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A STRATEGIC FRAMEWORK FOR ATTAINING GOLDEN LEED CERTIFICATION FOR RESORTS

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1. INTRODUCTION

As a matter of fact, many economies consider "construction" to be a core industry. An industry that is a pillar in the economy of a country is one that is important and fundamental to that nation's economic health and is frequently a key engine of infrastructure growth, job creation, and economic growth. (Balaban, 2012). However, it's important to keep in mind that the construction sector can be cyclical and that local demand, governmental regulations, and economic conditions all have an impact on how well it performs. The future of construction will also be more influenced by sustainability and environmental concerns. As a result, methods for evaluating green buildings have been created to assess and approve projects on a voluntary yet market-based basis like Leadership in Energy and Environmental Design (LEED) (Chi, et al., 2020). Therefore, although being a cornerstone industry in many nations, its function in the economy is still being shaped by difficulties and possibilities.

The urgent need for environmentally friendly and sustainable building methods led to the creation of LEED. The United States Green Building Council (USGBC) developed LEED, which offers a thorough framework for planning, building, and maintaining structures with a heavy emphasis on minimizing their environmental effect. It deals with concerns including enhanced indoor air quality and occupant well-being, as well as energy efficiency and resource conservation. By standardizing green construction methods (Amiri, et al., 2019), LEED not only fosters environmental management but also supports market transformation. It increases public awareness and understanding of sustainable construction while providing economic benefits through energy and operational savings. Additionally, LEED has influenced government incentives and guidelines that support green building, making it a crucial instrument in the global movement to develop a built environment that is more environmentally friendly and sustainable (Zhang, et al., 2019) .Buildings with LEED certification offer advantages for the environment, society, and governance by being healthy, highly effective, and cost-effective (Zhang, et al., 2018). The success of sustainability is symbolized by LEED certification, which is supported by an entire sector of dedicated businesses and individuals setting the path for market transformation. Buildings receive points under the LEED rating system based on how well they perform in categories including energy efficiency, water conservation, and indoor environmental quality. The better a building's LEED rating, the more points it will have earned. Certified (40–49 points), Silver (50–60 points), Gold (60–79 points), and Platinum (80+ points) are the four LEED certification levels (Pushkar & Verbitsky, 2019). Green building, also referred to as sustainable or environmentally friendly construction, is a comprehensive method of creating and maintaining structures with a strong commitment to reducing their negative effects on the environment and resource use (Retzlaff, 2009). These structures use technology and materials that conserve energy and water, reduce waste, and improve indoor air quality in the building process in order to be as energy-efficient as possible (Dakwale, et al., 2011).

Green building practices frequently place a high priority on site selection, land usage, and ecosystem preservation in addition to resource efficiency, promoting sustainable development and the environment (Ali & Al Nsairat, 2009). Such structures have features like ventilation and natural lighting since they are created with occupant comfort in mind. Green Buildings projects mainly targets designing infrastructures of a building that focus on reducing freshwater consumption to protect the groundwater, innovative usage of water instead of being traditionally disposed to reduce waste of water and energy, materials selection based on energy efficiency and reducing carbon footprint (Joustra & Yeh, 2009).Previous studies have showed that the usage of energy is decreased with LEED certification, especially in buildings with higher certification levels, like Gold or Platinum. Although it seems that the energy consumption of buildings with the lowest level of certification (Certified) is practically identical to that of uncertified buildings. More effectively LEED certification levels result in better performance goals and higher average savings. The average Energy Use Intensity of gold and platinum buildings are 45% higher than those of non-LEED buildings. (Turner & Frankel, 2008). However, marketing advantages seem to raise LEED certification to higher point levels than we would expect, emphasizing that buildings are built "greener" due to LEED certification thresholds than they would have been built otherwise. Marketing benefits play a very large role in motivating building owners to obtain LEED certification. The information indicates that a total of 15–20% of LEED-certified buildings score more points than would be predicted without the signaling that comes with green certification (Matisoff, et al., 2014). Furthermore, the number of energy points obtained by the building at the time of design or the certification level of the building did not significantly correspond with the measured energy performance of LEED buildings (Clay, et al., 2023).

Consequently, green buildings can result in significant energy savings for society as a whole. However, more work needs to be done to define green building rating systems to guarantee more consistent success at the building level (Newsham, et al., 2009).

The aim of this paper is to draft an extensive framework for attaining LEED (Golden certification for resorts, clarifying the required standards and procedures that are fundamental for achieving this distinguished sustainability acknowledgement. More importantly, the paper further aims to check how the cost, environmental benefits, energy and water distribution will be affected with the implementation of LEED.

2. LITERATURE REVIEW

The Leadership in Energy and Environmental Design (LEED) certification system has become known as a key framework for promoting sustainable building practices worldwide (Kientzel & Kok, 2011). The purpose of this review of literature seeks to provide a comprehensive overview of the research's results on the suitability of LEED certified buildings and the process of achieving gold certification.

According to research, LEED-certified buildings provide significant environmental benefits over conventional buildings (Iqbal, et al., 2023). Based on studies, LEED buildings typically consume less energy, emit fewer greenhouse gases, and have higher water efficiency (Scofield, et al., 2021). Furthermore, LEED certification encourages the use of environmentally friendly materials and promotes sustainable site development practices, which helps to ensure overall environmental sustainability (Yeeles, et al., 2023).

Multiple studies have emphasized the economic benefits of LEED certification (Maqbool, et al., 2023; Attiya, et al., 2020; Verma, et al., 2022). These include increased property values, lower operating costs due to energy and water savings, and improved occupant satisfaction and productivity (Vosoughkhosravi, et al., 2022; Elkhapery, et al., 2021). Furthermore, LEED-certified buildings frequently attract residents willing to pay a premium for sustainable and healthy living conditions, which improves the building's profitability (Lee, et al., 2022). Moreover, the achievement of LEED certification has been associated with several social benefits, including increased occupant well-being and health (Samarghandi, et al., 2023). According to research, features such as enhanced air quality inside, daylight, and green spaces help to create a healthier and more productive atmosphere inside (Karimi, et al., 2023; Dimitroulopoulou, et al., 2023). Furthermore, LEED certified buildings frequently engage with local communities through outreach programs, which promote social equity and environmental awareness (Worden, et al., 2020).

Regardless of all its advantages, the LEED certification system has been criticized and challenged (Karamoozian & Zhang, 2023). Some researchers have expressed concerns about the cost of seeking LEED certification, especially for smaller construction endeavors or those located in areas that have limited opportunities for sustainable materials and technologies (Agbajor & Mewomo, 2024; Maqbool, et al., 2023). Furthermore, there are ongoing debates about LEED's efficiency in satisfying its sustainability goals, with calls for a greater focus on post-occupancy performance tracking and assessment (Seminara, et al., 2022). Several case studies indicate successful LEED Gold certification for various building projects. These case studies provide an understanding of the design methods, building procedures, and innovative technologies used to meet the demanding standards for gold certification. Examining these examples can provide professionals with valuable guidance and motivation for their own gold certification projects (Pushkar, 2023; Pushkar, 2024; Valdes-Vasquez & Dunbar, 2023; Karamoozian & Zhang, 2023).

