building operation and maintenance activities, conservation measures for biodiversity, among others shown in Figure 2. Addressing these underperforming indicators is essential for enhancing ESPOCH's sustainability performance and achieving a higher ranking in the UI GreenMetric World University Rankings.

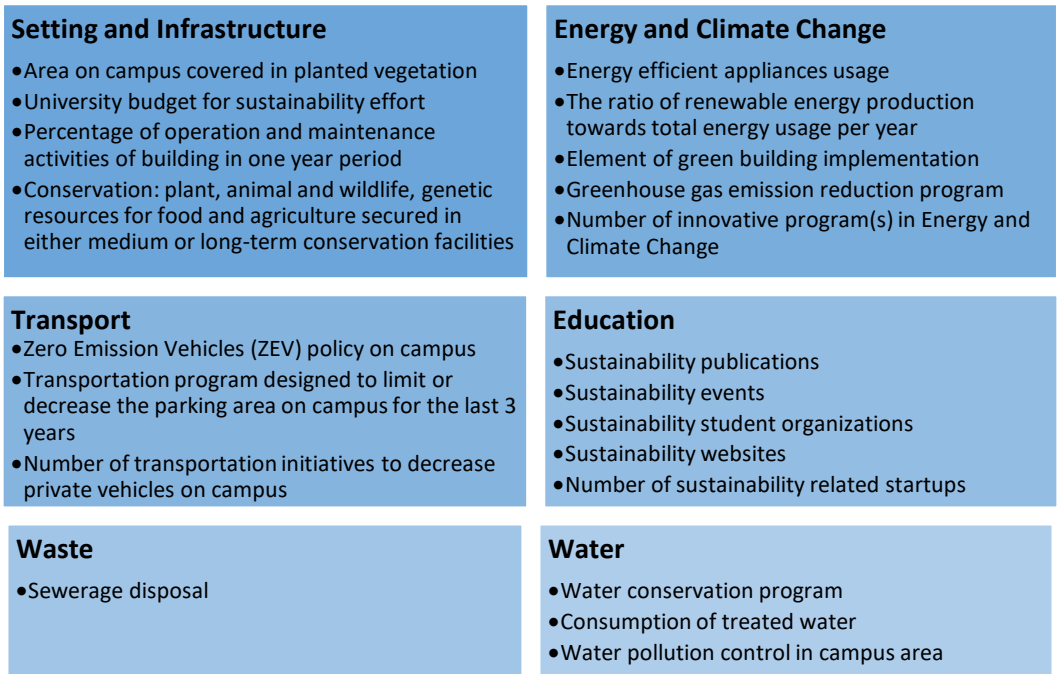

Figure 2. Underperforming indicators for ESPOCH

2.2 Distribution of campus areas of ESPOCH

In the context of ESPOCH's main campus in Riobamba, which has an area of 120.2 hectares, it becomes crucial to evaluate the institution's performance in sustainability indicators identified in the previous paragraph. The campus area is divided into sections occupied by buildings, forested areas with native trees, green spaces like parks and gardens, pedestrian and vehicular pathways, and parking zones.

As illustrated in Figure 3, it is essential to consider the distribution of the institutional areas in order to effectively address the underperforming indicators. By focusing on improving sustainability efforts in areas such as vegetation coverage, green building implementation, transportation policies, and water management, ESPOCH can significantly enhance its overall environmental performance and foster a more sustainable campus environment.

