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ENVIRONMENTAL AND ECONOMIC FEASIBILITY OF GREEN SUSTAINABLE BUILDINGS

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ABSTRACT

This study presents a realistic vision at which the building of Collage of engineering, Al-Qasim Green University will be developed and converted into an environmentally friendly green building that suits with environmental and climate changes to encourage progress in sustainable development and advancing. saving energy and water, minimizing waste, and improving the quality of educational environments. This study illustrates that if solar PV panels are used, they will generate 30-50 % of their electricity requirements, hence leading to a decrease in reliance on fossil fuel and a drop in carbon production of 25-35 tons yearly. LED lighting and movement sensors will cut the lighting energy load by 60–80%. The BMS and IoT sensors are expected to deliver a 20–25% increase in resource efficiency Rainwater harvesting, reuse of graywater, and smart irrigation systems will reduce up to 40 percent of water usage.

KEYWORDS: Sustainable Build, Innovation, Sustainability, Ecology, Retrofitting.

1. INTRODUCTION

In the light of the current conditions along with rapid pace of climate change and other environmental issues mankind is facing today it was about time to revisit inherently environmentally unfriendly processes such as traditional construction which lacks an environmental angle and long-term sustainability dimension being based on extensive energy use as well as unsustainable resource consumption. These issues have become more critical in developing countries such as Iraq, where most of the existing buildings are faced with multiple problems, including poor energy performance, lack of natural ventilation and thermal insulations, and high summer temperatures. This results in an unnecessary dependence on artificial cooling systems, resulting in greater energy consumption and damage to the environment due to harmful greenhouse gases [1, 2].

These issues affect building occupants' comfort and health in addition to causing an unwarranted increase in economic and environmental loads. The dominant urban style in Iraq is also generally without ecological ornaments or conservation of materials, which further defuse the environmental resilience of buildings (Mishtawi and Alsaray 2018). In this sense, the notion of "green buildings" comes to mind as a potential savior in a world where modern building needs must be counterbalanced with environmental protection. This is completed through the design and delivery of buildings that consume energy and water responsibly, minimize waste and emissions, create healthy indoor environment, with an emphasis on plentiful use of local materials and resources. [3, 4].

This work is about converting College of Engineering at Al-Qasim Green University from being normal building to be a green one. The evaluation will cover the building´s current energy / water consumption, ventilation systems (fresh air), use of water, materials in construction and lighting + cooling technique as well how it fulfills independently established international building standards concerning green buildings like LEED. The study seeks to pinpoint the environmental and technical deficiencies that exist in the current building and present a set of practical solutions applicable according to local native capacity, particularly to weather conditions as well as financial circumstances that prevail in Iraq.

2. METHODOLOGY

2.1. Statement of Problem

The majority of the existing buildings in Iraq, including the College of Engineering building at Al-Qasim Green University, as with many traditional buildings commonly found in Iraq is poorly and inadequately conforming to environmental performance and sustainability standards, resulting on a higher energy use, water consumption, operations cost and "Po P" indoor environment quality. These challenges are intensified by harsh climate, low quality construction materials and ignorance to the significance of green buildings. It becomes particularly critical to care about these concepts considering the role the universities occupy as places of learning. Therefore, we advocate to study the possibility of transforming lifeless typical buildings into lively green buildings and take the College of Engineering as a case.

2.2. Green and Sustainable Buildings

Conventional buildings: Conventional buildings are built with traditional construction materials and techniques; environmental performance and resource efficiency may not be considered [3]. Green buildings: Are those specially designed and managed to minimize drain on environment, optimize consumption of energy and water, and to improve physical indoor condition [4]. Sustainable buildings: Buildings to meet the needs of current and future generations, taking into account both environmental considerations as well as economic and social considerations. That's the general premise into which green buildings fit. A comparison between conventional and green buildings is shown in table (1).

Researchers consider a number of important factors pertaining to operational and environmental performance efficiency, including energy and water consumption, building material quality, interior environment quality, expenses, and environmental impact [5, 6]. This comparison highlights the main differences between the two models and highlights the advantages of green buildings as a more sustainable and effective option in today's urban environment. The main distinctions between conventional and green structures are likewise succinctly and comparatively shown in Table (2) [7, 8].