While LEED Gold certification is an important accomplishment in the design of environmentally friendly buildings, it does not come without challenges. Cost limitations, regulating complexity, and a requirement for specialization in green building and design practices are all common barriers to obtaining gold certification. Overcoming these obstacles necessitate meticulous preparation, involvement of stakeholders, and a dedication to creativity and constant enhancement (Kim, 2020; Ismaeel, 2019; Pushkar, 2023).

To get through the path to gold certification, owners of buildings and project managers can use a variety of strategies and standards of excellence. These may include early incorporation of environmentally friendly principles into the project's planning and design phases, collaboration with experienced green building professionals, and taking advantage of available incentives and resources provided by government agencies and industry organizations (Pham, et al., 2020; Gade & Selman , 2023). Furthermore, taking an integrated and multidisciplinary approach to sustainable design can help optimize building performance and increase the probability of receiving gold certification (Jalaei, et al., 2020).

This literature review has provided information regarding the feasibility of LEED certified buildings and the path to gold certification. By investigating the social, economic, and environmental advantages of LEED certification, as well as the obstacles and possibilities associated with the certification procedure, individuals can make better choices and take proactive steps to create healthier, more sustainable built environments for generations to come.

3. STUDY AREA

The proposed location for the project is Jezzine which is located 40 Km from Beirut and at an altitude of around 950 m and is considered a mountainous terrain. (as shown as Fig. 1). The town is surrounded by mountains, and the area is hilly with a range of heights. These mountainous regions offer incredible panoramas and difficult topography for both transportation and construction. While Jezzine's geography poses difficulties for building and transportation, it also adds to the town's distinct character and natural beauty. It has made the area an increasingly popular destination for hikers, nature lovers, and tourists wanting to explore its breathtaking views and take in the country's rich cultural legacy. The area is considered to be the main seasonal resort and touristic destination of Lebanon, particularly South of Lebanon. This is due to its topography on one hand (mountain peaks, valley) and its seasonal active waterfalls and pine forests (like Bkassine Pine Forest) on the other hand. The proposed project consists of 3,361,657 square meters, to be constructed on the harsh topography of Jezzine with different peaks and valleys (as shown as Fig. 1). The resort is divided between residential villas, schools, green areas, commercial stores, etc. The most prevalent land use areas are residential; however other land uses were proposed in order to develop a project which is as much self-sufficient as possible. It is important to mention that it is proposed to have 10 persons per villa (as indicated in Table 1).

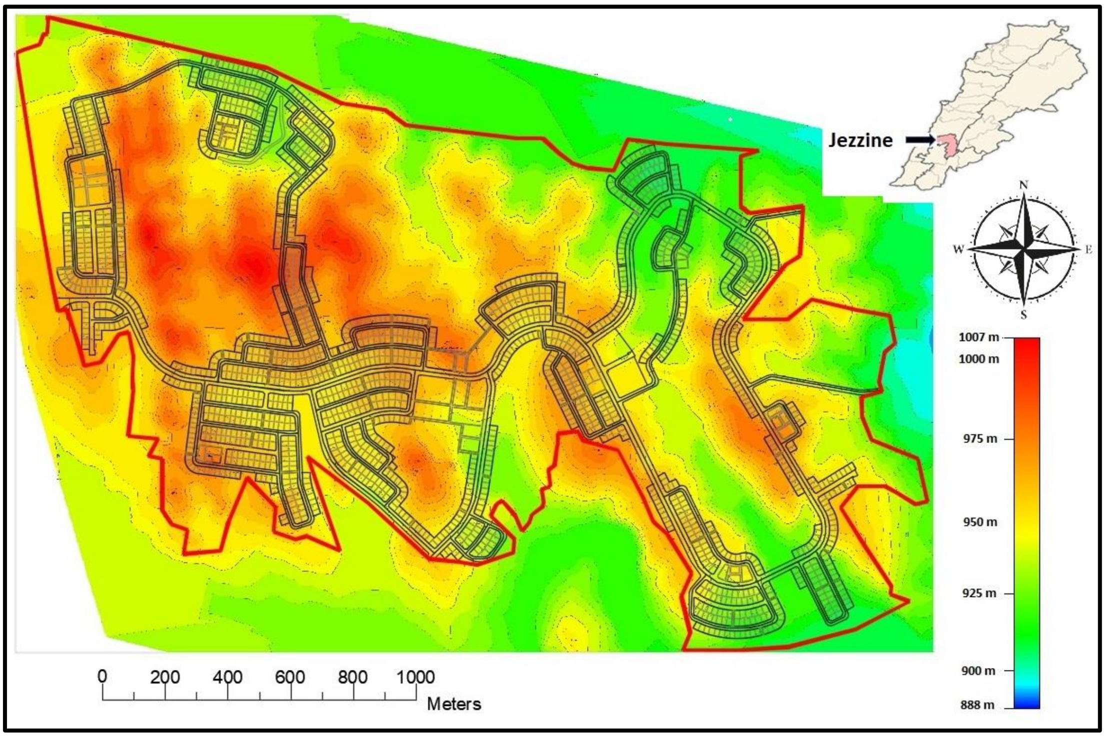

Fig. 1: Layout of the Resort in Jezzine area showing contour map of the study area

Table 1 Resort division of land use

Land Uses	Units
Residential (villas)	1,581 Dwelling units
Commercial Areas (m^2)	9,590 m^2
Local Mosques (m^2)	8,407 m^2
Green areas (m^2)	20,700.318 m^2
Elementary & Kindergarten School	689 students
Intermediate & Secondary School	372 students

4. METHODOLOGY

Embodying the agenda of research methodology, the illustrative flowchart shown in Fig. 2 outlines the streamlined sequence of "sustainable project implementation framework" process for attaining efficient LEED projects. This flowchart retains the essential steps to be followed while implementing LEED projects. It provides a high-level overview of the LEED certification process highlighting the significance of evaluating the costs and benefits at key stages.

4.1. Project Initiation

Management is the key to success of any project; whether small or big. Actually, "Project Initiation" is the *first* management phase of any project's life cycle; including LEED projects. This phase highlights the scope of the project and its objectives. Moreover, it illustrates the purpose or target the project aims to achieve at the very end; for example, reaching a Silver, Gold or Platinum certified LEED Project.

