Enhancing Campus Sustainability: A LEED-Based Case Study

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Abstract

Northern Kentucky University is committed to being a student-centered institution, prioritizing the well-being and learning experience of our students. Therefore, it is essential to measure the sustainability level of the campus. The goal is not only to enhance the students' experience but also to create an eco-friendly environment that nurtures the health and productivity of faculty and staff. It provides valuable learning experiences, specifically for construction management students, while empowering them to carry firsthand sustainable practices into their careers, thereby contributing to a more sustainable future.

Utilizing the Leadership in Energy and Environmental Design (LEED) criteria, a survey consisting of 25 questions was developed and distributed among Facility Management staff, who play a pivotal role in campus sustainability. The survey focused on the following categories: location and transportation, sustainable sites, water efficiency, energy and atmosphere, indoor environmental quality, innovation, and regional priorities. Anonymous responses from six out of eight surveys sent out were collected and analyzed.

The findings highlight substantial opportunities for enhancing campus sustainability, particularly in location and transportation, energy and atmosphere, and innovation and regional priorities.
The study suggests the development of short-term and long-term plans to transition the campus toward greater sustainability. The data analysis underscores the need to prioritize water use reduction, adoption of renewable resources, improvement of quality views and daylighting, and reduction of food waste.

Introduction and Background

Sustainability is grounded in a fundamental principle: our survival and well-being are intricately linked to our natural environment, whether directly or indirectly. The pursuit of sustainability involves establishing and preserving conditions that allow humans and nature to coexist harmoniously, fostering the support of both present and future generations. The National Environmental Policy Act of 1969 committed the United States to sustainability, declaring it a national policy “to create and maintain conditions under which humans and nature can exist in productive harmony, permitting the fulfillment of the social, economic, and other requirements of present and future generations”[1].

Construction is characterized by its fragmented, unique, and complex nature, often grappling with persistent challenges such as significant time overruns (affecting 70% of projects), average cost

overruns of 14% of the contract cost, and the generation of approximately 10% of material cost in waste. Additionally, it stands as one of the major contributors to environmental pollution.

Conventional practices in construction processes and management have proven inadequate in addressing unprecedented challenges, particularly concerning carbon emissions. These challenges underscore the imperative for industry practitioners to reconsider and enhance construction processes and technology. This highlights the substantial potential of the construction industry to advance sustainable development by tackling issues related to economic, social, and environmental aspects. The adoption of sustainable construction practices holds promise in reducing overall energy consumption, optimizing the utilization of renewable energy sources, minimizing waste, conserving water resources, improving water quality, incorporating water-sensitive design to mitigate flooding risks, curbing polluting emissions to water, air, and soil, and mitigating noise and light pollution [2].

Studies show that the learning process is significantly affected by the physical environment offered by school facilities. Elements such as spatial configuration, noise levels, thermal comfort, lighting, and air quality collectively affect the well-being of students, teachers, and staff in educational institutions. Sustainable schools, designed to be well-lit, healthy, and comfortable, foster an environment conducive to learning and student achievement. Notably, such facilities contribute to cost savings, energy efficiency, and resource conservation [3].

Daylighting and indoor air quality are two key aspects of sustainable building design that directly impact student performance. Studies show that improved indoor air quality in schools contributes to the well-being of both students and faculty. This, in turn, leads to reduced absenteeism and enhances overall student achievement [4].

Another study indicated that students in schools with daylighting, whether they were newly constructed or retrofitted, consistently outperformed the county average in all scenarios. To be more precise, students attending schools with natural daylight demonstrated a performance advantage ranging from 5 to 14 percent over those in non-daylit schools, depending on whether one considers short-term or long-term effects. Notably, the research revealed that the label "new" did not guarantee improved performance. Surprisingly, a newly constructed school without daylighting exhibited a negative impact on students' performance [5].

Considering the impact of a sustainable campus on the performance of students, faculty, and staff, a survey was conducted to identify a pathway toward a more sustainable campus. Subsequently, the survey was distributed among Facility Management staff to identify gaps and propose solutions. The results of this research are expected to pave the way for a more attractive, productive, and environmentally friendly campus, resulting in more students becoming familiar with sustainability concepts and practices.