Table 1: An analysis of traditional and green buildings [6, 9].

Item	Traditional Buildings	Green Buildings
Energy Consumption	High, as a result of inefficient appliances that use a lot of energy for heating and cooling and inadequate insulation.	Low, as a result of clever design that considers smart solutions like solar or wind-powered air conditioning and adequate insulation.
Water Consumption	high, as a result of significant water waste caused by a lack of rainwater gathering or reuse technologies.	Low, as a result of methods for collecting rainwater and repurposing graywater for garden irrigation or other uses.
Building Materials	Traditional and unsustainable, such as uninsulated concrete and brick, which contributes to a building's environmental footprint.	recyclable and sustainable, such low-carbon natural or recycled materials.
Indoor Environmental Quality	Weak, as a result of inadequate natural illumination and ventilation, which affects occupant comfort and safety.	Good, because occupants' comfort and health are improved by sufficient natural lighting and ventilation.
Operating Costs	High, due to the excessive energy and water consumption, as well as the maintenance of traditional systems.	Low over time because of the effectiveness of the water and energy conservation systems.
Environmental Impact	Negative, as a result of rising carbon emissions and overuse of natural resources.	Positive, using eco-friendly technologies to promote sustainability and lessen carbon emissions.
Climate-Smart Design	Lack of knowledge about the local climate conditions, such as wind or sun directions, which leads to thermal discomfort inside the building.	Sensitive to the local climate, through a design that corrects to wind and sun directions, which improves thermal comfort and decreases the need for heating and cooling.
Renewable Energy Systems	Absence of renewable energy systems and reliance primarily on non-renewable energy sources.	depends on renewable energy sources, like solar or wind power, to provide the building's energy requirements.
Flexibility for Expansion and Renovation	Limited, as at all renovation or modification requires significant reconstruction and additional costs.	Because new systems may be installed or old systems can be readily refurbished, it is flexible and adaptive to future developments.

Table 2: sustainable buildings vs green buildings.

Standard	Green Buildings	Green Buildings
Primary Focus	Environment and Resource Efficiency	Environment and Resource Efficiency
Scope	Focuses on the building itself	Focuses on the construction itself
Life Cycle	Regularly the operational phase	Often the operational phase
Health and Comfort	Part of the evaluation	Portion of the evaluation

2.3. LEED (Leadership in Energy and Environmental Design)

The LEED system was developed in 1998 by the U.S. Green Building Council (USGBC). It is the most well-known green building grading system in the world, with the goals of enhancing indoor environments, lowering the environmental effect of buildings, and increasing energy and water efficiency. There are various categories in LEED (Fig. 1). [10].

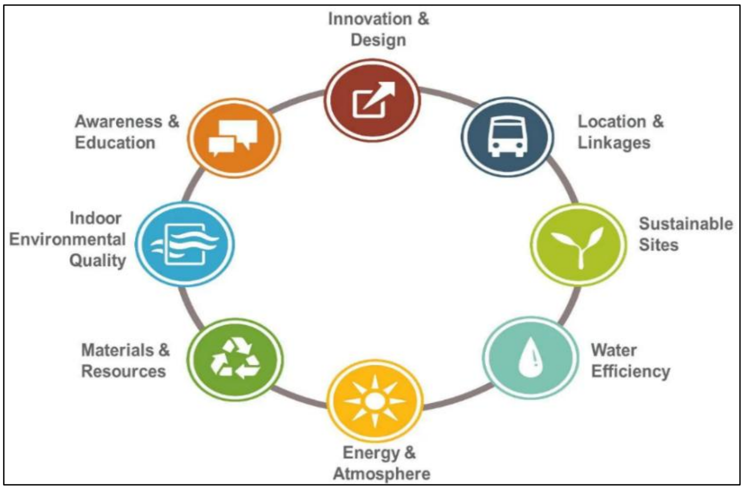

Figure 1: LEED Standard Categories.