4.2. Site Selection

This phase focuses on selecting the actual location where the project is to be executed. The site is chosen as to facilitate reaching the goal of the project and help retain the scope of the project. For LEED projects, the site should have conditions and characteristics that offer advantages for sustainable development and help in assisting this process. As for "Local Environment Assessment", it is considered an input sub-phase of "Site Selection". It is a type of detailed analysis that studies different features of the site and how it works in favor of the project's purpose. These features vary between topography, climate, vegetation areas (fruitful or landscape), water resources, and most importantly, the population existing in this site. Such a study aids in making innovative and sustainable design and in taking rational decisions. Not to mention, it decreases the risk of wasting time and money.

4.3. LEED Categories and Activities Selection

This phase, being the third phase in LEED projects' process, targets selecting the suitable and applicable LEED categories based on the input data gathered previously. Actually, LEED has six different categories; they range from "Ecology and Natural Systems", "Transportation and Land Use", "Water Efficiency", "Energy and Greenhouse Gas Emissions", "Materials and Resources", and "Quality of Life". Each of these categories has stated requirements or prerequisites that should be applied regardless of the earned credits. Not to mention, these categories may not all be selected for they may not all apply to the project's site and its conditions. This sub-phase represents the input data of "LEED Categories Selection" phase. It is considered a managerial phase because it is where the decision making begins. First, the activities are to be selected based on the categories' requirements on one hand and based on the credits stated in LEED program on the other hand. Not to mention, not all credits can be applied. Second, after choosing each activity which is preferred to be innovative, a loop of questions starts to form: "Is it rational? Is it applicable? Can it be implemented?". If the answer to the above questions was No, alternative activities should be found. However, if the answer was positive, the process would move to select the suitable appliances for the chosen activities. Moreover, each of these appliances are to be subjected to a cost-benefit analysis before being handled the final approval.

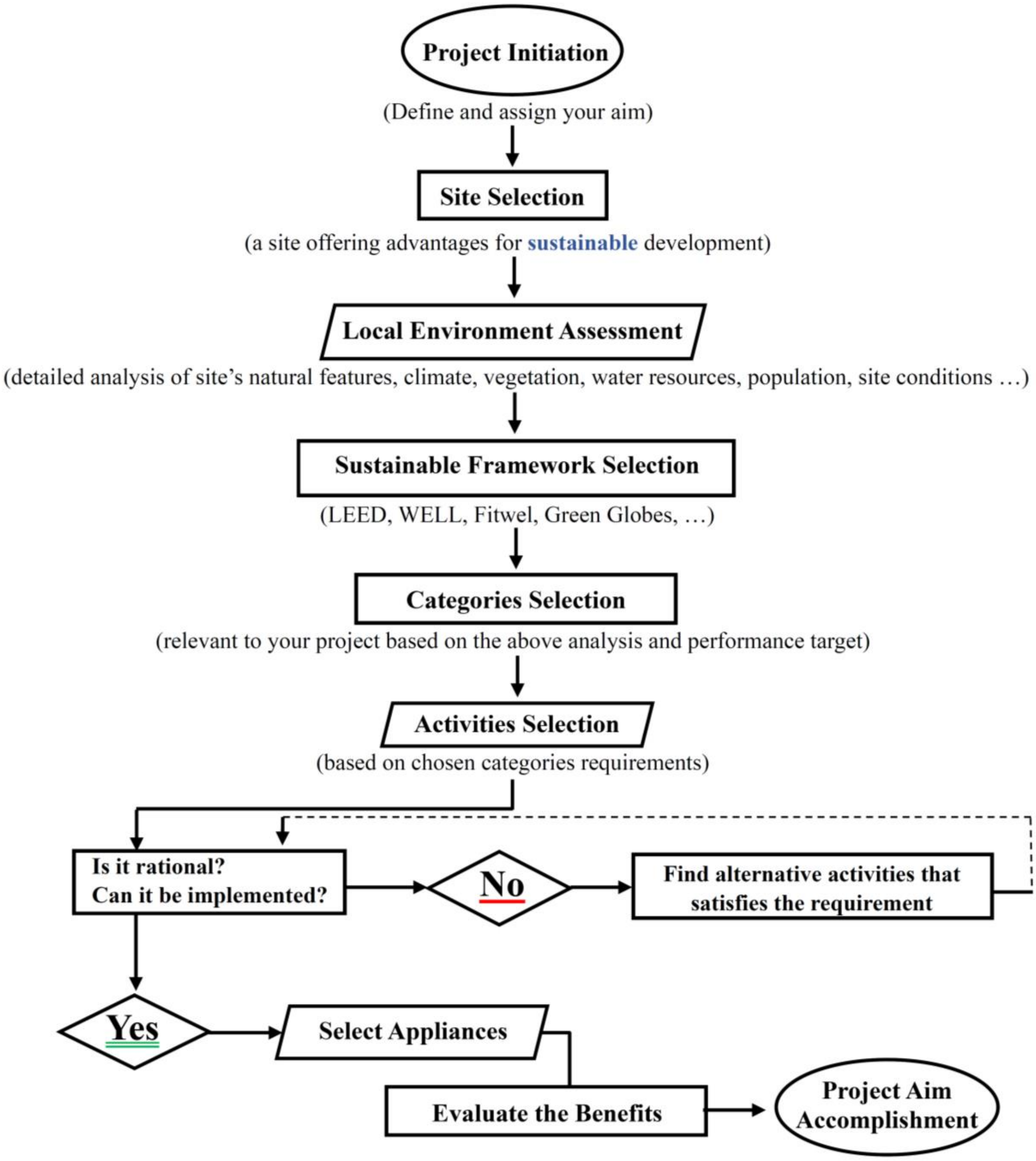

Fig. 2: Flowchart depicting the "Sustainable Project Framework" process for LEED project

4.4. Cost

The "Global Reporting Initiative" reported that cost is one of the three pillars that can't be neglected when aiming sustainable approach (Giovannoni & Fabietti, 2013). As an anecdote, "MeadWestvaco Corporation" testified that its new "barrier packaging" that was produced based on sustainable attributes offered a reduction in transportation fees. As such, it proved that sustainability provides a route to a better financial development (Soytas , et al., 2019). However, do projects actually account for feasibility or just pile up their costs while trying to satisfy their social and environmental performance? This posed problem demonstrates how indispensable it is to quantify the payments incurred to fulfill the project and its purpose.

Special LEED-related costs vary between:

Direct costs: costs of energy-efficient and water-efficient appliances used and cost of sustainable building materials and products; for example: cost of water-saving fixtures, cost of lighting systems.

Operational costs: cost of gasoline, labor cost, maintenance cost, costs for waste management and recycling programs.

These costs are considered the additional costs to the costs of any other project and that account for LEED projects in specific. Like in any project, in order to avoid cost overruns, these costs should be tracked and monitored.

