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LEED CERTIFICATE AS A GREEN BUILDING RATING SYSTEM: A STUDY OF MIDDLE EAS AND ASIA T COUNTRIES

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M.Sc. THESIS

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Approval

We certify that we have read the thesis submitted by Kazhan Jamal Ahmed titled **"Leed Certificate as A Green Building Rating System: A Study of Middle East and Asia Countries"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Applied Sciences.

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Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Kazhan Jamal Ahmed

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Kazhan Jamal Ahmed

Abstract

LEED Certificate as A Green Building Rating System: A Study of Middle East and Asia Countries

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The significance of making buildings more ecological is rising worldwide. Therefore, in recent decades, different green building rating systems have emerged in different countries of the world. There is a crucial need for the applications of green building also in Middle East and Asia. Within this framework, this study evaluates one of these green building rating systems, Leadership in Energy and Environmental Design (LEED) developed in USA. First chapter explains the research background and in addition the research problem, aim and objectives. In second chapter, green building has been evaluated in general including the definition and its history. In chapter three, LEED certification has been discussed in particular including the international examples of LEED-certified buildings. In methodology chapter, samples of LEED certified buildings from Middle East and Asia regions have been analyzed. The findings of the study showed that LEED certification is associated with the development of high quality, innovative, water and energy-efficient, environmentally sustainable buildings capable of improving indoor quality and the occupants' quality of life. LEED certification requires additional investment of funds for design and modeling, installation of important technology and features especially for improving water and energy efficiency, as well as supporting sustainability programs.

Keywords: green building rating systems, LEED certificate, international examples, Middle East and Asia, theoretical evaluation

Özet

Yeşil Bina Derecelendirme Sistemi Olarak LEED Sertifikası: Ortadoğu ve Asya Ülkeleri Üzerine Bir Araştırma

Kazhan Jamal Ahmed
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Binaları daha ekolojik hale getirmenin önemi artıyor. Bu nedenle son yıllarda dünyanın farklı ülkelerinde farklı yeşil bina derecelendirme sistemleri ortaya çıkmıştır. Orta Doğu ve Asya'da da yeşil bina uygulamalarına büyük ihtiyaç duyulmaktadır. Bu çalışmada, ABD'de geliştirilen yeşil bina derecelendirme sistemlerinden biri olan Enerji ve Çevresel Tasarımda Liderlik (LEED) sertifikası değerlendirilmektedir. Birinci bölüm, araştırmanın arka planını ve ayrıca araştırma problemini, amacını ve hedeflerini açıklamaktadır. İkinci bölümde yeşil bina tanımı ve tarihçesi de dahil olmak üzere bu sertifika incelenmiştir. Üçüncü bölümde uluslararası örnekler de incelenerek LEED sertifikası tartışılmıştır. Metodoloji bölümünde, Orta Doğu ve Asya bölgelerinden LEED sertifikalı bina örnekleri analiz edilmiştir. Çalışmanın bulguları, LEED sertifikasının, iç mekan kalitesini ve bina sakinlerinin yaşam kalitesini iyileştirebilen, yenilikçi, su ve enerji açısından verimli, çevresel açıdan sürdürülebilir binaların geliştirilmesi ile ilişkili olduğunu göstermektedir. LEED sertifikası, binalarda özellikle su ve enerji verimliliğinin artırılması ile sürdürülebilirlik programlarının desteklenmesi için tasarım ve modelleme ve teknolojik özelliklerin kurulumu bağlamında ilave bütçe yatırımı gerektirmektedir.

Anahtar Kelimeler: yeşil bina derecelendirme sistemleri, LEED sertifikası, uluslararası örnekler, Ortadoğu ve Asya, teorik değerlendirme

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List of Abbreviations

ASGB:	Assessment Standard for Green Building
BD+C:	Building Design & Construction
BEAM:	Building Environment Assessment Method
BREEAM:	Building Research Establishment Environmental Assessment Method
CASBEE:	Building Research Establishment Environment Method
DGNB:	Deutsche gesellschaft fur Nachhaltiges
ECD:	Energy and Environmental Canada
ESG :	Environmental, Social and Governance
GBI:	The Green Building Index
GBC:	Green Building Council
GBRS:	Green building rating system
GMC:	Green Mark Certification
GS:	Green Star
HKGBC:	Hong Kong Green Building Council
HVAC:	Heating, Ventilation and Air Conditioning
ID+C:	Interior Design and Construction
IISBE:	International Initiative for Sustainable Built Environment
LEED:	Leadership in Energy and Environment Design
NC:	For New Construction
ND:	LEED for eighbourhood Development
ND:	Neighborhood development
NZGBC:	New Zealand Green building council
O+M:	LEED for Building Operations and maintenance
O+M:	Building Operation and Maintenance
SBS:	Sick Building Syndrome
UNCED:	United Nations conference Environment and development
USGBC:	United States Green Building Council
VOCs:	Volatile Organic Compounds

CHAPTER I

Introduction

The impact of social demographic elements on the environment and urban building structures is evident and easily observed throughout the last two decades. For example, in 2020 the global population have expanded to nearly 7 794 798 739 individuals, up from 6 956 823 603 in 2010 (Worldmeter, n.d). This creates jobs for residential and commercial building units while also posing a number of issues that have been well-documented in academic research. According to certain assessments population growth jeopardizes the future of the planet (Schneider, 2022; Sanchez et al., 2019). Others believe it leads to the development of low-performing structural components, particularly when there is no suitable urban design, planning, or regulations in place to govern construction operations (Puchol-Salort et al., 2021).

Designing and developing appropriate and acceptable building structures to accommodate the growing population is critical, particularly at a time when attempts are being made to achieve sustainability (Ali et al., 2018; Salgado et al., 2020; Slach et al., 2019). Construction site, on the other hand consumes a variety of resources, which must be conserved. This occurs at a time when electrical energy shortages and pricing issues are on the rise (Iraganaboina et al., 2021). This is in line with recent studies that demonstrate that heating, cooling, and lighting currently consume more than half of a family's income total electric power (Lim & Lee, 2018). This adds to the pressure to pass standards capable of encouraging energy-efficient structures in the face of escalating climate issues, particularly given the fact that global temperatures are still anticipated to rise by 1.5 degrees between now and 2040 (McFall-Johnsen, 2021).

Furthermore, issues such as poor interior air pollution and build structural degradation, which restrict the building's life cycle, have pushed for the adoption of regulations capable of producing environmentally responsible and resource-efficient construction projects throughout the project lifespan (Bahramian & Yetilmezsoy, 2020). As a result, green building rating systems (GBRS) have been developed to address these issues. Green building certification systems are described as instruments that measure a building's current or predicted performance and transform that evaluation into an overall grade that can be compared to other structures. A

rating must provide a realistic and consistent foundation for comparisons, assess key technical elements of sustainable construction, and avoid complexity in order to contribute significance to a building's sustainability design and/or operations. All green rating systems provide recommendations for making a facility "green" and some offer certification while others allow for voluntary cooperation regarding efficiency, water recycling, resource improvements, pollution prevention, reducing waste, and management. There are different scoring systems like BREEM, LEED, CASBEE, BEAM, GS, GMC, GBI, ASGB, DGNB, ASGB, DGNB, ESTIDAMA.

The rank and credential processes and instruments are meant to promote and enable a stronger adoption of sustainable, societal, useable, and cost issues with some other conventional evaluation criteria, resulting in more sustainable architecture, fabrication, operation, preservation, and dissemble or demolition of buildings. These methods and technologies can both help with sustainability since they translate the long-term aim into precise performance indicators that can be used to assess overall quality. Distinct green construction grading and accreditation techniques have points of view, yet they all have some common ground. In general these systems and technologies address the same structure design and luck performance areas in one way or the other: site, water, power, resources, and indoor air quality.

Local legislation or standards, as well as traditional building solutions, are used to develop certification techniques. Because the weight of each criteria and signal in the assessment is predetermined based on local societal, economic, and financial settings, many of the methodologies proposed thus far can only have local or regional repercussions. However, there are a few world wide scale approaches that may be used. These approaches are most commonly utilized at the university, because the necessary reference cases must be built and analyzed independently for each type of structure, which is a time-consuming and costly procedure. There are three primary building grading and accreditation methods that serve as the foundation for alternative methodologies used across the globe, which were all designed by the International Code Council. In the United States 20 nations collaborated, and the Energy performance Design (LEED) program was established.