3. RESULTS AND DISCUSSION

3.1. Geographical Location

Al-Qasim Green University's College of Engineering is situated outside the university's main campus in the Babylon Governorate, more precisely in the city of Al-Qasim. The following geographic coordinates are where the college is located: latitude 32.5100° N, longitude 44.3500° E. The entire area is 8,460 m2, including 2,315 m2 for the structure and 4,000 m2 for the green spaces (Fig. 2). The Deanship Building, which houses the classroom building and the administrative wing, is one of the structures on the College of Engineering campus. The college also has the Student Club Building, which offers a social setting for students, and engineering workshops for hands-on training. Additionally, there is the Engineering Consulting Office Hall, which serves as a venue for engineering projects and consultations.

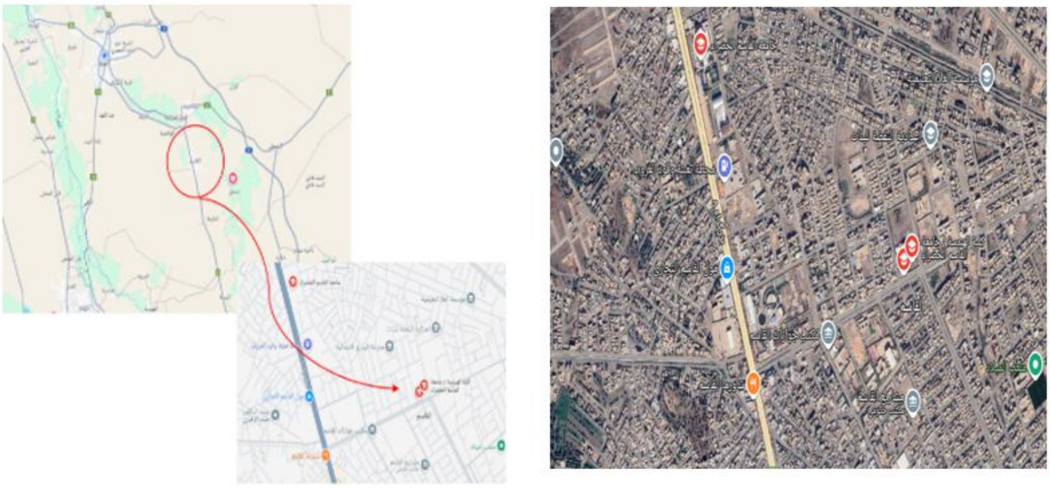

Figure 2: Location of the College of Engineering.

3.2. Climate

The climate at the College of Engineering resides within semi- arid and desert climate. The region is extremely hot in the summer reaching 50+ degrees Celsius. It is widely known that is a considerable challenge for comfort of both, students and faculty (and therefore to students' learning process) but also for the growth of plants or any kind of cultivation. Cold periods of less than 10 °C on the other hand, may induce considerable fluctuations in the climate, which can affect vegetation sustainability. The area receives little rain, only a few minutes in the winter season between November and March. It is an intermittent and modest rainfall. This means rainfall cannot be trusted to produce enough water for agricultural or environmental purposes.

3.3. Investigating Wind Trends

Examining wind speeds and directions is also essential for determining whether green building upgrades are feasible, particularly when it comes to renewable energy. Al-Qasim Green University's College of Engineering is situated in an open area that is subject to monsoon winds, particularly in the spring and fall. Winds often come from the northwest or southeast and range in speed from 10 to 25 km/h.

3.4. Topographical and Geological Characteristics

The area has a level surface, with some moderate inclinations on its margins. Sol: canoe clay, mixed with cold brackish water and filtered but bad drinking - at times, it is so rich in salt that cattle will not drink from it.

3.5. Current Land Use

The college's land use includes of administrative and instructional facilities, as well as many cultivated spaces with a variety of grasses and trees.

3.6. Waste Generated

The College of Engineering, Al-Qasim Green University produces different forms of waste from its numerous activities within the college. The major of these wastes include:

1. Torn paper Unused documents Study guides This waste can be recycled and utilized as raw materials for various projects or to make new paper.
2. The Student Club's food waste: produced from college students' food waste, which may be composted to create organic fertilizers that improve soil fertility in campus gardens and green spaces.
3. Tree Litter – Tree litter refers to tree leaves and small branches that drop or are about trees in the yard or next to a building. This waste can be collected and turned to organic fertilizer or be used to grow greener in agriculture soil.