4.5. Benefits

Although LEED Projects may involve additional upfront costs associated with sustainable design and construction, they are often offset by long-term benefits that should be measured and analyzed. These benefits vary between:

Environmental Benefits: carbon footprint drop, water consumption lessening, energy savings, pollutants reduction…

Financial Benefits: electrical savings, environmental savings, savings in operating and labor costs, growth of property value, increase in service life, earlier return period…

All the identified benefits -whether financial or environmental- are to be given monetary values and converted into common currency. For instance, *Insights Regency Lightings* (https://insights.regencysupply.com/) accentuates the method of calculation for electrical savings by following the equations, eqs. (1 – 4).

The *energy savings per bulb* in watts is calculated by subtracting the wattage of the new product from the wattage of the old product as follows:

$$Energy\ Saving\ per\ bulb\ (Watt) = Old\ Product\ Watt\ -\ New\ Product\ Watt \qquad (eq.1)$$

The *total annual run time* in hours is determined by multiplying the daily run time by days of the year (365) as follows:

$$Total\ Annual\ Run\ Time\ (hr) = Daily\ Run\ time \times 365 \qquad (eq.2)$$

The *total annual energy savings* in kilowatt-hours (Kwhr) is obtained by multiplying the energy saving per bulb by the total annual run time and dividing by 1000 to convert it to kilowatt-hours as follows:

$$Total\ Annual\ Energy\ Saving\ (\text{Kwhr}) = \frac{Energy\ Saving\ per\ bulb \times Total\ Annual\ Run\ time}{1000} \qquad (eq.3)$$

The *total dollar savings per bulb per year* is calculated by multiplying the total annual energy saving by the electricity rate as follows:

$$Total\ Savings\ per\ bulb\ per\ year\ = Total\ Annual\ Energy\ Savings\ *\ Electricity\ Rate \qquad (eq.4)$$

It is important to note that the Electricity Rate in Lebanon is \$0.27/Kwh

As for eq. 5, it shows how to determine the percentage of electrical savings:

$$\%\ Electrical\ saving = \left(\frac{Old\ Watt - New\ Watt}{Old\ Watt}\right) \times 100 \qquad (eq.5)$$

LEED specifications radically change the impact of the water distribution and wastewater collection networks. As LEED commands the use of water saving techniques within each property and the use of materials such as PVC and HDPE in the piping networks. The diameters needed to satisfy the network requirements are reduced and that in turn means that the overall environmental impact of the networks is lessened. In addition to this, the use of PVC piping would further limit environmental impact as it is considered a smooth material, PVC has a roughness coefficient of 0.009 (Bishop, 1978) The effect of the mentioned parameters is applied to the sewage collection and water distribution networks to quantify the difference in impact.

To measure the benefit impact on the network, the sewage and water networks were designed once, not considering the water savings from the application of LEED requirements, and another time considering the LEED requirements. The sewage collection network consists of both gravity and pressurized networks. The gravity sections were designed with the use of manning's formula by applying the following constraints; Q/Qfull = 0.91, d/D = 0.80 (Dey, 2013) and velocity between 0.70 m/s and 3.0 m/s (Shafiei & Tabesh, 2022). As for the pressurized section the darcy-weisbach equation was utilized to design the network. While the water distribution networks were designed in accordance with the Hazen-Williams equation with the constraint of pressure between 2 bar and 7 bar. Based on the improved networks, pumping stations were sized and their cost considered according to Equation 6. Equation 6 presents the capital expenditure based on the total power requirement of the pumping station (*HP*).

$$Pump\ station\ Cost(\$) = 5040\ HP^{0.69} \qquad (eq. 6)$$

4.6. Evaluate Cost VS. Benefits

Quantifying each of costs and benefits separately is not enough to analyze the profitability or feasibility of a project; as such, it can't measure the economic sustainability of the investment. Therefore, cost-benefit analysis is crucially needed. Knowing that it is one of the four efficiency indicators of feasibility, cost-benefit analysis is the key to ensuring that sustainability investments are financially sound and contribute to a successful LEED certification.

As part of "Engineering Project Management" point of view, for an entire project or for a single appliance, cost-benefit ratio is measured by dividing the Present Worth of positive cashflow (benefits) to the Present Worth of negative cashflow (costs). In order to proceed with the LEED project, this ratio should be greater that one. Nevertheless, if the ratio was found to be less than one, alternative appliances should be reconsidered. These new appliances should also be subjected to identifying and quantifying their costs and benefits at first, then entering the loop of cost-benefit evaluation until proven to be efficiently approved.

4.7. LEED Target Accomplished

This phase represents the *conclusion* of the LEED study and the theoretical achievement of the target or goal of the project which was assigned in the "Project Initiation" phase. During this phase, the credits of the chosen activities are counted and the earned points are summed up in order to assign its eligible certification. The LEED rating system is as follows: certified (40-49 points), silver (50-59 points), gold (60-79 points) and platinum (80^{+} points).

5. RESULTS AND DISCUSSION

This resort supports an inclusive pathway towards sustainability and resilience planning, elaborated through its various activities across a range of categories (as indicated in Table 2). On the level of "Natural Systems and Ecology", the resort sheds light on pollution prevention; mainly light pollution since it is rarely noticed or assessed. This is done through the use of full cut-off lights throughout the project that would also help diminish the waste of energy. In order to satisfy the requirements of "Water Efficiency" domain, diverse water management strategies are planned. For exemplification, treating water to enhance its quality, implementing an internal self-sufficient water resort that relies on the reuse of water within its system, and treating wastewater to be innovatively used for landscape irrigation. As for "Energy and Greenhouse Emissions", it's required to maintain reliability and resiliency in energy consumption and emissions. As such, the resort uses hydroelectric energy as a renewable source of energy for electricity production and suggests the collection of methane gas from the treated sludge to be used as biogas. Not to mention, "RFID chips" and "Internet of Things" aid the management of the advanced recycling systems. Furthermore, "Materials and Resources" category includes the use of smart-faucets, smart irrigation techniques, activated carbon filter to improve water quality, and HDPE as durable pipeline systems.

5.1. Project Initiation & Site Selection

Sustainable design is the main target of Engineering projects; relying on the balance between environment, society and economy at a time (Awadh, 2017). Knowing that compromising the environment has a direct effect on health and economy of a nation, it is better to start planning for projects -whether construction or general- with an environmental point of view in order to maintain *sustainable development*. Moreover, the latter is formally achieved by the assistance of green building rating systems; one of which is "LEED" (Awadh, 2017).

LEED or "Leadership in Energy and Environmental design", is the most widely used green building rating system. Actually, these rates start from certified, silver, gold to reach the Platinum LEED certification; based on points earned by the project. The latter depends on standards specified based on each project type and whether this project is an existing project or a new project to be executed (Pai & Elzarka, 2021). Not to mention, the scoring would be based on the proposed ideas that are actually put into action; this is due to the fact that some ideas appear to be in the right place and effective, yet, they can't be easily implemented at the very exact time. In other words, it is not an easy mission to achieve platinum certification. As such, this project aimed to achieve a *Gold-LEED certification*.