In particular, Leadership in Environmental and Energy Design, LEED is one of these rating systems. In order to earn LEED certificates, the key areas are listed below:

1. Efficiency in Water Use: Strategies of waste water, reduction of indoor water usage, and reduction of landscaping water usage.
2. Atmosphere and Energy: Verification and measurement, performance optimization of whole building energy, renewable energy usage, management of refrigerant, and commissioning.
3. Resources and Materials: Products of sustainably forested wood, materials of salvaged, materials of rapidly renewable, and material with content of recycled, the material buying of regionally manufactured, management of construction waste, reuse of building, and collections of recycling.
4. Quality of the Indoor Environment: Controllability of systems of lighting and thermal, control of using source, material of low emitting, quality of construction indoor air, enhanced ventilation, monitoring outdoor air delivery, and small control of environmental tobacco.
5. Process of Innovation and Design: LEED credentialed professionals and creative sustainable design solutions and applicability.
6. Project Sorts: The scoring system can be applied to all sorts major GSA (General Services Administration) operations, including residential development, major renovations, renter build-out (lease agreements), and sustainment.
7. Building Types: The rating system may be applied to any GSA (General Services Administration) type of structure, including office, courts, and frontier posts.

As part of the system's "pre-requisites," LEED defines minimum code compliance for several technological parts. A new building that does not fulfil those minimal requirements will not be eligible for LEED certification.

Research Background

The variables have a huge impact on the ecosystem. Energy efficiency, water recycling, equipment and supplies, interior climate, and sewer systems are all critical components of making it work (UNEP SBCI 2009), demanding an evaluation technique. Several grading systems have emerged across the world to reflect the setting of their birth. Two components of this value chain, according to (Ismael, 2018). Building production and building usage are usually divided. It is because the majority of resources, energy, and expenditure are spent in the building in development. All construction-related expenses are absorbed during the building's lifetime, raising the cost for facility maintenance as during service stage. Building

sustainability has always been evaluated. Various rating methods for assessing building sustainability initiatives are continuously being developed (Daz-López et al., 2019). The most well-known instances are the LEED and BREEAM. The introduction and evolution of various performance rating systems reflects this broadening and re scoping of what constitutes building sustainability (Doan et al., 2017; Shan and Hwang, 2018). Looking at the EU, the European Commission has developed a framework (Dodd et al., 2020) that supplements EU-standard by providing macro-objectives with accompanying indicators to help promote sustainability.

The list is made up of a variety of causes, consequences, and actions with no clear stakeholder emphasis for determining output and outcome in the construction value chain. The macro-objectives appear to follow the design process from within, comparable to the worldwide effectiveness systems of rating including LEED and BREEAM. Despite the fact that the framework is touted as a solution to the uncertainty around sustainability performance measurements, it fails to define the underlying meaning of sustainable. There is no shortage of indicators for assessing sustainable construction; the problem is deciding which ones to use and offering clear reasons for those decisions based on a sustainable concept. The difficulty is determining which signals to use and providing explicit reasoning for those judgments based on a sustainable approach, meanwhile methodology for evaluating green construction deployment and performance was required. This is due to the fact that the market for high-performance building design and construction is dynamic and changing. Workers in the construction business, on the other hand employ evaluation to examine and distinguish their items or innovations, they use grading systems. Since the year 2003, all GSA (General Services Administration) projects have been required to adopt the green building grading system of LEED in the US Green Construction Council and earn a certified rating. Among other things, such a rating aims to produce projects that are ecologically friendly and efficient. All through the project lifecycle resources are used efficiently (Díaz-López et al., 2019). They also have the ability to generate positive marketing, facilitate green education, measure and demonstrate changes, demonstrate and verify sustainability impact, and define environmental ambitions (Doan et al., 2017). All of these advantages can be enhanced if studies are conducted to assess the performance of current evaluation methods, which is the topic of this research.

Green Buildings in the Asia Region

There is no doubt that green buildings are becoming more popular also in Asia. Most nations must have had at least one internal green roof grading scheme, with some having two, such as Japan. The number of registration and certificates continues to rise year after year in the continent. In addition to this, the Leadership in Energy and Environment Design (LEED) grading system developed by the US Green Building Council has been implemented throughout the area. Although LEED is a standard designed in the United States, a growing number of landmark projects can be found in Asia. China is the second largest market for LEED outside of the United States. Haworth's furnishings building in Beijing was the inaugural LEED v4 certified project, and TAIPEI 101 became the initial building on the planet to reach 90 points with LEED v4 when it recertified its LEED for Current Building Platinum accreditation.

In addition, as Asia continues to expand, there are an increasing number of older structures that has not yet been addressed. Furthermore, the bulk of Asia's certified sustainable structures have already been benchmarked against systems that analyze conception and construction criteria but do not check true results. There are various reasons for optimism about green building's future. A growing number of both provincial, and state authorities are establishing green construction policies that include objectives, which are often accompanied by subsidies and/or regulations. As it is noted, there is currently minimal awareness, understanding, and knowledge dealing the favorable both financial and non-financial implications green building systems from across Asian real estate market. There is also a widespread lack of passion in departing from 'business as usual'.

Further climate change is taking place and immediate action is required, although this is not widely accepted in many growing Asian real estate markets. However, if a widespread level of understanding of the necessity for shift is achieved and the numerous advantages to be obtained by doing so, there is cause to be optimistic about the future of sustainable construction in Asia. The region's capability to cope with a crisis, readiness to accept new thoughts, and desire to display initiative would imply that a reform at a rapid speed, on a large scale will be fulfilled including the establishment of green building systems.

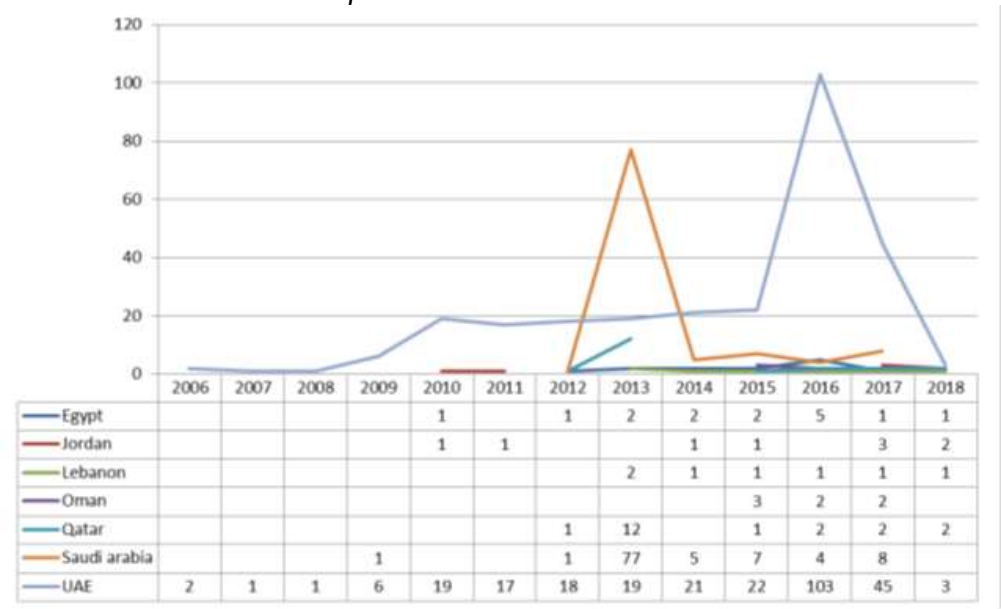
Green Building in Middle East Region

Water shortages, harsh weather conditions, ecological deterioration, and an availability of fossil fuels present distinct socioeconomic and ecological difficulties to the Middle East area. Commercial buildings in the Middle East take more energy than that of other regions of the world, owing to the intense heat, widespread utilization glass exteriors, and strong dependence on climate control. In recent years, the Middle East housing industry has worked hard to promote eco-friendly design, indigenous building techniques, and sustainable buildings procedures.Carbon-neutral structures, personality urban design, and cultural awareness embracing traditional Islamic design are some of the key drivers of the Middle East's green construction sector's success. Many governments in the area are marketing energy more aggressively.Optimization has stimulated the local green construction sector as a method of achieving energy security. In terms of societal factors, the main motivations for organizations becoming green in their construction are improved and productivity increases. Green building has emerged as a prominent issue in the Middle East in recent years. The number of LEED-certified constructions has risen quickly, from 623 in 2010 to more over 2500 by 2020.

Sustainable buildings not only help to safeguard the atmosphere in the Middle East, but they also provide several benefits to building inhabitants and users. Reduced project costs, lower running expenses, higher interior air quality, and minimal maintenance are some of the key advantages of green structures.To summarize, green building techniques may act as accelerators for smart urbanism in the Middle East, while also assuring energy security, mitigating environmental issues, and creating new employment and income possibilities. The majority of efforts have received the "Gold" accreditation, the second highest LEED certification mark, demonstrating the existing opportunities in the context of environmental building. This signifies that the present level of quality control and level is equivalent to the global level (Ismaeel 2016). This is particular true for new office properties and small-scale housing complexes.

Figure 1.