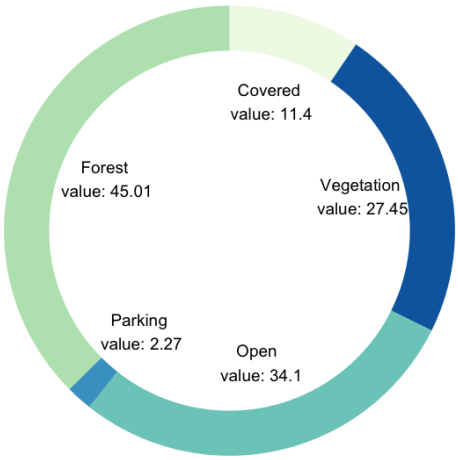

Figure 3. Distributed Areas (Ha) of the Campus of ESPOCH in Riobamba

2.3 Measuring carbon footprint at the institutional level

The carbon footprint (CF) is a measurement of the greenhouse gas (GHG) emissions generated by human activities. It can be calculated using the formula: Carbon footprint = Activity data x Emission Factor. In this formula, activity data refers to the level of activity that produces GHG emissions, while the emission factor (EF) represents the amount of GHG released per unit of activity data. EFs vary depending on the specific activity being considered.

The result of this calculation is expressed in units of equivalent carbon dioxide (CO_2 eq), which accounts for the global warming potential (GWP) of different GHGs. The Kyoto Protocol [3] identifies the main GHGs contributing to climate change as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and, since the COP 18 held in Doha in 2012, nitrogen trifluoride (NF_3). However, CO_2 is the most prevalent GHG and has the most significant impact on global warming. Therefore, GHG emissions are often measured in terms of CO_2 equivalents.

The universal unit of measurement for GWP is the carbon equivalent gram (gC or geqC) and its multiples (carbon equivalent kg/kgC, and carbon equivalent ton/tC or teqC). In CO_2, the weight of carbon accounts for only 12/44 (0.274) of the total weight. Consequently, 1 kg

of CO2 corresponds to 0.274 kg of carbon equivalent (and 1kg eqC = 44/12 kg eqCO2). GHGs are measured by converting the activity data into CO2 equivalents.

Emission factors and data used in a CF study may be subject to a margin of error or uncertainty, which can be attributed to the data sources (surveys, estimates) or the calculation method. In this study, primary data from direct consumption surveys were used, and an assumed uncertainty of 5% was considered.

ESPOCH is committed to addressing its greenhouse gas (GHG) emissions by focusing on the following strategies:

- The University will account for 100% of its GHG emissions resulting from operations under its direct control. Emissions from operations in which the University holds partial ownership but lacks control will not be included. Control can be defined in both financial and operational terms.
- ESPOCH will consider emissions from operations where it exercises financial control, meaning it has the authority to direct financial and operating policies to derive benefits from its activities. Emissions from partnerships involving joint financial control will not be accounted for in this study.
- Emissions from sources under the University's operational control will be included in the analysis.
- The emission activities considered within these scopes for calculations include direct emissions, such as vehicle travel and fuel consumption (gasoline and diesel), and indirect emissions, such as water and electricity consumption.
- The timeframe for this study covers the period from January 1, 2022, to December 31, 2022.
- GHG emissions are measured by converting observable activity data into CO2 equivalents using emission factors, such as the conversion of 1 kWh of electricity to 450 grams of CO2 equivalent.

2.4 Campus population and GHG emissions

ESPOCH has a diverse campus population, which plays a significant role in the institution's greenhouse gas (GHG) emissions. Data obtained from the Department of Human Talent and Career Secretaries reveal the distribution of personnel on campus, as shown in Figure 4. Students make up the largest proportion of the campus population, which has a direct impact on the total emissions generated.

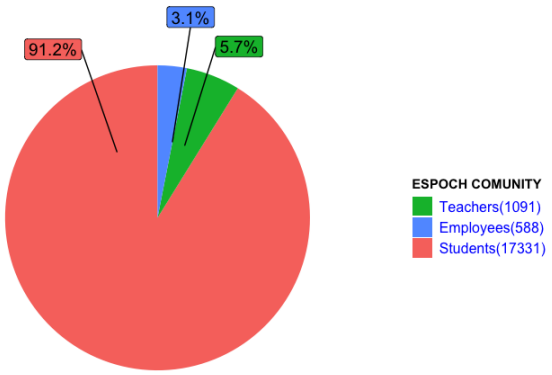

Figure 4.Composition of the ESPOCH Community in the Year 2022

To assess the GHG emissions associated with the various activities on campus, it is

essential to identify the sources and collect the relevant activity data for the year. The emission factors used in this analysis are derived from the Carbon Footprint Registry for compensation and absorption projects [4]: Electricity (0.4507 kg CO2/kWh), Naphtha 89 (2.07 kg CO2/l), and Diesel (2.62 kg CO2/l). Based on these factors, it is possible to calculate both the emissions linked to the organization's activities and their emission intensity.