5.2. LEED Categories and Activities Selection

5.2.1. Natural systems and ecology

Communities depend on nature and ecosystem services to not only sustain life but also enhance the quality of life. Ecosystems protect and even regenerate natural systems, thereby increasing the ecosystem services they provide and creating ecologically resilient communities. Light pollution, also known as photo pollution, is a hidden pollution type that almost all people disregard. On health level, its danger affected about 80% of people worldwide; ranging from disorders to severe illness (Cao, et al., 2023). Knowing that artificial night light is one of light pollution forms, the use of full cut-off lights and side floor lights offers to help in resilience planning and light pollution (as indicated in Table 2). For illustration, (as shown as Fig. 4) non-cutoff and semi-cutoff lights have dazzling glare and part of its energy is wasted whereas the full-cutoff lights are found to serve 100% of good light with no wasted energy. However, (as shown as Fig. 3) these lights have one disadvantage; its uniformity-range of light-gets smaller. Moreover, putting more poles doesn't solve the problem. As such, the solution was found in keeping the same distance between poles as that of semi-cutoff lights but with a larger height.

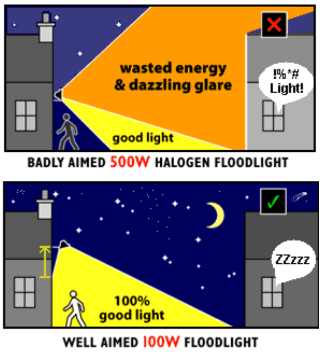

Fig. 3: Efficiency illustration (Eric Vandernoot, Department of Physics, FAU.)

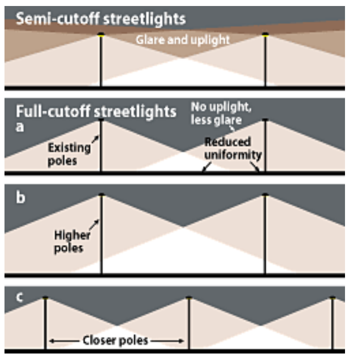

Fig. 4: Light poles' uniformity (Oberjohn, K. (2018). Park Hills Street Lighting.)

One of the most common and important pollution problem is the bad\excessive use of artificial outdoor light, having a huge negative impact both on wildlife and humans, by its contribution to increase the rate of carbon dioxide (CO_2) in the atmosphere obscuring the sky's natural light at night (Tong, et al., 2023). Furthermore, it disturbs natural rhythm done by human being causing: headache, disturb sleep, irritability, stress and anxiety by decreasing melatonin production which is a hormone produce by our brain in response to natural darkness, helps timing of our circadian rhythms and sleep, being exposed to light at night may stop or prohibit those hormone production.

In order to solve it, the test of few available alternatives was in-fact efficient. Table 3 represents the selected alternatives and its annual savings. Comparing the results of two of the best available alternatives: first alternative: use 1000 full cut-off lights on sidewalks to keep the night sky visible (35W LED) in addition to 250 side floor lights fixture (Leonlite 5W Low Voltage landscape pathway lights), second alternative: use of 1250 500W halogen flood light. (as indicated in Table 3).

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Table 2 Required LEED points for each of the chosen categories and activities

Activities	points
Natural Systems and Ecology	
Ecosystem Assessment, Construction Activity Pollution Prevention and Green Spaces	required
• Use of full cut-off lights on sidewalks to keep the night sky visible	7
• Use of side floor light fixture (may be solar)	
Resilience Planning	6
Water Efficiency	
Integrated Water Management	required
Treatments ensure the quality of water	required
Activated Carbon filter improves the quality of drinking water	required
• Stormwater Treatment • Use of strategies to collect max stormwater	5
• Treatment of wastewater • Use of stormwater after being treated as a supply for the resort inner network (basins in kitchen and bathroom and in shower) • Reuse of wastewater after being treated for landscape irrigation • Reuse of basin and shower water for flushing in the W.C.. • Reuse of the 98% of water from sludge after being treated as another source of water for irrigation or flushing	5
• Smart sensored faucets to reduce the waste of water - • Smart irrigation via either: sensor or infrared self-irrigation / monitored irrigation application (ex: rainbird)	2
Energy and Greenhouse Emissions	
Power Access, Reliability and Resiliency	required
Collecting methane to be used as biogas to reduce GHG emissions	19
Use insulators in the Structure to decrease CFC from air conditioners	
• Reuse of water stated above reduces the consumption of energy as per (EERE) • Sensor lights in rooms (not glare)	4
• Use of hydroelectric energy to produce electricity (already found in Jezzine)	6
Biomass energy	
Use insulators in the Structure to decrease CFC from air conditioners	
Methane collection	
Internet of things and consumer incentives	2
Materials and Resources	
Construction and Demolition Waste Management	required
Solid waste Management: Innovative recycling strategies	required
• Organic waste infrastructure to be collected • Composting system from the organic waste	7
• HDPE used for durable pipe systems • Activated carbon filter to improve the quality of drinking water	2
• RFID (radio frequency identification) chips helps in enhancing recycling systems • Internet of things	2

Table 3 Energy and annual savings per selected light appliance

Alternative	APPLIANCES	Unit price ($)	Lifespan (years)	Number of fixtures	Env. Benefit % energy saving	saving $/year/fixture	saving $/year
1	Use of full cut-off lights on sidewalks to keep the night sky visible (35W LED)	37.18	5.7+	1000	65%	62.7	62700
	Use of side floor light fixture (LEONLITE 5W Low Voltage Landscape Pathway Lights)	5.49	5	250	57%	6.4	1600
2	Halogen Flood Lights Solar Powered with Motion Sensor and Remote Control for Parking Lot Garden Yard Garage-500w	252	6	1250	62%	180	225000

The first option involves purchasing a total of 1,250 energy-saving light units. The total purchase value for this option is 38,552.50$. However, considering the energy savings, the total cost after savings is calculated to be 64,300$. This means that with first option it effectively saves 25,747.50$, making it a promising choice. On the other hand, the second option involves buying 1,250 halogen flood light units. The total cost for this option is significantly higher, at 315,000$. Even though these are also energy-saving units, the total savings would only amount to 225,000$. Therefore, the total cost after savings would be 90,000$ more than the initial investment, making this option less desirable. Overall, the 500w halogen flood light can be a transformative element when used in small areas, where cost-effectiveness and energy savings are clearly noticeable. However, for larger scale projects, it is advisable to utilize modern technologies that minimize light wastage. This approach not only illuminates most areas effectively but also reduces the temperature emitted in the area where the light is projected, thereby contributing to the mitigation of global warming.
For instance, with the first alternative, the area under the light placement tends to maintain a mild temperature of 29°C. In contrast, with the halogen light, the temperature can reach up to 33°C. Furthermore, the first alternative is more cost-effective and energy-efficient than the second alternative, and both options have approximately the same lifespan. Therefore, the first alternative emerges as the most promising choice.