Methodology

The influence of sustainable buildings on employees and students goes beyond environmental factors. It includes aspects such as physical health, mental well-being, productivity, and the cultivation of a sustainable mindset that can have a positive impact on the wider community.

Atici et. al [6] explored the potential correlation between environmentally friendly practices on university campuses and academic success. This study confirms a connection between green university practices and academic rankings. Consequently, higher scores in environmental performance are found to correlate with enhanced academic performance among universities. Additionally, the positive influence of sustainability on academic performance is reinforced when considering the environmental performance at the country level.

Northern Kentucky University is a student-centered institution, and we deeply care about our students and their learning experience. Therefore, I wanted to measure the sustainability level of the campus not only to enhance the students' experience but also to provide an eco-friendly environment that embraces a healthier and more productive faculty and staff.

LEED, which stands for Leadership in Energy and Environmental Design, is a widely recognized green building certification system developed by the U.S. Green Building Council (USGBC). LEED provides a framework for designing, constructing, operating, and certifying buildings with a focus on sustainability and environmental performance. A survey with 25 questions has been developed based on LEED checklist to explore opportunities for improvement in various categories, including location and transportation, sustainable sites, water efficiency, energy and atmosphere, indoor environmental quality, innovation, and regional priorities. It was distributed among Facility Management staff who have the most knowledge about the sustainability status of our campus. They are in charge of the sustainability of the campus, planning, design, construction, as well as operation and maintenance. Six anonymous responses were collected out of the eight surveys that were sent out.

Data Analysis

In this section, Excel software was used to analyze and interpret the collected data. The questions were categorized into seven different categories based on the LEED rating system.

1- Location and Transportation

The LT category is the most recent addition to the LEED rating systems. It emphasizes reducing one of the main contributors to global warming: transportation. Its goal is to apply strategies to reduce the costs, pollution, and resources associated with daily transportation, given that the U.S.

Energy Information Administration (EIA) reported that transportation emissions contributed to 33% of the total greenhouse gas emissions in the U.S[7].

Table 1. Location and Transportation

Question	Avg.	Var.	CV
The campus is conveniently located with access to public Transportation	4	3	0.75
The campus promotes alternative transportation options (e.g., biking, walking).	4.5	0.3	0.06
The campus offers enough EV charging station.	3.83	1.37	0.36
There is a parking space designated for green vehicles.	3	3.6	1.2
The campus offers enough pedestrian amenities such as trees, benches,…	4	2.4	0.6
Average	3.86	2.13	0.59

The first question was whether the campus is conveniently located with access to public transportation. The average score for question one was 4 out of 5, with a variance of 3 and a coefficient of variation (CV) of 0.75. A CV equal to or greater than 1 indicates relatively high variation, but this is not the case here. Variance represents the average amount of variability in the dataset, determining, on average, how far each value lies from the mean, which is 3 in this instance. Considering both variance and CV, it can be interpreted that the university has provided some public transportation options; however, it was not sufficient, especially in the eyes of people who don't live in nearby neighborhoods.

The second question is addressing the campus's alternative transportation options (e.g., biking, walking). The average score was 4.5 out of 5, variance of 0.3, and CV of 0.06. It shows strong agreement on sustainable transportation options for the campus.

The third question is about having enough EV charging stations on campus. The average score is 3.83 out of 5, with a variance of 1.37 and a CV of 0.36. This indicates that the responses varied, but there is certainly room to add more EV charging stations on campus.

The fourth question addresses if there is parking space designated for green vehicles. The respondents gave an average score of 3 with a high variance of 3.6 and a high CV of 1.2 for this question. It can be interpreted that while respondents are not on the same page, there should be more parking areas assigned for green vehicles.

The fifth question was about having enough pedestrian amenities such as trees, benches, bike racks, and garbage and recycling cans. The average is 4, with a variance of 2.4 and a CV of 0.6, showing that the majority of respondents see the campus as offering enough pedestrian amenities.

2- Sustainable Sites

The goal of the Sustainable Sites (SS) category is to minimize the environmental impact during the development of a building site and throughout the building's lifecycle [8].

Table 2. Sustainable Sites

Question	Avg.	Var.	CV
The campus landscaping includes native and drought-resistant plants.	4.33	0.66	0.15
The campus minimizes light pollution through efficient outdoor lighting design.	4.5	0.25	0.05
Average	4.41	0.45	0.1

The first question addresses whether the campus includes native and drought-resistant plants. The high average of 4.33, along with a low variance of 0.66 and a low CV of 0.15, shows strong agreement on having native and drought-resistant plants on campus, which reduces water and chemical consumption.