Growth in LEED Certifications From 2010 to 2018



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Egypt					1		1	2	2	2	5	1	1
Jordan					1	1			1	1		3	2
Lebanon								2	1	1	1	1	1
Oman										3	2	2	
Qatar							1	12		1	2	2	2
Saudi arabia				1			1	77	5	7	4	8	
UAE	2	1	1	6	19	17	18	19	21	22	103	45	3

(Ismaeel, 2019)

LEED certification in the Middle East follows the same principles as in other countries. That is, countries in the Middle East seek to ensure that buildings are designed to the required LEED standards. Such standards relate to the minimum standards of being a permanent building, water efficiency and energy usage, complying with environmental standards and regulations, meeting a minimum of building occupancy and the threshold of floor area requirements, and maintaining reasonable site boundaries (Love that Design, 2020).

Differences in LEED certification in the Middle East will differ between countries mainly because of the Region's ability to comply with each of LEED certification categories. That is, building design national laws together with corporate factors play important roles in determining the level and nature of the impact of LEED Certification, especially in the Middle East. As such, studies have shown through Table 1 that the UAE leads the Middle East in terms of certified projects with 142 certified projects, 68 with silver certifications, 163 gold certifications and 61 platinum certifications. Saudi Arabia follows second with 17 certified projects, 636 silver certifications, 213 gold certifications and 8 platinum certifications as shown in Table 1.

Table 1.

Comparison of LEED Certification Between the Middle East and Other Countries

	Total projects	**Certified**	**Silver**	**Gold**	**Platinum**
UAE	434	142	68	163	61
Saudi Arabia	874	17	636	213	8
Turkey	466	26	69	311	60
Qatar	110	1	6	44	59
Israel	466	5	16	30	11
Oman	15	1	4	7	3
Lebanon	15	1	2	11	1
Kuwait	10	1	3	5	1
Bahrain	5	1	2	0	2

Source: https://www.lovethatdesign.com/article/leed-certifications-where-does-the-middle-east-stand-in-comparison-to-the-world/

In overall, the Middle East leads the total number of projects and respective LEED certifications. But the number of the Middle East's overall gold certifications is higher than its silver and platinum certifications. As a result, the Middle East can be said to be making huge efforts towards designing and developing sustainable building structures contributing to the preservation of the environment and materials resources and contributing to the improvement in people's lives.

Research Problem

Considering that Green Building Rating Systems (GBRS) are intended to address both the significant environmental consequences of building operations, a thorough evaluation of these grading systems is required. This is especially important in the face of global warming, population increase, ecological mismanagement, expanding need for pleasant construction units, and rising energy costs and scarcity issues. Existing research ignores the significance of evaluating GBRS's efficacy in dealing with much issue (Ismael, 2018; Sanchez et al., 2019; Shan & Hwang, 2018). Furthermore, these issues place pressure on rating systems to be improved and new units to be introduced.

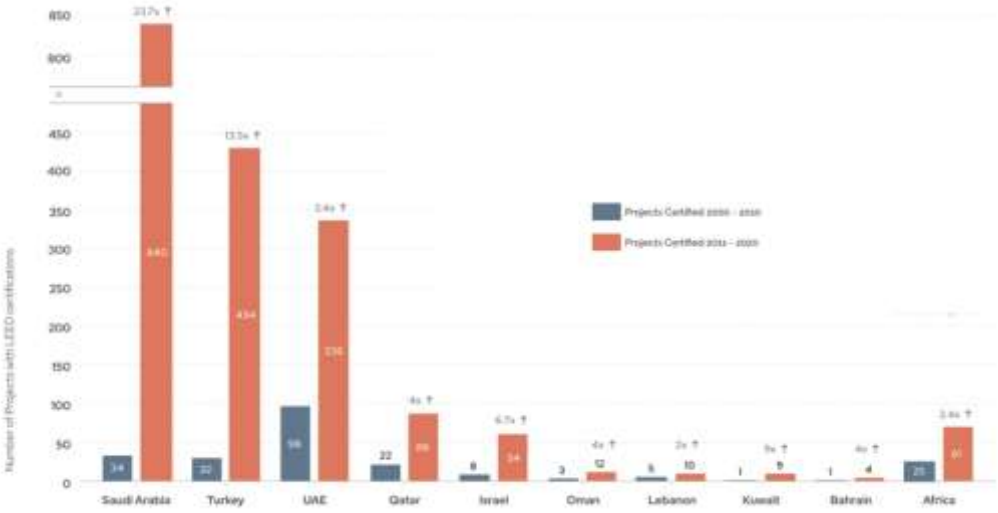
Nevertheless, such attempts can only be made viable by examining GBRSs. Nonetheless according to research, the success of GBRS in generating ecologically responsible projects that use assets wisely throughout the project lifespan has to be examined regularly. LEED is one of the most widespread rating systems. There are

certified buildings within different categories all around the world including Asia and Middle East regions. Therefore, the aim of this research is evaluate the LEED certification with a particular focus on Middle East and Asia regions.

The UAE led the way in the preceding decade (2000-2010), accounting for half of all authorized projects. Turkey, Saudi Arabia, and Qatar each contributed 35%. While LEED still has a lot of clout in the UAE, with the establishment of Estidama, the Abu Dhabi-based standard but by Urban Planner Council, it's unclear if it'll keep up the momentum or give way to the country's own certificate holder. Over the previous decade (2011-2020) Saudi Arabia, and Turkey have been responsible for over 90% of all authorized projects in the area, with Saudi Arabia paying for 50% and the UAE and Turkey jointly accounting for 40%.

Figure 2.

Growth in LEED Certifications in the Last Two Decades in Middle East



Sourcce:https://www.lovethatdesign.com/article/leed-certifications-where-does-the-middle-east-stand-in-comparison-to-the-world/

Buildings in the Middle East take more energy than those else where in the globe, owing to the intense heat, widespread use of glass façades, and strong dependence on climate control. In past years, the Middle East sector has worked hard to promote eco-friendly architectural features, typical construction techniques, and green building methods. Carbon-neutral structures, self-sustaining urban planning, and diversity training embracing traditional Islamic design are some of the key drivers of the Middle East's green construction sector's success.

Research Questions

1. How can the green building characteristics be defined?
2. What are the different green building rating systems worldwide?
3. What are the main features of LEED certificate?
4. What are the international examples of LEED certificated buildings?
5. What are the international examples of Leed certificated buildings in Asia and Middle East countries?

The research is to conduct a qualitative study of LEED certification, including international examples, evaluating this rating system's characteristics and dimensions with a focus on comercial buildings in Middle East and Asia countries. As a result, it uses journal articles, websites, books, and urban planning and design papers to obtain a comprehensive understanding of each GBRS (green building rating systems) in general and LEED certification in particular. For the theoretical evaluation of international LEED certification, in different countries, different types of buildings (residential, commercial, hospital, school) with four levels of LEED Certification (platinum, gold, silver, certified) are displayed.

CHAPTER II

Sustainability and Green Building

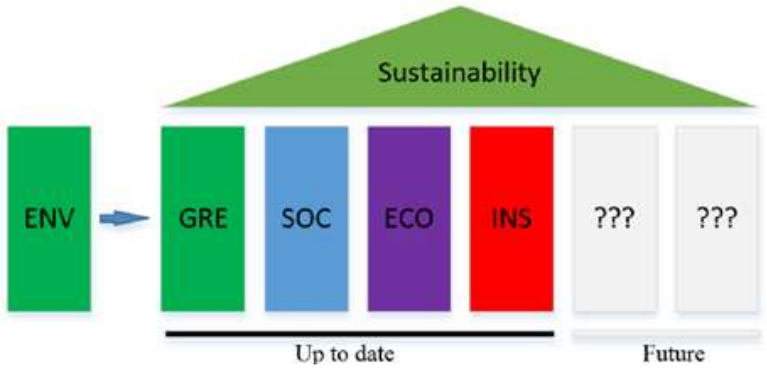
Introduction

The phrases "green" and "sustainable" were used frequently (Ragheb et al., 2016). It was described as using land and fuel effectively, saving water as well as other sources, improving interior and outdoors air quality and expanding the use of renewable or recycled resources (Li, Y 2016). The definition of green building has changed over time, but it is now largely acknowledged as "providing information about healthy, relevant, efficient space and natural sense of harmony architectural style with the greatest possible cash reserves on assets (energy, land, water, and materials), environmental conservation, and reduced pollution during its entire lifecycle." In 1987, the Brundtland commission provided one of the early definitions starting that "sustainable development is advancement that is based on long-term resources ". Addresses present requests are not met jeopardizing previous generation" capacity to meet its own requirements (Lorenz & Lützkendorf, 2008). The United Nations recommended emphasizing on numerous factors such as a participatory democratic system, non-discrimination education, state welfare systems, gender equity, and so on (Berardi, 2013).