5.2.2. Water efficiency

Water is the lifeline of any community. Water demand has been constantly increasing in urban and peri-urban areas due to ascending population densities (Dawadi & Ahmad, 2013). On the contrary, this fact is stressing freshwater reserves leading to perennial shortage of water in these communities (Dawadi & Ahmad, 2013). This credit category addresses water at multiple levels – meeting demand, maintaining water quality, reducing water losses, capturing stormwater, and managing urban floods. To fulfill the prerequisite of having sustainable groundwater use, the concept of having a self-sufficient water network in the resort was predicted.

5.2.3. Greywater recycling

In line with LEED and Lebanese standards for green buildings, an effective strategy to conserve water is to implement a greywater recycling system. Greywater, which is relatively clean wastewater from basins and showers, can be collected, treated, and reused for flushing toilets in bathrooms. This not only reduces the demand for fresh water but also decreases the volume of wastewater that needs to be treated and disposed. As for the quantity and quality of water, using activated carbon filter to purify water and having a wastewater treatment plant -where its effluent is to be used for landscape irrigation- are of great benefit in maintaining a good quality of water. Not to mention, in case of high and sufficient precipitation rates, stormwater can be harvested in rainy seasons to be domestically used as a source of water on one hand and to reduce the pressure on groundwater on the other hand. By integrating these strategies, we can create a more sustainable and water-efficient community.

For an environmental project or resort to be truly considered as such, it must strive to preserve the natural local vegetation within and around the resort. Therefore, this paper includes carefully selected three types of vegetation to be preserved and incorporated into the environmental resort illustrated in Table 4. The planting of olive trees and Prunus-cerasifera is particularly beneficial in an environment where water conservation is of utmost importance. These two tree species are known for their minimal water requirements and remarkable lifespan. They play a pivotal role in reducing water consumption and promoting sustainable land management. Their inclusion in the landscape design not only contributes to the aesthetic appeal of the resort but also aligns with the principles of environmental conservation and sustainability. Overall, the inclusion of Olive Trees and Prunus-Cerasifera in your landscape design, along with efficient grass irrigation, significantly contributes to reducing water consumption and promoting sustainability. These plant species not only aid in water conservation but also enhance the visual appeal of the landscape while providing various environmental benefits. This decision reflects a commitment to responsible land management and water resource conservation (KheirKhah & Kazemi, 2015).

Table 4 Water Conservation and Environmental Benefits of Selected Vegetation in a Sustainable Resort

Plant Type	Quantity	Water Requirement	Daily Water Demand	Lifespan	Environmental Benefits	Water Saved per Year
Olive Trees	1250 (trees)	60 liters/tree/year	1 cubic meter	Several decades to centuries	Reduces soil erosion, provides habitat for wildlife, contributes to carbon sequestration	75,000 liters
Prunus-Cerasifera (Cherry Plum)	2800 (trees)	600 liters/tree/year	1710 cubic meters	20 years	Enhances aesthetic appeal of the landscape	1,680,000 liters
Grass	20,700 square meters	10 mm irrigation rate	207 cubic meters	7-10 years	Used for recreational or aesthetic purposes	75,556,161 liters

5.2.4. Energy and greenhouse emissions

According to “The International Energy Agency”, CO_2 discharges which are a type of greenhouse gases increased by 43% which is continuously causing the environment to be in devastated (Pe´rez-Lombard, et al., 2008). For more emphasis, “LEED” reports also highlighted that communities consume over two-thirds of the world’s energy and account for more than 70% of global CO_2 emissions. As such, community energy systems can play a huge role in combating climate change. In addition, access to energy is critical in determining the quality of life of residents. This credit category encourages communities to provide equitable access to reliable power while simultaneously reducing the adverse impacts of energy use on environment (as indicated in Table 2).

One of our main goals is self-sufficiency relying on solar energy, by building a solar farm within our resort capable of furnishing the required amount in kwh for each residential and utility building in our resort alongside all other external utilities such as light, pumping, irrigation…etc. The use of solar energy among all other alternatives are based upon providing the best sustainable development, it is clean friendly to the environment and also energy saving moreover, this technology has no removable parts, low maintenance procedure and longevity (Maka & Alabid, 2022). To calculate the energy consumption and the cost of running solar energy for the given project, we need to consider the average solar irradiance and the efficiency of the solar panels. According to NASA, the average intensity of solar energy that reaches the top atmosphere is about 1,360 watts per square meter. However, most solar panels operate at around 15% efficiency, which means they typically produce around 150 watts of energy per square meter (Julian, et al., 2020).

The total energy produced by the solar panels for this project would be approximately 182,553.3 kW (as indicated in Table 5). As of October 2023, the average cost of solar panels in Lebanon is 2.24$ per watt. Therefore, the cost of installing solar panels for this project would be approximately equal 408,919,392$. Renewable sun-based vitality holds critical significance in natural supportability, and it plays a pivotal part in assembly LEED (Authority in Vitality and Natural Plan) benchmarks (Maka & Alabid, 2022). In addition, Hydroelectric power represents a pivotal element in the realm of sustainable energy production. As a renewable energy source, it leverages the kinetic energy of water to generate electricity, thereby minimizing the environmental impact associated with greenhouse gas emissions. Furthermore, hydroelectric power plants typically boast extensive operational lifetimes, rendering them a cost-effective solution over extended periods.

Table 5 The total energy produced for each category and related cost

Category	Area (m^2)	Power Density (watts/m^2)	Power (watts)	Power (kW)	Daily Cost (USD)	Annual Cost (USD)
Residential Villas	670,990	150	100,648,500	100,648.5	$27,175.10	$9,923,911.50
Mosques	15,970	150	2,395,500	2,395.5	$646.79	$236,077.35
Schools	37,312	150	5,596,800	5,596.8	$1,511.14	$551,566.10
Businesses	9,865	150	1,479,750	1,479.75	$399.53	$145,827.45
Gardens	46,938	150	7,040,700	7,040.7	$1,900.99	$693,861.35
Light for Road and Parking Lot	435,947	150	65,392,050	65,392.05	$17,655.85	$6,444,385.25
Total				182,553.3	$49,289.40	$17,995,628.00

For the hydroelectric power plant, the estimated daily cost is $49,289.40, and the annual cost is approximately $17,995,628.00. This option provides a renewable source of energy with minimal environmental impact and long operational lifetimes. However, installing solar panels would require a significant initial investment of approximately $408,919,392. However, solar panels also offer a renewable source of energy and play a pivotal role in meeting LEED (Leadership in Energy and Environmental Design) standards (Maka & Alabid, 2022). The operating cost of solar panels is generally lower than that of a hydroelectric power plant, as they require minimal maintenance and no fuel. In terms of environmental impact, both options are environmentally friendly and contribute to reducing greenhouse gas emissions. However, solar panels have the added advantage of being silent and not affecting water bodies or aquatic life.