Figure 5 presents the monthly consumption of electricity, gasoline, and diesel in tonnes of CO2 equivalent for the year 2022, ranked in descending order from the highest to the lowest consumption month. By examining the campus population and its corresponding GHG emissions, ESPOCH can identify areas for improvement and implement targeted strategies to reduce its overall environmental impact. Understanding the distribution of emissions across different population groups will enable the institution to develop customized initiatives that effectively address the specific needs and challenges faced by each segment of the campus community.

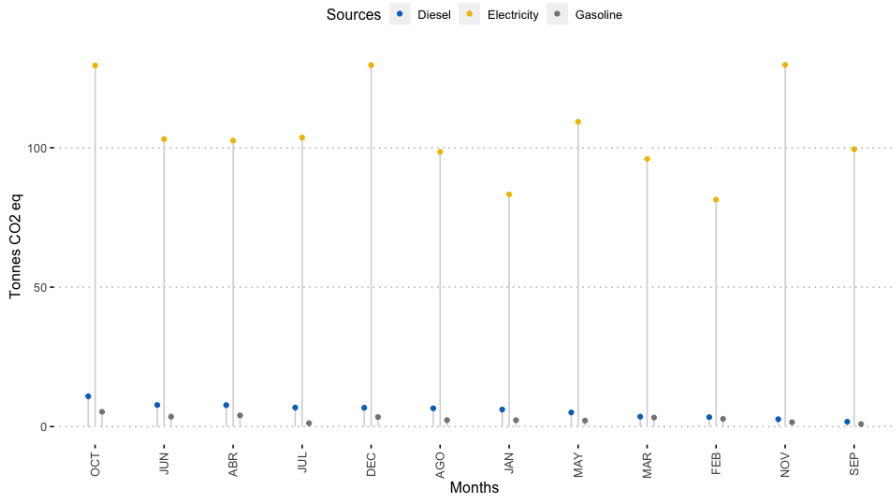

Figure 5. Consumption Electricity, Gasoline and Diesel in Tonnes CO2 Equivalent in 2022 Year

Figure 6 illustrates the water consumption in kilotonnes of CO2 equivalent for students, faculty, and staff during the same year. It is evident that student consumption is considerably higher compared to that of other members of the university community.

The considerable water consumption by students can be linked to their daily routines and the infrastructure provided by the university. For example, various campus amenities, such as the gymnasium, swimming pool, sports fields, and agriculture plots further contribute to elevated water usage. Moreover, laboratories and other research facilities need water for experiments and equipment cooling, which adds to the overall consumption.