3.7. People in the College

The College of Engineering has some incredibly interesting people, all part of the everyday existence in the College. These people are a random sampling of teaching faculty, administration and students. Here are the numbers, back of the envelope style:

1. Lecture faculty: The college has 70± Faculty of both sex and they are teaching theoretical as well

as practical to students in this institution on different type of Engineering. These faculty members enhance the scholarly and research presence of the college.

2. Administrative Staff: The college employs about 55 administrative and technical personnel who are in charge of planning day-to-day activities like maintenance, hall management, and administrative follow-up.
3. Students: The college has over 600 male and female students enrolled in various engineering majors. These students, who comprise the majority of the university community, are the ones who frequently use the facilities for research and instruction. Knowing the expected number of students makes it possible to properly plan for providing green facilities and environmental needs that promote sustainable education and assist raise environmental consciousness among all college members.

3.8. SWOT Analysis for the Study Area

A strategic tool for evaluating an area's possibilities, threats, weaknesses, and strengths is SWOT analysis. In this context, SWOT analysis is used to assess the environmental and urban situation at the College of Engineering at Al-Qasim Green University with the goal of developing sustainable environmental projects and achieving a shift toward green buildings [11].

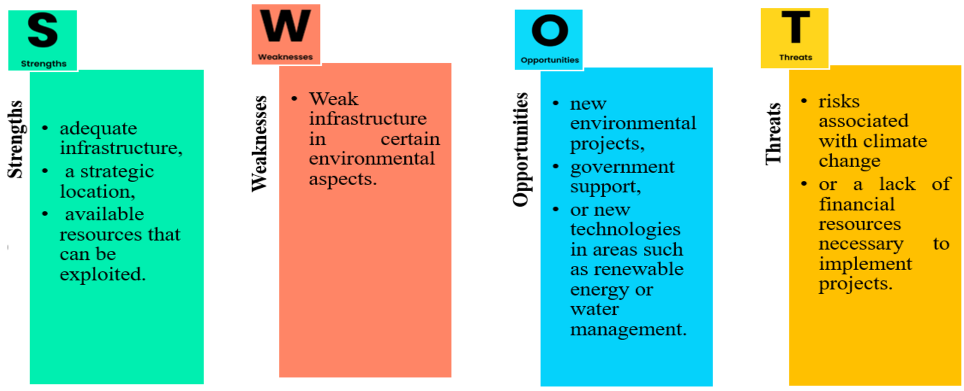

Figure 3:

3.9. Proposed Vision for Transitioning into a Green Building

The College of Engineering building urgently needs to be transformed into a green facility due to the study area's environmental and climatic constraints as well as the growing need to implement sustainable development concepts.

This change is motivated by the environmental and urban features of the territory (as pointed out above), mainly as it results from SWOT analysis, presenting very plausible opportunities for that same smooth logistic despite several constraints.

3.10. Energy

The optimal option for power generation in Al Qasim City is solar energy due to the high number of sunny days throughout the year (more than 300 day/ per year). The project objectives to tap into this resource for energy efficiency, by:

- Solar PV panels on the roofs of buildings providing 30–50% of demand for electricity, particularly in spring and summer.
- Change of lighting system to LED, which resulted in 60-80% lower energy consumption and maintenance costs.
- "Lights-off" devices in low-activity areas to save a further 20%.
- Including a BMS system to take readings of the use and help improve operation.
- Learning about wind power: Utilizing small rooftop turbines, even though the area lacks much wind. This is part of an effort to diminish the release of carbon emissions, save money, and build the image that a college can sustain itself.

3.11. Water Management

Climate change and lack of rainfall lead to very tough water conditions in Al Qasim City therefore there is the urgent needs switch over to smart solutions taking place inside educational buildings. There's a way to make it: College of Engineering hosts international experts The College of Engineering has produced an integrated approach to water management development plans that include:

- Water use reduction: The utilization of water saving valves and intelligent mixers systems lead to savings of 30–50% in sanitary rooms.
- Rainwater harvesting: By collecting rain water

from the buildings roofs and storing the same in ground tanks almost 10-15% of total water consumption for the period of rainy season can be saved.

- Reuse of Grey water: Wastewater from laundries and laboratory after initial treatment 35-40 This can be used for watering plants resulting current demand for irrigation water by 30-40%.
- Smart irrigation system -emphasizing ease and low weight employing drip irrigation and a soil humidity sensor that reduces water wasted through the irrigation to 25-35% compared to conventional technologies.
- Environment Awareness - Awareness campaigns and Workshops to propagate water saving culture that encourage responsible behavior and minimize waste in [12].