Both hydroelectric and solar power are viable, environmentally friendly options for energy production. The choice between them depends on project-specific factors like budget, location, and environmental considerations. Both contribute to environmental sustainability and are key to achieving LEED and Lebanese green building standards. Actually, solar power harnesses the sun’s energy to generate electricity, has minimal environmental impact, and contributes to several LEED credits. It’s silent, doesn’t affect aquatic life, and requires minimal maintenance. Hydroelectric power uses water’s kinetic energy to generate electricity. It’s a cost-effective solution with long operational lifetimes and contributes to LEED credits related to water efficiency and renewable energy. In Lebanon, it’s particularly relevant due to abundant water resources. Implementing these renewable energy sources enhances a project’s sustainability by reducing energy consumption, minimizing greenhouse gas emissions, and promoting water and energy efficiency. This aligns with the principles of LEED and the goals of Lebanese standards for green buildings.

5.2.5. Materials and resources

Communities are significant accumulators of materials and nutrients, leading to high levels of natural resource consumption that impact both the environment and human health. The objective of this category is to transition from a waste-generating society to one that views waste as a valuable resource. This shift from a linear to a circular economy is facilitated by the development of communities, which, due to their concentration of resources, capital, data, and skills, stand to benefit greatly from such a transition.

One proposed strategy is to establish a specialized collection network for solid waste, similar to that for wastewater. Additionally, organic waste could be repurposed as a resource for energy production and composting. In terms of solid waste recycling, new strategies have emerged, such as the use of Radio Frequency Identification (RFID) chips and Internet of Things (IoT) technology. RFID chips are set to replace outdated and ineffective recycling symbols. With this advanced recycling technology, smart recycling bins can establish a direct connection between residents and municipalities, enhancing waste management efficiency. The IoT, which has become increasingly prominent, plays a crucial role in this context. IoT technology, which involves the use of sensor hardware installed in garbage disposal units and residential dumpsters, can provide valuable data on recycling practices when paired with the appropriate front-end software. This data includes who is recycling, where it's happening, and the effectiveness of these efforts. Environmental savings can be translated into cost savings by applying the same methodology used for electrical savings, as previously discussed in this paper. Air conditioners, which operate for only six months of the year (excluding spring and fall), serve as a reference point for these calculations. In traditional solid waste collection management systems, the average workforce involved, can reach up to an average total of 240 workers per day to handle the waste collection needs of a community. This not only represents a significant labor cost but also indicates a system that may be inefficient and environmentally unfriendly. Our innovative strategy revolutionizes this approach. By integrating advanced technologies and efficient waste management practices, we've managed to reduce the workforce to just 20 workers per day. This represents a significant reduction in labor costs and demonstrates the efficiency of our system. But the benefits go beyond just cost savings. Our strategy also promotes environmental sustainability by optimizing waste collection, encouraging recycling, and reducing the overall impact on the environment.
The success of This strategy is evident not just in the numbers, but also in the positive effects it has on the community and the environment. This is a clear testament to the effectiveness and success of our approach to solid waste management. The following table provides a detailed breakdown of the operational cost savings associated with recycling:

Table 6 Potential cost savings through efficient waste management and recycling

Item	Quantity	Unit Cost	Annual Cost Savings
Trash Collecting Trucks	4	-	-
Workers per Truck	3	-	-
Total Workers	240	$15/day	-
Average Total Workers	20	$15/day	$ 1,204,500
Gasoline for Trucks	4	$100/day	$ 146,000
Total			$ 1,350,500

5.3. Costs & Benefits

5.3.1. Water savings

Efficient water management is paramount in today's world, where every drop counts. Simple measures, such as using water-saving technologies like Smart Faucets and Rainbird kits (https://www.rainbird.com/mde/alzrat-alshrq-alawst) can lead to substantial savings. One gallon of water equals to 4 liters, a crucial conversion factor for comparing water volumes across units. This facilitates precise assessments of water consumption and savings in different measurements. In Lebanon, a gallon of water costs $0.25, emphasizing the economic benefits of conservation.

- Smart Faucet Savings: A smart faucet, utilizing motion sensors and efficient water flow rates, can save up to 700 gallons according to Bankrate, significantly cutting costs and lessening environmental impact.
- Rainbird Kit Savings: The Rainbird kit, featuring a water-efficient sprinkler system, can save a substantial 15,000 gallons (about 56781.15 L), highlighting its effectiveness in promoting efficient water usage.
-

For Smart Faucets, the savings amount to $175, and for the Rainbird kit, the savings are $3750. These figures are calculated by multiplying the number of gallons saved by the cost per gallon in Lebanon ($0.25/gallon). Due to water savings techniques applied, the water demand is reduced from 200 L/Capita/Day to 140 L/Capita/Day. The water and wastewater networks were designed with the savings considered and without these water savings (non-LEED) (as indicated in Table 7 and Table 8). Table 7 shows the difference between the total weight of pipe material used in the networks that are designed based on LEED complainant water-saving techniques and material choice in comparison to a conventional approach for the same location without water savings and its environmental impact. While Table 8 shows the difference in energy required for pumping which is a factor of the smaller flow requirement of the LEED system and its environmental impact. Overall LEED requirements reduced the impact of energy required for pumping by 35%. The combination of the use of a smooth material and a smaller water demand reduces the environmental impact of the materials used by 2%.

5.3.2. Cost

The research conducted adheres to all requisite LEED and eco-friendly standards, demonstrating cost-efficiency without compromising on quality. By investing in renewable energy sources such as solar power, the reliance on fossil fuels is reduced, leading to significant long-term cost savings. The implementation of energy-efficient practices, such as using full cut-off lights on sidewalks to maintain night sky visibility and employing side floor fixtures, drastically reduces electricity consumption, further contributing to cost savings. Waste reduction strategies, such as the use of a sewer and water treatment plant, allow for the reuse of treated sewer water for irrigation and flushing. Additionally, treating potable water at the source ensures its safety for use and consumption. These strategies not only benefit the environment but also offer financial advantages by reducing water disposal costs. The use of green building materials and energy-efficient appliances can further decrease operational costs. Moreover, the resort can contribute to environmental preservation by minimizing its carbon footprint and reducing waste output. The procurement of locally sourced materials and food supports local economies and reduces transportation emissions (Worden, et al., 2020). Effective waste management strategies, such as composting and recycling, can minimize contributions to landfills, which are a major source of soil deterioration and pollution. Importantly, the resort can contribute to biodiversity conservation by incorporating native plants into its landscape, creating habitats for local wildlife, and implementing measures to minimize disturbance to surrounding ecosystems. By integrating these strategies, our green resort can operate more sustainably while also making a positive contribution to the environment.