Greener and more durable principles are undeniably simple and, firstly, a little fuzzy. They may, however, be discussed in more detail phase. Although the concept of green is continuously evolving, it is clear that the planet is at its heart. But at the other side, resilience may be conceived of as a not ever development planning emphasis on ecological construction approaches (Ameen & Li, 2015), this is because (Bond, 2012). Hence the disparity in existing sustainable construction techniques is attributable to different notions of sustainability in different nations (Bourdeau L., 1998). Sustainability, according to Wangel (2016), ought to be a prescriptive notion formed for a specific goal rather than being defined inferential. Sustainable development, on the other hand, an emphasis on four fundamental pillars: environmental, social, economic, and institutional issues (Sharifi and Murayama, 2014) With both the definition being updated on a regular basis, it's expected that more pillars will be included to examine the long-term viability of construction processes (Doan et al., 2017).

Figure 3.

Sustainable Frame Work



(Doan et al., 2017)

In a nutshell, GBRSs (green building rating systems) are market-driven, voluntary, and third-party norms that assess the sustainability criteria using a multi criteria approach and encourage the use of socially, ecologically, and financially viable methods in building design, building, and management (or neighbourhoods). Because the concept incorporates two distinct Elements-Green Buildings and Scoring System each independently may aid in defining the entire. The USGBC, a commercial and charitable foundation created in 1993 with the purpose of promoting sustainability in building, constructing, and management, administers LEED certification. The LEED system and the annual Green Build World Summit and Expo, which bring united green construction specialists from all over the world, help the USGBC achieve this goal. To begin with, going green is a complicated concept that encompasses a wide range of challenges. "A structure that, in its design, structure, or operation, minimizes or removes negative consequences on our climate and natural environment, and can produce positive benefits according to the Green Building Council (World GBC)

According to the United Nations Environment Programmer, Construction industry accounts for further than 40% of worldwide energy use and also more than half of all carbon pollution, if we keep doing life as normal with in construction sector, emissions would more than treble by 2030.The Liberty Island`s new Ithaca Technology campus have 250 foots tall dormitories that follows the Passive Design concept, which concentrates on total energy efficiency rather than LEED norms. The strict Zero - energy design, which is frequently employed in heating energy

consumption, total electricity consumption, airflow, and temps for thermal environment are all capped in Europe. Sustainable building, according to the US Green Structure Council, is defined as "the planned, designing, development, and operation of the facility with several central, major elements: energy consumption, fluid use, interior environment protection, part of a story, and the house's effects on its location." The relation in to the components used (the energy required for all methods material - related from extraction and smelting to industrial production, transportation, and delivery), reduced waste, and what tends to happen to building supplies when the facility is torn down are all factors that are sometimes taken into account. A tower's life cycle evaluation examines all from raw resources extract to process, production, usage, upkeep, and disposal, as well as operational carbon, greenhouse gases, consumption of resources, contamination, and waste. Ever more genuine assessment are being made using although life cycle assessments are used, they are still not usually included in green building rating schemes. Even though percent of ecologic decisions are made in the first 10% of the system design, as per Green Roof Partnership, going green involves the cooperation of everybody operating on a constructing from of the beginning, such as clients, planners, technicians, construction firms, and local residents.

As a construction grading of consensus-based LEED is a system that is centered on the utilization of LEED current building technologies that was designed and tested in 1998 in the United States. The city councilman groups of U.S Green building were responsible for the creation of LEED. Using a whole-building environmental quality perspective, the grading framework aims particular environmental problems associated to buildings. For large renovations and new construction, existing structures, business interior, cores and shells, houses, and community development all have LEED variants besides the LEED-NC. Other adaptation guides available to expand LEED's relevance and versatility (for example, various structures and campus, schools, medical services, labs, accommodation, and retail pilot) are also exist. This review utilizes LEED-NC Version 2.2 except as otherwise stated.

History of Green Building

A 'green' facility is one that decreases negative effects on our environment and natural environs while simultaneously having the capability to develop positive

traits through its design, construction, or administration. Green building attempts to build facilities that are not only ecologically sustainable, but also assist individuals in living better more prosperous lives. This included power bill reductions for renters or homes as a result of energy and resource consumption. R. Buckminster Fuller (B. Fuller 1895-1953), an American architect and engineer, was considered in the 1930s to mix innovation and engineering into social development in order to use less resource in order to fulfil the rising need for human survival. B. Fuller proposed a design philosophy of "keeping costs down." It involves making the most efficient and plentiful use of limited resources through the most acceptable design. It also effectively implements ecological circulation and the notion of resource recovery. Paola Soleri, an Italian-American architect, was the first person in history to utter the phrase "green building" in the 1960s. The oil crisis in the 1970s made so many people understand that the rapid growth of human civilization had already made a great sacrifice on the environment, and that humans needed to take meaningful steps. The building industry's high resource consumption has to adapt its basic development strategy by lowering resource consumption as sustainable solution. At the same time, several forms of electricity technologies have been developed. The community has been worried about energy-saving construction, such as the utilization of solar energy, geothermal power, renewable power, and other innovative energy-saving technology.

In the 1980s, as the power construction sector grew, industrialized countries such as the United Kingdom, France, and German began to pay greater attention to building energy performance and energy preservation. Simultaneously, indoor environmental concerns began to emerge. Many people developed sick building syndrome (SBS) as a result of living in the enclosing area for an extended period of time, which had a negative impact on their physical and psychological health. The built interior and its influence on human heath are currently the focus of study in industrialized nations. The Conference of Environment and Development by the United Nations was held in Brazil's capital, Rio de Janeiro in June (UNCED). of 1992 the gathering drew 183 foreign delegations and 102 heads of government. The meeting established a sustainable project proposal and accepted the "Agenda 21" and "Rio Declaration" as thematic texts. This stage's scientific focus shifted to power design and the safe generation of new environments throughout the next decades. Designers advocate the third principles, which include conserving sustainable

materials and effort, recycling construction materials or goods, and repurposing old building repairs and materials. Thru a variety of ecological conservation and energy-saving methods, the third philosophy attempted to lessen the influence on the environment.

Green Building Council '98 (GBC 98) in October of 1998, took place in Vancouver, Canada, had begun 19 projects` pilot testing USGBC created LEED 1.0. This was a global green construction conference. The United States, the United Kingdom, and Canada were among the 14 countries present. The meeting's major issue was living environment, and specialists and researchers from all around the world presented their findings. USGBC released LEED 2.0, according to what is learned in the program of pilot in March 2001. In November 2002, in Statesville, N.C., the USGBC celebrated the Third Creek Elementary, and initial LEED Gold primary school, as part of its expansion in the recent market sections. LEED experienced a lot of major breakthroughs in 2003.

The USGBC had developed and evolved since its inception as resources, employees, amassing strength, and a young non-profit, and in the last year had introduced LEED v2.1. In April, both LEED for Commercial Interiors and LEED for Buildings started pilot testing, and in October, LEED for Shell and Core debuted. In November, the initial existing structure of LEED-certified was Washington, D.C`s the Society building of National Geographic in. LEED certified 100 projects in April 2004. LEED for New Installations was shared with the public in March 2000. Aside from GBC98, International Initiative for a sustainable Built Environment (IISBE) has played a key role in promoting green construction by launching the Green Construction Competition 2005 and the ’s Sustainable Prize 2011. In April 2009, the USGBC released LEED v2009. Among the several enhancements over its predecessors, LEED v2.2, 2019 LEED v4.1, LEED V4.1 and in 2015 LEED V4 includes updated relevant criteria and allows projects to earn LEED credit with architectural functional testing. It also strives to encourage performance by completely integrating team effectiveness backed through an easy data-driven way and recent techniques for continuously measuring effectiveness.

Assessment of Green Building

The green building grading system measures administration, health and well-being, transportation, water, materials, land use and environment, and pollution

across several fields. The certain criteria for grading differ from one certification to another. The green building is defined as the “planning, design, construction, and operations of buildings with several central, foremost considerations: energy use, water use, indoor environmental quality, material section and the building’s effects on its site green building council. The vitality inherent in the elements used (the electricity necessary for all aspects linked with the item, from mines through production, transport, and distribution), waste minimization, and what becomes to concrete structures after the structure is dismantled are all considered (Cole, 2019). The life span evaluation of a building covers anything from resource extraction to refining, production, usage, management, and demolition it also analyses energy content, greenhouse gases, consumption of resources, pollutants, and wastes. Product lifecycle assessments are being used to evaluate performance outcome in an increasing number of cases, albeit they are not necessarily included in green building rating systems. Building construction evaluation system is just a clear evaluation and rating system that is a component of the entire green building life cycle. It would use a set of criteria to determine whether "green" level the intended property had attained. Simultaneously, by producing a set of index values, the building construction evaluation system gives clear and detailed guidelines to direct and identify sustainable construction from many viewpoints.