The second question in this category explores whether an efficient outdoor lighting design was applied on campus to minimize light pollution. Again, the high average of 4.5, with a low variance of 0.25 and a CV of 0.05, indicates that the campus has an efficient outdoor lighting system.

The last question in this category asks about the rainwater management strategies applied on campus. The responses are shown below in Figure 1.

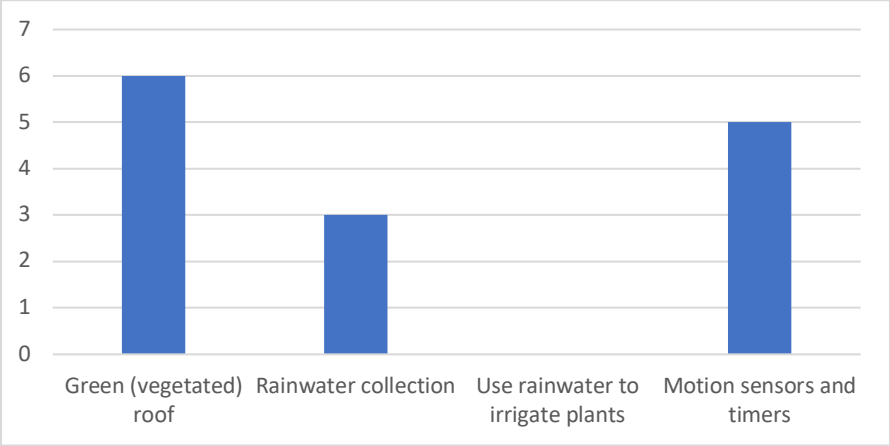

Figure 1. Rainwater Management Strategies

It can be seen from the graph that the campus has enough green roof and somehow collects rainwater. However, we need to use the collected rainwater for irrigation purposes, while also considering the addition of motion sensors and timers.

3- *Water Efficiency*

It is vital to conserve water, not only because of a shortage of resources but also to reduce the burden on natural streams.

Facility Management personnel have been asked about the indoor water reduction strategies applied on the Northern Kentucky University campus. The answers are tabulated below.

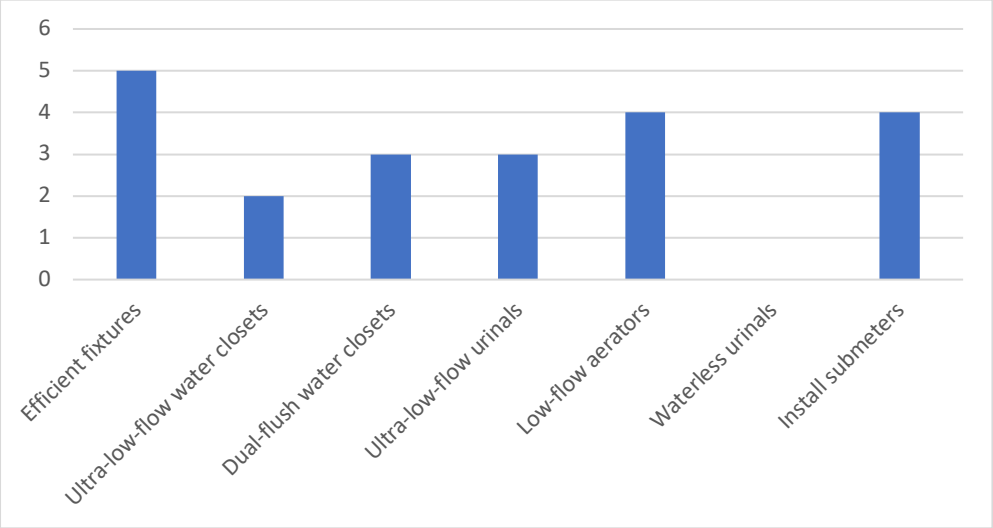

Figure 2. Reducing Indoor Water Use Strategies

As Figure 2 shows, there is room for improvement; waterless urinals may or may not be an option based on their performance and smell in institutional buildings. However, updating fixtures, water closets, and urinals campus-wide would dramatically improve the campus's performance in regard to indoor water use.