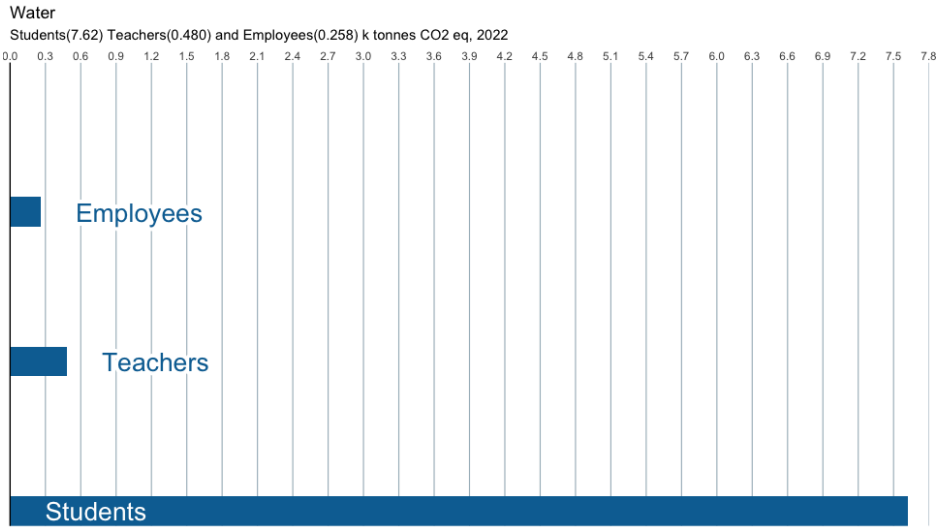

Figure 6. Consumption Water in K Tonnes CO2 Equivalent in 2022 Year

In light of the partial results obtained from analysing the sources of CO2 emissions at ESPOCH, a comprehensive summary table has been prepared to present the institution's total carbon footprint.

In Table 1, the activity data column represents the actual consumption levels of each emission source on campus. This data is gathered from utility bills, fuel purchase records, and other relevant sources, and is used to quantify the extent of each activity generating greenhouse gas emissions. The emission factors column, on the other hand, contains values that indicate the amount of greenhouse gases released per unit of activity data, such as kg CO2 per kWh of electricity consumed or per liter of fuel used. Finally, it was found that the carbon footprint of ESPOCH for 2022 is 9.728,39 tons CO_2 eq.

Table 1. Summary of Emissions by Source for The Year 2022 in Tons CO2 eq.

SOURCE	ACTIVITY DATA		EMISSION FACTOR	EMISSION ($tons\ CO_2\ eq$)
	VALUE	UNITY		
Gasoline	15.857,72	lt	2,07	32,83
Diesel	26.327,31	lt	2,62	68,98
Electricity	2.813.733,09	KWh	0,48	1.266,18
Water	1.520.800,00	lt	0.50	8.360,40
				9.728,39

3. CO_2 Emission Reduction Action Plan

After evaluating various alternatives to reduce identified emissions, ESPOCH has decided to implement a comprehensive improvement plan that includes the following areas:

3.1 Setting and Infrastructure

Allocate sufficient funds within the institutional budget to finance projects for regular maintenance of buildings, expansion of green areas with the incorporation of native plants, preservation of existing green spaces, and conservation of flora and fauna inhabiting the university campus. Encourage the polytechnic community to care for and preserve green areas, avoiding actions that compromise their integrity.

3.2 Energy and Climate Change

Implement an energy awareness and conservation plan that provides environmental education and promotes responsible energy consumption among office staff. Training individuals is crucial for reducing electricity and fuel usage, making awareness campaigns and workshops essential. The goal is to foster a university community with the knowledge needed for responsible energy use in their workplaces, study areas, and research facilities. Continuous and specific training can be delivered through informative brochures and organized awareness workshops. This Energy Awareness and Conservation Plan also proposes sending environmental awareness emails to office staff and designing energy-saving posters.

Promote the adoption of an energy manager role, responsible for energy management and disseminating knowledge about the potential benefits of energy management. This would allow for proper monitoring of Energy Management Plans and the possibility of integrating management and audit systems.

3.2.1. Behaviour Improvements for Lighting Systems

In the pursuit of enhanced energy efficiency, several behavioural improvements can be adopted to optimize the use of lighting systems within the workplace:

- Optimize natural light use by choosing light-coloured wall paint, using blinds or curtains to prevent glare, keeping windows clean, and regularly cleaning light bulbs and lamps to maintain lighting efficiency.
- Adjust lighting according to workplace needs in terms of intensity and quality.
- Notify building maintenance personnel if any broken or dirty lighting fixtures cause a loss of lighting efficiency.
- Implement daytime control of outdoor lighting for more efficient energy consumption management.