The green roof standards may also be used as norms and rules inside this green construction sector to affirmative action measures green building speculating, stimulate and promote excellent green structures, and achieve the goal of clean up the work sector. Green construction is the development of an assessment system that has significant and difficult task. It necessitates the cooperation of professionals from numerous professions because it pertains to a broad range of job complicated and diversified sectors. Modern science evaluation methods are critically needed as technical assistance for the functioning of the green structural systems. Blue construction will be fully acknowledged and put into reality if there is a clear and user-friendly evaluation method, as well as a scientific, complete norm of “green building." The assessment method and standards will be highly useful and will play a vital role in fostering the ‘greening’ of buildings. There are several systems developed worldwide for such an assessment. BREEAM, LEED, CASBEE, BEAM, GS, GMC, GBI, ASGB, DGNB, ASGB, ESTIDAMA are among these green building rating systems.

- **BREEAM (Building Research Establishment Environmental Assessment Method)**

  BREEAM debut in UK Since 1990, it has been the world's most popular building evaluation technique. BREEAM became is among the most comprehensive and widely accepted assessments of a property's sustainability impact, serving as the gold standard for sustainable architecture, construction, and maintenance. BREEAM is frequently used throughout europe, as well as several other parts of the world about 72 countries in addition, BREEAM had. Verified over 425,000 buildings and 1.9 million registered projects in 60 countries as of October 2015. It has a significant influence on other as first sustainable buildings testing system ; it leads to the growth of green construction by providing green building rating methods.

  This type of research necessitates the use of eco-friendly technologies and materials. It can assist to protect or raise the standard of living in the immediate neighbourhood due to its design and features. It is required to have a high level of performance in order to do so pollution is reduced through conserving energy, water, and some other resources. The BREEAM Residential Development Basic Manual addresses a wide range of types of building. BREEAM has five levels of certification its starts with (outstanding 85points, Excellent 70 points ,Very good 55points,Good 45 points, Pass30 points).

- **LEED (Leadership in Energy and Environmental Design)**

  LEED certification is a system that seeks to increase the buildings energy efficiency and performance in the environment of LEED that has been founded as a non-profit organization by the green Building Council of United States (USGBC) in 1994 and dedicated LEED is the most certification system of green building in the world, every day more than 150 nations have recognized 1.85 million square feet from certified building area. It is also widely regarded as one of the most perfect and impactful evaluation process between all green building rating systems. LEED certification is an impartial assessment of a building's or neighbourhoods green characteristics, enabling for asset, elevated, healthy, and expense building design, construction, operation, and upkeep. The evaluation step is not specified in LEED. The LEED Certificate is a globally recognized official certificate that assesses whether or not a construction is healthy, because LEED is

the most extensively utilized certification scheme, and it is included in the majority of research. Despite the fact that several research on environmental assessment systems have been conducted Performed, there appears to be absence of contrast one of the most widely used grading systems around the world an extensive set of criterion for judging,as well as a transparency and public in the weight training in use for contrast, since this ratings allocated to the parameters in multiple types of the same grading system can fluctuate.

- **CASBEE (Comprehensive Assessment System for Built Environmental Efficiency)**

  Development in Japan started in 2001. Which was before building work, and old structures and rehabilitation evaluation methods are all focused on the building's life cycle. CASBEE introduces a novel evaluation paradigm that differentiates between environmental load and architectural performance quality. CASBEE results are presented as an eco-efficiency measure by linking these two criteria (Building Environmental Efficiency). The finest structures will lie in the portion reflecting the lowest environmental load and maximum quality on the Ecological responsibilities are on one axis, while worth lies from the other. The purpose of CASBEE is to analyse and evaluate architectural sustainability impact. The CASBEE analysis takes into account the tower's design, interior cleanliness, material utilization, energy consumption, and existing power loads. The CASBEE rating has five potential grades: superior (S), good (A), good (B+), slightly poor (B-), poor (C).

- **BEAM (Building Expertise in Administration & Management)**

  In 1996 the BEAM Steering Committee created the Hong Kong BEAM, which eventually partnered with other significant actors to create the Green building Council of Hong Kong (HKGBC)The HKGBC launched an updated BEAM version in 2010.

- **GS (Green Star)**

  The Green Star new Zealand grade scheme, which is modelled on the Australian Green Star, was developed by the NZGBC in 2007. (New Zealand Green Building Council). It was the only one that doesn’t include a guide for analysing the facility over the course of its life. Because that is has seen it on the sale for a

year, the range of certifications is also still restricted. Furthermore, since 2009, it has grown fold, raising the total quantity of certifications to 125.

- **GMC (Green Mark Certification Scheme)**
  In January 2005, the Green Mark Certification Scheme was introduced. The buildings department of Singapore uses the green mark grading system to assess the environmental friendliness of infrastructure assets, recognizing projects that have implemented increased environmental sustainability plans and procedures. (GBI) The Green Building Index measures how green a building is. The Green building Index (GBI) construction rating instrument that attempts to improve sustainable construction and raise awareness about the issues between main players such as developers, engineers, and other general contractors and constructors. In January 2018, GBI and its subsidiary, GB Initiative Canada, completed the purchase of the global right to Green Globe, allowing GBI to service current Green Globes consumers in Canada.

- **GBI (Green Building Index)**
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- **ASGB (Assessment Standard Green Building)**
  In 2006 Chinas Ministry of construction attempted to develop a local green building standard with the "Evaluation Standard for Green Building. The goal of the system of rating is building an is therefore that fosters green economy on a voluntarily. In 2000, ECD Energy and Environmental Canada created the first Green Global rating system. Green Global Existing Buildings Green Globes were bought by a multinational commercial real estate service and investment business in 2008. The Green Building Index (GBI) and its subsidiary, GB Index Canada, finalized the purchase of the global rights to Green Globes in January 2018, allowing GBI to serve in Canada there are now Greens Badges users.

- **DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen)**

  The German Green Building Council (DGNB) is an independent organization was founded in 2007 in Stuttgart, German by a collection of people and firms from the growing construction industries (DGNB 2015). The DGNB accreditation for properties or neighbourhoods places a premium on actual quality but instead of single computations (DGNB 2015). In Germany, construction plans include fresh and innovative offices, apartment areas, hotels, educational institutions, housing, commercial, helped to make, and retailing (DGNB 2015). This grading system comprises six separate evaluation categories with 49 elements, making it a complete assessment tool for entire building quality. This tool covers six topics: Biological quality, commercial quality, Social value, service product, quality requirements, and site performance.

- **ESTIDAMA (The Pearl Rating System)**

  The capital of the United Arab Emirates, Abu Dhabi, has started the 'Estidama program, the goal of making the emirates a sign of sustainable (UPC 2010).(PRS) the Pearl Rating System is a sustainable construction’s intensity created in 2007 by the Abu Dhabi Urban Planning Council (UPC 2010). The goal of this approach is to apply the fundamental ideas of green building by emphasizing the importance of using land, material, energy, and water in a reasonable fashion (UPC 2010). PRS's objective and vision are to establish a feeling of balance connecting Estidama's four facets: environmentally, economical, culture, and socially through creating more resilient communities, cities, and international corporations (UPC 2010). There are seven classifications in the Pearl grading system: Natural Systems, Precious Water, Resourceful Energy, Liveable Buildings, Integrated Development Process, Innovating Practice ,Materials. All obligatory credits (1 pearl), all obligatory credits +60 credits (2 pearls), All obligatory credits +85 credits (3 pearl).

CHAPTER III

A Rating System of Green Building: LEED Certificate

History of LEED Certification

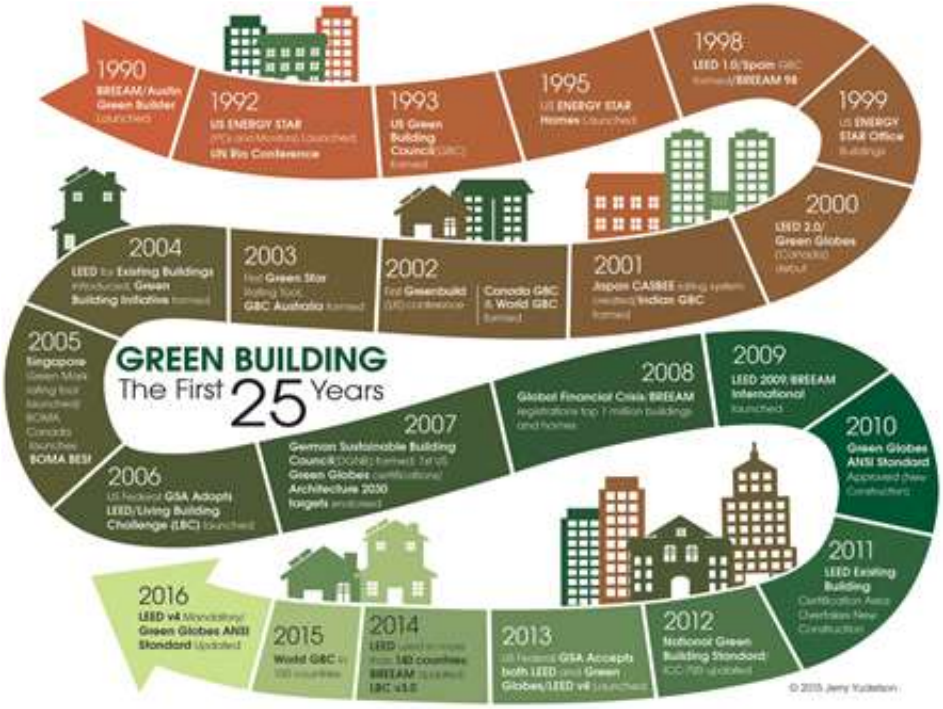
The LEED program of Green Building Council in the United States is the world's most widely used green roof evaluation system (USGBC). From version 1.0, which was intended for rapidly growing or commercial spaces, to version 4.0, which was designed for existing buildings. A group of thinking and business professionals created the USGBC in 1993, a non-profit trade association that respects the environment in the design, construction, and operation of a facility. Robert K.Watson (2018), prior manager in the Energy Programs of Sustainable Architecture and Worldwide at the Defence council of natural Resources, non –Partisan, a non –profit organization of environmentalist advocacy located in New York, led the first LEED panel. Watson led the "wide consensus protocol" as the founder President of LEED, which he maintained until 2006.