Respondents were asked, 'What suggestions do you have for further improving water efficiency on campus?' They proposed, “Calculate the cost and effect of water-saving equipment. This is a sustainability issue, but the return on investment and functionality of the changes need to be analyzed and chosen for the right reasons, not just because it saves some water.” Another suggestion was to “Collect rainwater for irrigation.”

4- *Energy and Atmosphere*

It is important to have a system in place on campus that reduces energy usage, increases efficiency, and measures performance.

Table 3. Energy and Atmosphere

Question	Avg.	Var.	CV
The campus incorporates energy-efficient building designs and technologies.	4.67	0.27	0.057
Renewable energy sources (e.g., solar panels) are utilized on campus.	2.83	2.17	0.76
Average	3.75	1.22	0.4

Responses to the first question in this category depict strong agreement on incorporating energy-efficient building designs and technologies on campus, with an average score as high as 4.67, a low variance of 0.27, and a low CV of 0.057.

However, the responses to the second question have a low average of 2.83, a high variance of 2.17, and a CV of 0.76. This indicates that there is significant room for improvement in the energy sources being used on campus to make them more renewable and sustainable, thereby minimizing the carbon footprints of the buildings and saving money on utility bills.

Facility Management staff were asked about reducing energy demand strategies applied on campus and their responses are shown below in Figure 3.

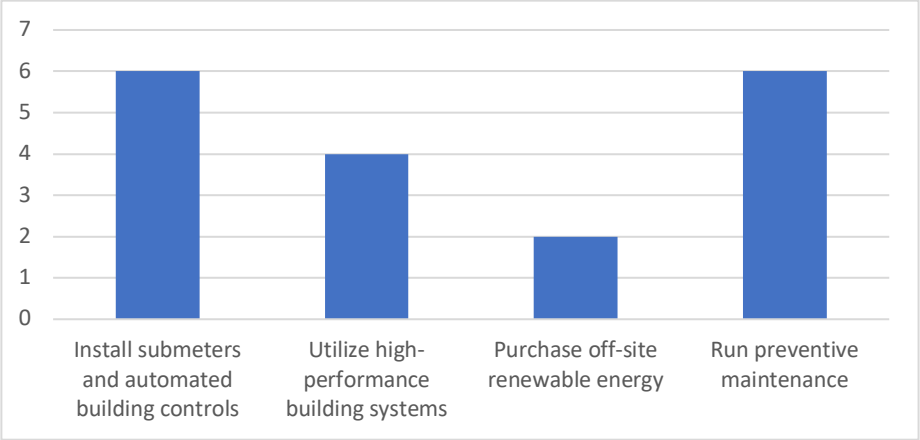

Figure 3. Reducing Energy Demand Strategies

Figure 3 shows that purchasing off-site renewable energy would be a viable option towards having a LEED certified campus. The next aspect that needs extra attention is utilizing high-performance building systems across the campus.

Moreover, respondents have been asked about untapped opportunities to reduce energy consumption and increase renewable energy use on campus. They suggested using more motion sensors for lighting, LED lighting, and solar energy.

5- *Materials and Resources*

Facility Management personnel have been asked about reducing energy demand strategies applied on campus, and their responses show that composting food waste needs immediate attention. Following that, implementing construction and solid waste planning and management strategies, and conducting a waste stream audit are secondary priorities in this category(Figure 4).