3.12. Waste and Recycling – Towards a Zero-Waste College

The problem of solid waste generation is severe in the College of Engineering, as there are no efficient systems in place to manage it specifically with high influxes of plastic and paper garbage. For converting to a green building, the following steps are suggested in the plan:

- 100% segregation of waste within the college through the provision and painting of containers (green for organic, blue for plastic, yellow for paper, black with purple tone for electronic).
- Working with local recycling companies for the collection and processing of re-usable waste in line with environmental practices.
- Paper and plastic: Recyclables to be reclaimed; decreasing overall waste by 40- 60%.
- Environmental initiatives, such as staff and student competitions, posters, and training, can promote a recycling culture.
- Creation of a centralized collection center for recycling waste which will also be used as an environmental education center.
- for the composting of organic waste along with several one-decade follow-up operations: Organic waste to be processed in order to produce compost for green space irrigation, reducing 20–30% organic waste.

3.13. Smart Systems: Using Digitization to Promote Sustainability

Intelligent green systems Smart infrastructure is essential to the shift to green buildings and boosts operational effectiveness by cutting down on waste whilst promoting user awareness through the incorporation of technology with management of the environment.

- The Building Management System is a centralized system that connects energy, water, ventilation, and lighting to maximize performance in real time and accomplish the following:
- Find errors and leaks right away.
- Automatically shut off lights after hours of business.
- Lowering the cost of operations and being 20-25% more efficient.
- College Mobile App: The electricity and water consumed per department or lab is displayed to bring in the element of transparency and healthy competition among departments & involve students in real time monitoring.
- IoT Sensors: Installed the local prone areas (water tanks, air conditioners etc.) to sense the performance indicators and send alerts when it gets more than usual.
- Lighting and air conditioning programmed by motion detectors or natural light sensors to only run when required, reducing energy consumption up to 30%.
- Interactive Environmental Display: Show real time sustainability performance measures (e.g., energy, water recycling etc) to generate awareness and performance change for sustainability on campus.

3.14. Economic Feasibility

A full cost/benefit analysis is conducted that compared the capital costs associated with proposed environmental strategies for construction in one of the College of Engineers green building projects and associated pay-backs through energy savings, water conservation, and avoidance of trash generation. The total capital spending is about 35,000,000 ID for the following packages as shown in Table 3:

Table 3: Economic feasibility

Item	Expected Outputs	Estimated Cost (Dinars)
Thermal insulation and exterior cladding	Decrease the building's heat load by 20%	9,000,000
Solar energy systems (PV panels)	Produce 30–50% of annual electricity consumption	15,000,000
LED lighting + motion sensors	Reduce lighting consumption by 60–80%	4,000,000
Water harvesting and treatment system	Saves 30–40% of irrigation water	5,000,000
Waste sorting and recycling	Reutilizes 50% of the college's waste	1,000,000
BMS system + mobile	The smart operation of the building is monitored and optimized by the application.	1,500,000

3.15. Environmental Feasibility

The conversion of Al-Qasim Green University College of Engineering into a green building project adds to a group of actual environmental advantages on four levels:

- Carbon footprint-Reduced Carbon Emissions: Less dependance on grid based electricity from the fossil fuel based national grids with solar lights yielding a reduction of 25 to 35 tons of CO_2 every year. With thermal insulation and LED lighting, air-conditioning load is moderated by an additional 15–20%, thus decreasing energy use and related emissions.
- Enhancing Quality of Indoor and Outdoor Air: The increase in green areas, planted with local plant species -achieves greater absorption of dusts and polluting agents and a rise in oxygen –level that's available to the university environment. Utilizing natural ventilation (e.g. wind driven turbines) helps to reduce indoor pollutant buildup by an assessed 30–40% and captures comfort and health benefits in the classroom.
- Improving the Efficiency of Natural Resource utilization: Technologies such as rainwater collecting, graywater utilization, and water-saving valves can reduce groundwater pressure by up to 40%. By lowering waste through real-time control and operation as needed, smart systems (BMS, IoT) enhance resource sustainability.
- Improving Local Biodiversity: Establishing green spaces and educational gardens with native plants helps the environment and reintroduces some wildlife, such as beneficial insects and birds.