Non-profits, regulatory agencies, economists, scientists, programmers, architects, equipment makers, and some other technology companies were among the participants. The original members rapidly recognized the necessity for a methodology which might be defined and determine just what "green building" meant. They started by looking at pre-existing green roof measurements and grading systems, and in 1998, they developed the initial LEED pilot project program (LEED V1.0). LEED version 2.0, renamed rating System of LEED Green Building for New Commercial Development and Large Upgrades, was released in 2000 after major changes to the pilot program (LEED NC). LEED for Health Care (H), LEED for Development of Neighbourhood (ND), LEED for Home (H), LEED for Existing Building (EB), LEED Retail (R), LEED for shell & Core (CS), LEED for School (S), and LEED Commercial Interiors (CI) are three LEED certification programs All LEED data moved online in 2006, eliminating a method that requires designers and other experts to submit 2 - 3 binders of information for receiving Certification of LEED (spawned a slew of problems regarding all the documentation). In 2009, LEED 3.0 was released. The creation of the Green Building Certification Institute (GBCI), an Organization of third –Party Certification entity in charge of reviewing all LEED documents, was one of the most significant advancements. In Canada, the

LEED v4 rating system can be applied via the Global route and the Additional Conform Routes.

Figure 4.

The Development of Green Building From its Roots By Years



Robar, 2018

Buildings that are LEED certified boost productivity, minimize carbon pollution and offer a better atmosphere for humans. They are essential in dealing with global warming and meeting ESG .ESG is environment, social, Governance variables used to assess how much farther along enterprises and nations are in sustainable and the targets, as well as boosting resiliency and advocating for more equitable policies society. A project obtains marks through collecting to qualifications and allowances to manage waste, water, energy, carbon, transit, supplies, heath, and interior environment protection in order to attain LEED certification. verifies and reviews sites and assigns points to each LEED Level Platinum (80+ points), Gold (60-79 points), Silver (50-59 points), and Certified (40-49 points).

Figure 5.

LEED Certificate Logo for classification

(Robar, 2018)

Platinum (80+ points), Gold (60-79 points), Silver (50-59 points), and Certified (40-49 points). LEED certified building promotes healthier surroundings, decrease emissions, enhance effectiveness, and save cost for individuals. It is essential for reaching ESG goals and fighting climate change. Values, as well as ability to respond quickly and improving higher egalitarian societies. Through fulfilling systems of credits and green building, health, materials, transportation, waste, water, energy, and carbon, a project earns marks to get certification of LEED. Before granting points that correspond to a LEED rating level, GBCI checks and assesses projects: During 2007 and 2008, the volume of efforts over the past in LEED Online rose, resulting in a total of 18,400 projects. By the end of 2008, the USGBC had received about 700 projects applications every month. From 2008 and into 2009, the number of LEED projects registered increased. Each quarterly in 2008, a total of of 2,100 projects were resisted. The 2.300 projects recorded in the first quarter of 2009 were comparable to the same period the previous year. The amount of LEED registrations has steadily increased since its rollout in 1993. Except for a 9% rise in registers from 2010 and 2011, project registrations followed the wider market tendency of decreased building construction during 2009 and 2010. Following hat. After that period, the average monthly LEED project registration rate returned to the level seen in the two months prior the collapse. Environmentalism is spreading; as is enthusiasm in environmentally conscious and procedures the rising number of LEED registrations in recent years reflects this trend. In 2005, there were just 3,156 LEED registrations in the United States, but by the end of 2018, there were 67,593. The total of LEED licenses in the U. S. had reached at 69,066 as of October 2019. LEED was created by Robert K. Watson, an NRDC scientist, and swiftly gained backing from a variety of groups, including USGBC a semi company

which gives certified and improves the concept. And LEED accreditation is in high demand all across the world. The United Arab Emirates, Sweden, Turkey, Germany, Taiwan, Korea, Brazil, India, Canada, and China are among the top consumers of the technology after the United States.

Goals of the LEED

LEED's purpose is to decrease the impact on the climate. Individual health should be improved as well as water supplies should be maintained and restored. The environment and ecological processes must all be protected and developed. It encourages the use of regeneration and effective bronzers. Rather than focusing on just one aspect of the design, such as energy, water, or healthcare, it aims to improve the surrounding's level of living (Zhang, 2015). LEED is a preliminary design process of analyzing all of the important factors come along to provide the greatest possible structure. In reality, climate warming is liable for 35% of LEED credits, 10% of credit facilities are due to climate change, 15% of credits have an effect on ecosystems, and effect of human health accounts for 20% of credits. In reality, warming accounts for 35% of LEED credits, 20% of credits have an effects on human life, 15 % of credits have an influence on environments, and 10 % of debt instruments have an influence on the earth. A secure world receives 10% of the credit, while institutions receive 5% and environmental services receive 5%. USGBC created a recommended standard (US Green Building Council). In 1998, a pilot game was released (LEED 1.0). Between 2008 and 2015, the living space of LEED-certified projects17 increased by about 100 percent, from roughly 0.15 billion to over 15 billion. There are no explicit LEED Canada Version 4 criteria for evaluating a building's lengthy durability.

Table 2.

Versions of LEED Certification through History

Time line of LEED						
Versions	LEED V1.0	LEED V2.0	LEED V2.1	LEED V2009	LEED V4	LEED V4.1
Year	1998	2000	2003	2009	2015	2019

(Zhang, 2015)

Logistics and mobility, resilient installations, recycling and reuse, energy and atmospher, educational resources, indoor air quality, invention, and regions priority are the eight areas that make up the LEED-NC criteria". We can observe that LEED incorporates three components of environment, economic, and social, substance from particular items of the LEED evaluation index. The majority of the assessment indices, however, are oriented in the environmental sector. Only a minor portion of the assessment factors are connected to social issues, such as density and social links, public transportation, and so on. While macroeconomic variables are not visible in the LEED evaluation index, financial benefits are associated with environmental benefits in practically each LEED indication. LEED is a comprehensive method that focuses on all aspects of a facility, not just one, such as energy, water, or healthcare .LEED is just a opposed of concentrating on just one facet of a design, a comprehensive strategy that analyzes all of the major aspects that tend to form the best structure possible is used property, also including gas, water, or wellness. The USGBC was determined to turn LEED into a helpful tool for identifying green buildings and a chance for people to have a greater comprehension of sustainable construction from the start. At the outset of LEED program, the USGBC established market change as a defined aim. LEED Certification will provide the following benefit:

- Gain competitive edge - According to 61 percent of company leaders, sustainability contributes to performance of higher financial and differentiation of market.
- Attract tenants: The best rents is demanded for LEED-certified buildings, with rates of lease-up that is between average and 20% over average; occupancy levels for non-green structures are expected to be 4% greater compared to green construction.
- Performance management: LEED is considered as the ideal system of performance appraisal & project of green construction all over the world. It provides an all-encompassing structure for green design, implementation, administration, and sustainability.
- Meet ESG objectives: In meeting their ESG goals, LEED helps investors through providing a framework of green construction which is universally recognised and rigorous to measure and manage realty efficiency.

LEED Criteria Assessment

Qualification for the USGBC's LEED Certification as a time-consuming procedure includes a slew of criteria and regulations. Certain credits in LEED are assigned points. Each one of these subcategories also has obligatory criteria that score no credits, according to Robar (2018).The USGBC has collaborated with local amateurs and professionals to highlight innovation in building. Innovation credits offer the chance to earn credit for exceeding LEED standards or for creative performance in building construction subcategories. Indoor Environment Quality, Material and Resources, Energy and Atmosphere, Water Efficiency, Sustainable Sites, Location and and Transportation, Regional Credits and Innovation and Design are the eight categories in which a project may earn points up to its maximum of score under LEED. See Table 3.