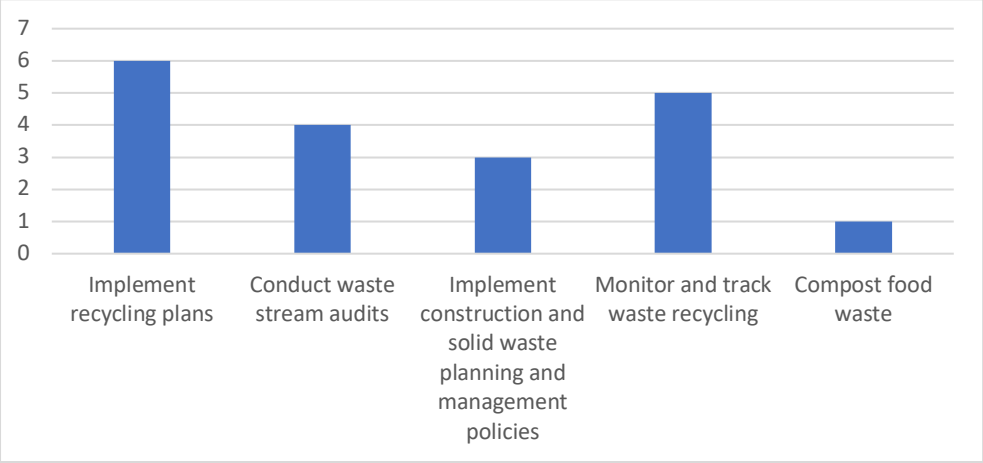

Figure 4. Reducing Energy Demand Strategies in Materials

6- *Indoor Environmental Quality*

The well-being of building occupants, the indoor environment, and the financial sustainability of an organization are intricately linked. In general, content and satisfied individuals are more likely to remain in a particular space.

Table 4. Indoor Environmental Quality

Question	Avg.	Var.	CV
Campus buildings prioritize indoor air quality and ventilation.	5	0	0
Daylighting and access to outdoor views are considered in building designs.	4.83	2.17	0.03
Average	4.91	1.08	0.015

Facility Management personnel were asked whether campus buildings prioritize indoor air quality (IAQ) and ventilation. The average score of responses was 5 out of 5, with a variance of 0 and a CV of 0, indicating no doubt about the priority given to IAQ and ventilation on our campus.

They were also asked whether daylighting and access to outdoor views are considered in building designs. The average score of 4.83, with a variance of 0.17 and a CV of 0.03, depicts that the design of the campus buildings was mindful of daylighting and accessibility to outdoor views.

The author explored indoor air quality (IAQ) strategies that have been applied on campus and asked respondents to select the strategies they found on campus. The results are shown in Figure 5, indicating the possibility to implement more carbon dioxide monitoring systems, improve hazardous gases or chemicals exhaustion, and establish a green building policy.

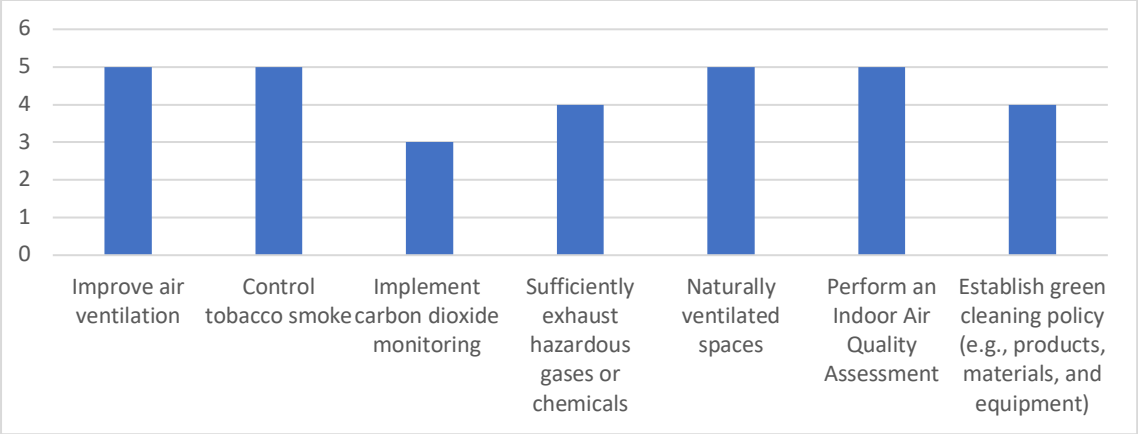

Figure 5. IAQ Strategies

Respondents have been asked about the types of occupant comfort strategies applied on campus. As the results of the survey shown in Figure 6 indicate, the view and acoustic performance of the buildings can be improved.