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Table 7 Total Environmental Impact of Pipe materials

System	Material	Weight of Material (Kg)	Environmental Impact/ unit ($KgCO_2e$ / m^3)	Total Environmental Impact ($KgCO_2e$)
WW Collection (LEED)	PVC	201,875.40	2.36[a]	476,425.95
WW Collection (Non-LEED)	PVC	206,037.92	2.36[a]	486,249.49
Water Distribution (LEED)	HDPE	173,028.71	2.33[a]	403,156.89
Water distribution (Non-LEED)	HDPE	178,065.05	2.33[a]	414,891.57

Data obtained from (Venkatesh, et al., 2009)[a]

Table 8 Environmental Impact Due to Energy Use

System	Pumping Req/year (kWh/year)	Environmental Impact/unit ($KgCO_2e$ / kWh)	Total Environmental Impact ($KgCO_2e$)
WW Collection (LEED)	99,749.8	0.273 [b]	27,231.7
WW Collection (Non-LEED)	151,177.0	0.273 [b]	41,271.3
Water Distribution (LEED)	463,392.7	0.273 [b]	126,506.2
Water distribution (Non-LEED)	709,388.6	0.273 [b]	193,663.1

Data obtained from (Scherer, et al., 2016)[b]

5.3.3. Financial benefits: (Appliances Savings)

A modern greenhouse can never be perfect/completed without the latest modern appliances that facilitate the life of any families, saves lot of energy and money helping reducing the Greenhouse-emissions and carbon generation, in order to determine the cost and types of our appliance to be chosen a specified methodology must be undertaken, first, make a list of all the appliances in your home or business that you want to calculate savings for. This could include items like refrigerators, dishwashers, air conditioners, heaters, washing machines, dryers and more, secondly, for each appliance, determine its current energy usage, this is usually listed in the appliance's manual or on a label on the appliance itself the energy usage is typically given in watts or kilowatts, third, multiply the energy usage of each appliance by the number of hours it is used each day and then by the number of days it is used each year. This will give you the annual energy usage for each appliance, do not forget to identify energy efficient alternatives research energy-efficient alternatives for each appliance. Look for appliances with Energy Star ratings, which are more energy-efficient than standard models, furthermore, determine the energy usage of the energy-efficient alternatives. This information is usually available in the product specifications, Again, multiply the energy usage of each energy-efficient appliance by the number of hours it is used each day, and then by the number of days it is used each year, then subtract the annual energy usage of the energy-efficient appliance from the annual energy usage of the current appliance. This will give you the annual energy savings for each appliance, multiply the annual energy savings for each appliance by the cost of electricity in your area. This will give you the annual cost savings for each appliance. Not to mention, there are other factors to consider, such as: the cost of purchasing and installing energy-efficient appliances, and the lifespan of the appliances.

As for the savings calculations:

From Electrical savings: based on the method of calculation highlighted by "insights regency lighting" (https://insights.regencysupply.com/) previously in the methodology of this paper and noting that the Electricity Rate in Lebanon is \$0.27/Kwh, the (35W LED) full cut-off lights and the (Leonlite 5W) pathway lights -used in this project- were found to save 62.7 \$/fixture/year and 6.4 \$/fixture/year respectively.

From the water savings: a further reduction in annual electricity usage was realized. The reduction in water demand allows for smaller water distribution and wastewater collection networks. This, importantly, leads to decreased pumping requirements which achieve cost savings in operating and capital expenses. However, this comes at the expense of, for example, efficient water faucets which cost more in comparison to traditional faucets. With the assumption of 12 faucets per residential unit with LEED-compliant faucets costing \$175 and traditional \$75. The pumping costs were based on operational and capital expenditure, operational costs were based on electricity used per year in kWh while capital expenditure was based on equation (eq. 6) from (Walski & F.ASCE, 2011).

The results show that the present value (PV) of the system was considered, with the interest rate of 3.8% and design value of 30 years (as indicated in Table 9). The calculated factor of annuity which converts reoccurring annual coast into present value over the project period is 17.72. The results show that regardless of the extra expense of installing more efficient faucets, over time the savings in pumping requirements reduce the total cost by ~ \$9 million which is a saving of almost 18%.

Table 9 Discounted Cash Flow for the System, over 30 years

Parameter		**Value**	
		LEED Compliant System	**Conventional System**
Design Lifetime	Years	30	
Average Interest Rate	%	3.8	
PV of Faucets	\$	\$ 3,320,100.00	\$ 1,422,900.00
PV of Pumping station	\$	\$ 35,287,550.32	\$ 44,759,938.63
Factor for Annuity		17.72	
PV of Operating Cost	\$	\$ 2,692,424.43	\$ 4,114,425.48
Net Present Value	\$	**-\$ 41,300,074.75**	**-\$ 50,297,264.11**

6. CONCLUSIONS

In brief, our investigation of the "LEED certification process" has shed light on a strategic pathway that offers sustaining a Gold LEED Certification. As illustrated in our designed flowchart, this approach speaks for an advanced prompt for *sustainable* building activities. Moreover, not only does this pathway forge the route to a sustainable design certification but also lays the foundations for other collaborative units to develop critical reasoning and managerial thinking that -in turn- proposes to maintain a robust environment and a greener setting. For bye, extending beyond the certification process, the project also contributes positively to the environment by reducing carbon footprint, preventing light pollution, innovatively avoiding overexploitation of groundwater, minimizing waste output, and preserving surrounding eco-systems and biodiversity. For exemplification, water consumption dropped off to a 30% water savings and the smart systems put to practical use depreciated and controlled the water demand for landscape irrigation. Moreover, the decrease in GHG emissions from the pumping operation and piping materials in the water distribution and wastewater collection networks - realized as 35% and 2%, respectively – illustrates the importance of the followed approach. Additionally, the smaller demand of pumping operation resulted in 18% less energy costs over a period of 30 years. Furthermore, a smart waste management system, encircling both solid and organic waste, was outlined. This outline may offer a benchmark for future upcoming resorts where there may be a separate network for solid and organic waste, guaranteeing significant reductions in time, labor costs, and effort. In a nutshell, "Lodge in the Green" innovatively attains 78 points through its infrastructure design, which meets the criteria of a Gold-LEED certification. On a final note, this paper stands forth as a "visual testament" to the strategy toward a more sustainable future. Its contribution to a resilient and clean energy future is paramount in addressing the environmental challenges of our time.

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