For a project, LEED are awarded 110 total points; these LEED rating credit categories are:

- Regional Priority (RP)
- Innovation & Design (ID)
- Indoor Environment Quality (IEA)
- Material and Resources (MR)
- Energy and Atmosphere (EA)
- Water Efficiency (WE)
- Sustainable Sites (SS)
- Location and Transportation (LT)

Regional Priority: Regional priority gives four points credits attempt to incentivise the accomplishment of LEED credits that meet locally related environmental, social equality, and human health risks.

Innovation & Design: Provides boundaries for projects with six points that employ emerging ideas and tactics to enhance a facility's function well beyond what can be needed by other LEED credits, or perhaps to accommodate for sustainable construction concerns not specifically handled anywhere else LEED. Qualified specialist on the project to guarantee a fully implemented design and production.

Indoor Environment Quality: In addition to the prerequisites, Enhanced Indoor Air Quality Techniques (such as enhanced airflow and pollutions prevention), Moderate

Materials, the proportions and operation of a Renovation Indoor Air Quality Evaluation, Thermal aspects, Interior Illumination strategies to promote convenience and wellness by offering control systems all through, Full sunlight, Value Views, and Ukulele Multi core.

Materials and Resources: Building Product Exposure and Efficiency - Environmental Compliance Assertions, including the Purchasing of Key Inputs and Building Composition, and Waste generation Control should all be examined in accordance to the provision.

Energy and Atmosphere: This division has the highest point value as well as the most credentials. Because of the strong relationship between reducing emissions and quality assurance ("commissioning"), this section mixes the two. To begin receiving max points, a third-party Quality assurance Authority (CxA) must perform "Enhanced Commissioning," a more comprehensive and intensive QA/QC process, and the airtightness, in case of mechanical, electrical, pipework, and eco-friendly power generation and modules required in the pre - requisites, should be included in the contracting plan and method. Energy-related locations can be managed to gain for exceeding energy- efficient standards, Advanced Energy Metering, Load Control (such as load shedding or shifting), Photovoltaic Electricity production (Such as solar) Augmented Pressurizer Governance, as well as Green Energy and carbon Offsets, where 50-100 percent of energy consumption is sourced from an ecofriendly source.

Water Efficiency: While reducing interior and exterior water usage and measuring are required, points can be gained for little or no irrigate layouts, projected indoor water savings of 25 to 50 percent, and cooling tower (HVAC system) groundwater.

Sustainable sites: It is aimed to avoid advancement on unsuitable sites. Facilities of public transport / neighbourhood advancement to shorten the distance travelled by vehicle and to encourage frequent physical exercise for increasing liveability and people's life.

Location and Transportation: Conserve or rehabilitate biodiversity, open space, storm water treatment, solar heat gain lowering (i.e. avoid big, exposed tarmac parking lots), and artificial light mitigation are all techniques to consider when creating the site.

Table 3.

Characteristic of LEED Certified Building

No.	LEED credit criteria	Criteria assessment elements
1	Location and Transportation	Green vehicle
		Location of Neighborhood development
		Protection of sensitive land.
		High Priority site
		divers usage and surrounding density
		Availability of quality transit
		Bicycle facilities
		Reduce footprint of parking
2	Sites of Sustainable	Joint use facilities
		Direct exterior access
		Places of respite
		Tenant design and construction guidelines.
		Site master plan
		Prevention of construction Activity pollution.
		Site development -protect or restore habitat.
		Open space.
		Rainwater management
		Heat island reduction
		Site assessment
		Environment site assessment
		Reduction of light pollution
3	Energy and Atmosphere	Water metering.
		Metering of building level water
		Reduction of outdoor water use
		Reduction of indoor water use
		Use of cooling tower water
4	Atmosphere and Energy	Increased commissioning
		Performance of optimise energy
		Metering of advanced energy
		Demand response

Table 3.Characteristic of LEED Certified Building(Continued)

		Production of renewable energy
		Management of increased refrigerant
		Carbon offsets and green power
		Metering of building level energy
		Management of fundamental refrigerant
		Minimum energy performance
		Fundamental commissioning and verification
5	Resources and Material	Management of demolition and construction waste
		Design for flexibility
		Reduction of PBT source
		Medical furnishings and Furniture
		Building product disclosure and optimization
		Recyclables collection and storage
6	Quality of Indoor Environment	Acoustic performance
		Quality View
		Interior Lighting
		Thermal comfort
		Indoor air quality
		Control of environmental tobacco smoke
		Quality strategies of increased indoor air
		Quality of Indoor Air in management plan
		Enhanced quality strategies of Indoor air
		Environmental tobacco smoke control
7	Innovation and Design	LEED accredited professional. Innovation
		Integrated project &design
		Innovation in design
		Documenting Sustainable building cost impact
8	Regional Priority	Optimize energy performance Quantity control of storm water design

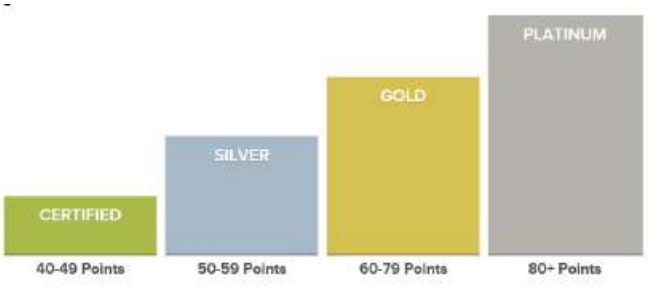
	Restore habitat or development protector of site Water use reduction –Measurement and verification

(Zhang, 2015)

All buildings pursuing certifications must meet the appropriate rating program's basic program criteria , which on the USGBC website. The sustainability methods used in the development, design, and construction of various LEED certification will change depending on the kind of architecture, the design' focus, and the degree of certifications they attain (basic, silver, gold, or platinum). Zhang. Y (2015) to acquire LEED certification, the goal must fulfill all minimum essential requirements (pre-requirement), and the certified total scores must exceed the corresponding level to achieve the corresponding level. LEED's scores in several areas can be a free exchange, indicating that LEED has some flexibility. LEED covers a wide spectrum of green construction evaluations. LEED final grade is divided into the following four levels; Certified level (40-49), Silver (50-59), Gold grade (60-79) and Platinum (80 Points and above).

Figure 6.

Levels of LEED Certification



(Zhang, 2015)

CO2 reduction in emissions, energy and water conservation, energy savings, improved indoor climate, ethical use of mineral wealth, and thinking about indirect pollution are some of the indicators that are examined in Certifications. The main rationale for getting a building LEED certified is to indicate that you are serious about achieving sustainability, construction, and design. Any constructor or builder will claim to be environmentally conscious, but a fourth rating (particularly one with such a great record) demonstrates to your

peers that you are. LEED certification is available for various sorts of structures. Because the certificate is issued in several categories based on the nature of the project. LEED is applicable to different structure kinds and stages; especially new housing, interior design, building operation and maintenance etc. Table 4 shows the LEED certification categories (Building Design & Construction, Interior Design & Construction, Building Operation and Maintenance, Neighbourhood Development and LEED for Home). In addition there are the categories of Communities and Cities and LEED Zero.

Table 4.

LEED Certification Catalogue

	List of LEED building rating system	Building type
LEED Certificate	LEED BD+C Building Design & Construction	Recent construction Hospitality Canters of Distribution& Warehouse Canters of data Health care Schools Retail Shell &Core
	LEED ID+C Interior Design & Construction	Hospitality Retail Commercial Interiors
	(O+M) LEED Building Operation and Maintenance	Retail Hospitality Schools centers of Distribution & Warehouse Data canters Multifamily
	Neighbourhood Development LEED ND	Plan Project

Table 4. LEED Certification Catalogue (Continued)

LEED Homes	Home & Multifamily Low-rise Multifamily Midrise

(Zhang, 2015)

i. LEED BD+ C: Building Design & Construction

LEED v4.1 provides an introduction to dwellings, combining the much more relevant terminology from the BD + C and all other home standard unit with the needs of the property sector. As a compulsory system of rating for both multifamily and small household buildings, residential BD+C is currently used. Thanks to the addition of additional multifamily option in LEED V4.1. LEED BD+C cannot be used in LEED v4.1 residential projects. Residential BD+C is for residential development or extensive renovations of residences. Multifamily homes of core and shell, rather than in LEED Residential BD+C, should be completed in minimum 60% of the floor space of program in the certification time. This grading system is for constructions which are new or even have experienced considerable changes core and shell, rather than in LEED BD+C. The design must comprise the total gross floor space of the building. LEED for Construction Process (LEED BD+C) is a framework for designing and constructed holistic sustainability activities that enable you to pinpoint each environmental component and optimize the benefits LEED certification should be obtained for all projects. LEED certification may be used for a range of initiatives, including hospitals, industrial plants, markets, and office complexes. LEED BD+C may assist any project. Use a specialty choice for one-of-a-kind requirements, or New Development and Major Renovation for anything else.