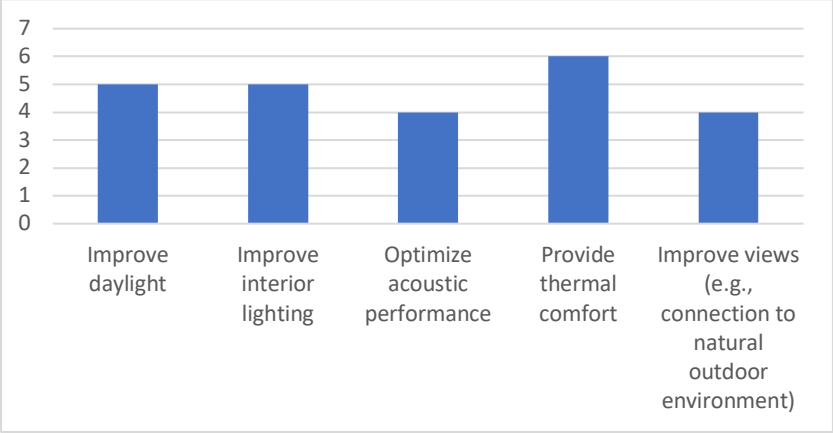

Figure 6. Occupant Comfort Strategies

Finally, the respondents were asked about suggestions to improve the IAQ of campus buildings. They suggested: “Support Differed maintenance to continue to improve outdated systems.”, “More controls and newer HVAC equipment”, and “Following design standards”.

7- *Innovation and Regional Priority*

This category promote projects that strive for exceptional or innovative performance. It also offers motivation for earning credits that specifically tackle geographically specific environmental, social equity, and public health priorities.

Table 5. Innovation and Regional Priority

Question	Avg.	Var.	CV
The campus actively seeks innovative solutions to environmental challenges.	3.8	0.16	0.04
Local and regional priorities related to sustainability are integrated into campus initiatives.	3.8	0.7	0.18
Average	3.8	0.43	0.11

When respondents were asked about implementing innovative solutions to environmental challenges, they perceived the campus as not very innovative in this regard. The average score of 3.8, with a variance of 0.16 and a CV of 0.04, reflects agreement on this sentiment. Similarly, they feel the same way about incorporating regional priorities regarding sustainability into campus initiatives.

Moreover, regional priorities were determined based on their regional importance, as identified by the USGBC regional councils and chapters, and were then shared with the respondents. Subsequently, the respondents were asked whether these regional priorities were applied on campus or not. The summary of the responses is shown below in Figure 7.