3.2.2. Behaviour Improvements for Computer Systems

To enhance energy efficiency and reduce unnecessary power consumption from computer systems, the following behavioural practices are recommended:

- Unplug electronic devices when not in use, and avoid leaving computer equipment on during periods of inactivity longer than one hour.
- Turn off monitors during short breaks.
- Consolidate printing jobs and turn off printers when not in use.
- Do not leave equipment in standby mode after work hours, especially printers, where the difference in consumption between off mode and standby can be significant.
- Configure computer equipment to enter energy-saving or sleep mode after 10 minutes of inactivity.

3.2.3. Behaviour Improvements in Paper Resource Management

To promote responsible paper resource management and reduce paper consumption, the following behavioural adjustments can be introduced:

- Reduce paper consumption by changing habits, encouraging staff and students to separate and reuse paper.
- Place paper collection containers at each desk or in offices and classrooms to facilitate recycling.
- Encourage double-sided printing to save paper, copying, shipping, and storage costs.
- Display guidelines for paper-saving practices in offices and classrooms.
- Include awareness messages in email signatures.

3.3 Transportation

- Maintain proper control and management of vehicle use and fuel consumption to keep accurate records for potential improvements.
- Perform regular vehicle maintenance to avoid excessive fuel costs and prevent mechanical failures.
- Periodically check tire pressure, as underinflated tires can increase fuel consumption and reduce tire life.
- Monitor oil, air, and fuel filter conditions to optimize fuel consumption.
- Reduce private vehicle use and practice sustainable mobility.

3.4 Waste

- Train staff and students on environmental issues, including waste separation and management, through information channels and dissemination of educational materials. This initiative must be promoted by the decision-making body.
- Separate organic waste for sustainable management (composting or recycling), avoiding incineration or landfill disposal.
- Collect inorganic waste generated in different offices (packaging, cardboard, paper, etc.) separately and deliver it to the appropriate authorized waste manager.

3.5 Water

- Implement water distribution control systems for different university facilities.
- Regularly review the operation of toilets, faucets, valves, cisterns, and elevated tanks.
- Promote rational water use among the polytechnic community.
- Implement rainwater harvesting systems for use in garden irrigation, restrooms, and building cleaning.
- Encourage wastewater treatment systems for use in green spaces.

3.6 Education

- Promote academic events and entrepreneurship related to sustainability.
- Implement sustainability-focused websites in each faculty.
- Motivate students, professors, and administrators to undertake actions aimed at reducing the institutional carbon footprint through plans containing good environmental practices.
- Encourage professors and researchers to publish work emphasizing sustainability issues.

4. Concluding remarks

The sustainability initiatives in this work offer a comprehensive approach to addressing the weaknesses identified in ESPOCH's sustainability performance, based on the 2022 factfile of the UI GreenMetric World University Rankings. By implementing these initiatives, the university can significantly enhance its contribution to a more sustainable future and serve as a model for other higher education institutions.

Continuous monitoring, evaluation, and adjustments to these initiatives will be necessary to ensure their long-term success and adapt to any changes in the university's needs or external factors. Furthermore, promoting a culture of sustainability within the university community is crucial for the success of these initiatives. This requires active engagement, collaboration, and communication among students, faculty, staff, and stakeholders.

It is essential to recognize that the sustainability plan is an ongoing process, requiring persistent efforts to adapt and improve. Other universities can learn from the experiences of ESPOCH and apply its insights to their own context. By sharing knowledge and best practices, higher education institutions can collectively advance sustainability on a global scale and contribute to the achievement of the Sustainable Development Goals.

Future research could examine the impact and effectiveness of the proposed initiatives, providing valuable feedback for refining and further enhancing ESPOCH's sustainability efforts. Ultimately, this case study serves as a valuable resource for institutions seeking to enhance their sustainability performance and contribute to a more sustainable future.

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