3.16. Calculations of Environmental Performance Assessment

The environmental performance of the building was quantitatively examined through major sustainability metrics. Using the formulas in this part, the analysis computes the operational Carbon Emissions (CO_2), Water Efficiency Indicator (WEI), and Energy Use Intensity (EUI). These derived indicators give a baseline for analyzing the current building condition before adopting green retrofit solutions (table 4).

Table 4: data of Environmental Performance Assessment

Parameter	Value
Gross Floor Area (GFA)	800 m^2
Annual Electricity Consumption	19,324,800 kWh/year
Number of Occupants	800 persons
Daily Water Consumption	6,250 L/day
Emission Factor — Electricity	0.69 kg CO_2/kWh
Annual Kerosene Consumption	77,040 L/year
Emission Factor — Kerosene	2.52 kg CO_2/L

1. Energy Use Intensity (EUI)

$$EUI=\frac{\text{Annual Energy Consumption}}{Cross\ floor\ Area}=\frac{19324800}{800}=24165\ kWh/m^2\cdot year$$

2. Water Efficiency Indicator (WEI)

Annual Water Consumption = Daily Water Consumption × 365= 6,250 × 365 = 2,281,250 L/year = 2,281.25 m^3/year

$$EUI=\frac{\text{Annual Water Consumption}}{\text{Number of Occupants}a}=\frac{2,281.25}{800}=2.85\ m^3/\text{person}\cdot\text{year}$$

3. Carbon Emissions (CO_2)

CO_2 (Electricity) = Annual Electricity × EF_electricity = 19,324,800 × 0.69 = 13,323,112 kg CO_2/year

CO_2(Kerosene)=Annual Kerosene × EF_kerosene = 77,040 × 2.52 = 194,140.8 kg CO_2/year

Total CO_2 Emissions = CO_2(Electricity) + CO_2(Kerosene)= 13,323,112 + 194,140.8 = 13,517,252.8 kg CO_2/year = 13,517 tons CO_2/year

3.17. Comparative Studies

This part aims to study some successful attempts among universities and educational institutions concerning sustainability as the main strategy of the current research to transform COE building into a green building (Table 5). Through the learnings derived from these similar cases, these models can be used to achieve Al-Qasim Green University's environmental transition objectives. [13, 14].

Table 5: A Few Experiences at University.

Key results	Sustainable management applied	Educational organization
Cairo University	Connecting solar cells on college buildings	Decrease electricity bills by 35%
Jordan University of Science and Technology	A smart rain harvesting system	Save 40% of irrigation water
European Universities (Selected Models)	Via recycled building materials	Decrease buildings' carbon footprint by 20%

4. CONCLUSION

The conversion of Al Qasim Green University's College of Engineering is a sign of good economic and environmental determination and feasibility. The project is expected to produce quantifiable advantages in several performance categories through the integration of smart technologies, renewable energy systems, and sustainable water/waste management solutions.

- If solar PV panels are used, they are, in fact installed on the building —it will generate 30-50 per cent of its electricity requirements, hence leading to a decrease reliance on fossil fuel and a drop in carbon productions of 25-35 tons yearly. LED lighting and movement sensors will cut the lighting energy load by 60–80% whereas warm air insulation will save around 20% of the building's heating load.
- In the water industry, actions like rainwater harvesting, reuse of graywater and smart irrigation systems will reduce up to 40 percent usage of water. The waste interferences (sorting, recycling and composting) will result in 50% of the solid waste not going to dumpsite [-landing] as well as a 20-30% reduction in organic.
- Intelligent technologies such as the BMS and IoT sensors are expected to deliver a 20–25% increase in resource efficiency, and support real-time monitoring of performance. The combined investment cost of 35,000,000 IQD (equivalent to 4–6 years' payback time) is rationalised by long-term savings and operating convenience.
- Above all, this project improves environmental performance and lowers costs; however, by focusing on the Iraqi university building type it can also be considered an exemplary case for a sustainable design practice in Iraq with exemplar-antecedent-like(r) potentials between innovation and regional feasibility.

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