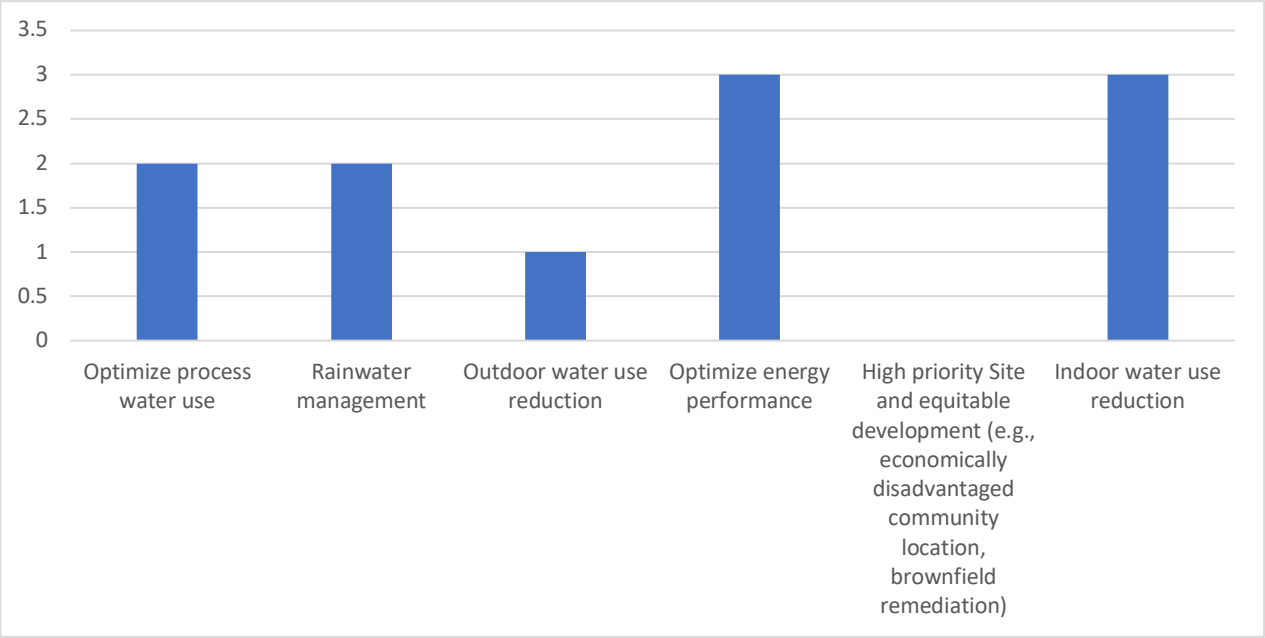

Figure 7. Regional Priority Strategies

Again, it can be observed from Figure 7 that the campus requires significant attention with regard to regional priorities. Reduction in outdoor water usage can be considered a high priority, with rainwater management and optimizing process water use following closely. Additionally, the energy performance and indoor water use of the campus can be improved. Further elaboration is needed to explore the existence of high-priority sites on our campus for consideration in future development.

Discussion and conclusion

The data and analysis presented in this study indicates that there are a lot of opportunities to make the campus more sustainable. The survey results demonstrate that there are more opportunities in location and transportation with an average of 3.86, energy and atmosphere with the average of 3.75, and innovation and regional priority with the average of 3.8.

The campus can offer more EV charging stations and add designated parking space for green vehicles. Currently, there are just 2 EV charging stations and no designated parking space for green vehicles on campus. The administration should collect rainwater and use it to irrigate plants and/or other purposes such as flushing the toilets. Also, it is recommended to use high efficiency irrigation system such as dripping.

EPA states that 70% of the total water consumption on a daily basis is inside. So, other necessary strategies to conserve water is to update water closets to ultra-low-flow rate and dual-flush which saves at least 20% of water. Also, upgrading urinals to ultra-low-flow ones are another effective

strategy. Using WaterSense-labled products are effective too since they are 20% more water efficient than average products in the same category.

The campus performance can be significantly enhanced by incorporating more renewable energy resources, as suggested by the respondents. Additionally, high-performance building systems can be beneficial.To enhance sustainability, the university should implement practices such as composting food waste and adopting construction and solid waste planning and management policies to minimize the environmental impact of materials and resources consumed on campus.

Improving Indoor Air Quality (IAQ) through the implementation of carbon dioxide monitoring is crucial for creating a safer environment for students, faculty, and staff, considering the proven impact of IAQ on occupant well-being in previous studies [4].

Establishing a green cleaning policy and minimizing the presence of hazardous gases or chemicals would further contribute to improving the air quality inside buildings. Respondents emphasized the importance of enhancing views from buildings, aligning with a study by Nicklas and Bailey, which illustrates how students' performance can be improved by providing greater access to natural light [5]. This is particularly crucial in our geographic location, with gloomy winter days, especially considering the campus was built in the 1970s and inspired by brutal architectural style.

The responses also highlight the need for improvement in the acoustic performance of buildings. The responses underscore the need for immediate attention to regional priorities and innovation. Both outdoor and indoor water usage should be curtailed through the implementation of efficient watering systems and fixtures. Additionally, rainwater should be effectively managed, recycled, and reused, along with the optimization of process water usage. Furthermore, there is a call to enhance the energy performance of the buildings.

In summary, the campus needs to develop both short-term and long-term plans to transition towards a more sustainable environment. A comprehensive evaluation of the costs and benefits associated with different options is essential.

Upon analyzing the data, it is evident that the plan should prioritize water use reduction, utilization of renewable resources, enhancement of quality views, and reduction of food waste.

In the short term, actions such as using more motion sensors for lighting, LED lighting, updating fixtures and implementing food waste composting can be included. For the longer term, strategies like upgrading building systems, constructing rain gardens, implementing drip irrigation systems, incorporating renewable resources such as solar panels, and integrating more quality views into buildings should be considered.

Establishing a living laboratory that educates occupants on sustainable design could be particularly beneficial. This living laboratory not only provides valuable learning experiences for construction management students but also serves as an attractive marketing point. Eventually, the campus can aspire to become a net-zero facility, enhancing the learning and working experiences for occupants while empowering students to carry firsthand sustainable practices into society, thereby contributing to a more sustainable future. Construction management students will benefit the most from a sustainable campus, as they can apply this learning to their careers.

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