- **(Recent construction) New Construction and Major Renovation:** Constructability operations for new structures and substantial upgrades of older ones that do not satisfy the applications listed below are covered. (This option is also available to LEED v4 teams for multi apartment complexes with four or more occupiable stores above ground).
- **Core and shell Development:** In developments by which the developers have the responsibility to design and development of the fire safety equipment, sewage, electricity, and full mechanical while not really the fit-out of tenant.

- **Data Centers:** Buildings constructed and outfitted especially for high personal computers such as rack mount servers, which are utilized for process of data. LEED BD+C: Data canters just adders data centres of whole –building (Grater then 60%)
- **Health care:** Hospital that operates Seven days a week and 24 hours a day and offers medical treatment of patient such as long-term and acute care.
- **Hospitality:** Pertaining to inns, motels, hotels, and some providers which provide short-term or transitory accommodation with no meals.
- **Retail:** They are associated with the businesses of huge box, electronics, clothing, restaurants, banks, and all related individuals who have their own set of standards.
- **Schools:** The property of K-12 schools, for facilities such as main and extra instructional areas. In addition, it could be applied in – anti buildings in postsecondary and college campuses learning.
- **Warehouses and Distribution Centers:** Facilities of self-storage are structures which are utilized for keeping items, produced goods, worldly belongings, material or retail.

ii. LEED ID +C: Interior Design and Construction

Interior Design and construction (ID+C) of LEED fully equipped interior spaces. Moreover, at the time of certification, minimum 60% of the floor space of project should have been finished. Interiors are considered incomplete for ID+C projects if it lacks the furnishings, equipment, and equipment needed for the space's daily operations. This rating system applies to completely equip interior spaces. There are patient‘s as well as in projects accessible. LEED is applicable to all project types, from office buildings to coffee bars; LEED ID+C have solutions to suit any building, new or old.

- **LEED ID+C:** Hospitality. Interior space devoted to inns, motels, hotels, and some services enterprises which provide short-term or transitory lodging with no meals.
- **LEED ID+C:** Retail. Guides retailer’s interiors places utilized for conducting the selling retail of costumers goods of products, including

both storage spaces which they support or service areas of direct customer (show-room) and preparations.

- **LEED ID +C:** commercial Interiors. For interiors places assigned to applications which are not hospitality or retail.

iii. LEED O+M: Operation and Maintenance of Building

Operation and Maintenance (O+M) LEED enables existing building to give greater thought to structural system by incorporating Whole facilities or interiors which are not obligatory and occupied for minimum 12 months. That facility might be obtaining work, but there could be little to no work. LEED contributes to tall building development by stressing both achievement sustainability practices and outcomes. Consider that although the new construction is extremely energy efficient, it can take up to 80 years to counteract the consequences of dismantling an older home and building a new one. However, most historical properties across the world are effective and valuable, but with careful planning and construction, this could be rectified by implementing LEED O+M. LEED certification may be used to a wide range of projects, from office towers and cafes to data centres in the city. LEDD O+M provides Option for all types of building.

1. **LEED O +M Existing Interiors:** Presenting spaces of interior housed in a part of a presenting structure. Interior areas can be used for commercial, retail or hospitality purpose. Structures that have been fully functioning and inhabited for minimum 12 months. The project might be conducting maintenance and there might be small or no constructing. The proposal should contain the total gross floor space of the structure.
2. **LEED O +M Existing Buildings:** Existing structure that isn't used for K-12 education, retail, data centres, warehouse& distribution centres, hotel.
   - 2.1. **LEED O+M: Retail.** Existed structures that utilized for being utilized for the retail selling of customers products, including facilities for direct customer support (showrooms) as well as areas for preparations or store that assist customer care.
   - 2.2. **LEED O+M Hospitality.** Existed structures devoted to Inner, motels, hotels, or some services -related enterprises that offer transitory or short-term housing either with meals.

2.3. **LEED O+M: Schools.** On K-12 school grounds, existing buildings have core and additional classroom spaces. Non-Academic and higher education construction in schools property are also possible application.

2.4. **LEED O+M: Distribution & Warehouses centres.** Existed structures that house things, manufactured items, commerce, natural resources, or personal effects (such as self-storage).

2.5. **LEED O+M: Data Canters.** Existing structures those are intended and built to fulfil the demands of high density computer equipment such as server racks, which are utilized for data processing. Using whole computer systems are addressed under LEED O+M Data Canters.

2.6. **LEED O+M: Multifamily.** Existed multi-family developments having 20 and greater apartments, whether in a single structure or many towers in same complex (e.g., 20 town homes).

iv. LEED (ND) Neighbourhood Development

Neighborhood Development (ND) LEED is designed for inspiring and assisting in the creation of better, more ecological, and quite well communities. It considers entire populations rather than just houses. New land expansion or rehabilitation projects including residential, non - residential buildings, or a mix of the two. Project could be in every development level, between initial plan and completion. It should be mentioned that from the total floor area of the building, minimum half be residential development or substantial refurbishment. Buildings inside this project as well as wider community features are assessed. This guide contains instructions for the following:

1. **LEED ND Plan Certification:** your neighbourhood-scale project is eligible for approval if it is presently at any stage of layout and is up to 75 percent completed. We created this service to assist you or your contractors in marketing and funding your property to potential renters, bankers, government authorities, and others by confirming your proposed sustainable initiatives.
2. **LEED ND:** Built Project: Intended for area initiatives that are nearing or have been done inside these past three years.

v. LEED in Homes

Home and residential building which are higher than 4 stories might utilize LEED.

- Multifamily Low-rise (1 to 3 stories)
- Multifamily midrise (4 or greater)

vi. LEED in Communities and Cities

In towns and cities, LEED works with local leaders to develop ethical, ecological, and thorough plans for ecological systems, energy, water, trash, mobility, and a range of other factors that lead to standard of living.

The certifications change the way towns and societies are conceived, built, and run in order to increase overall economy and wellbeing. The LEED structure includes indicators and activities for social, financial, and natural environments, as well as a clear, data-driven approach of monitoring and communicating success. The program is in accordance With the US Sustainable Development Goals and if influenced by our engagement alongside thousands of towns and neighbourhoods around the global.

For communities and cities two choices are accessible:

- Design and plan. Recent communities and cities which are in the stages of designing/planning.
- Existing. Communities and cities from which greater than 75% are built.

vii. LEED Zero

What occurred when we took the concept of minimizing the environmental footprint of buildings to its logical conclusion? LEED has provided a framework for greater built environments while simultaneously decreasing greenhouse gases through measures affecting materials, waste, water, transportation, energy, and land for more than two decades. Building in the work, the USGBC is improved a LEED supplement (LEED zero) which validates the achievement of net zero objectives within concrete institution

1. **Carbon of LEED Zero:** identifies carbon emission of net zero from consumption of energy by emissions of carbon prevented or offset in a time of about one year.

2. **Energy of LEED Zero:** certifies net carbon neutral output from energy use across prevented or offset greenhouse gas emissions during a 12-month period.
3. **LEED Zero Water:** acknowledges a drinkable water use balances of zero during a 12-month period.
4. **LEED Zero Wastes:** Buildings that have achieved GBCI's genuine accreditation at the Platinum level are recognized.

International Examples of LEED Certified Buildings

This section evaluates chosen international buildings that are certified as LEED in last five years by USGBC organization. Four different category of buildings as Commercial, Residential, Hospital, and School are chosen. Four examples (platinum, gold, silver, certified) for each category are analysed according to the specific LEED criteria. These evaluation criteria are 'Indoor environment quality, material and resource, energy and atmosphere, water efficiency, Sustainable site, location and transportation.Table 5 below shows the criteria assessment for the LEED Certification version (LEED v4, LEDD 2009) by points. In addition, the chosen samples are listed below. Table below created depdends on the certification paper that showing all LEED Critera of the buildings from main USGBC source (Residential,Commercial,Hospital and school)

Residential buildings

- Trellis House in USA.
- Soyak Soho Building in Turkey.
- Square Equinox 3 in Canada.
- Liberty Warehouse Apartments in USA.

Commercial buildings

- Mesheireb Properties Headquarter in Qater.
- Cummnis Beijing New Office in China.
- JLL Orange County in USA.
- Circuito costa rica CoE Johnson control in Costa rica.

Hospital buildings

- Hospital fraternidad- Muprespa Habana in Spain.
- David H. Koch Center NewYork-Presbyterian in USA.

- KMCWC NICU Building in USA.
- SIH Cancer Center in USA.

School building

- Amman Baccalaureate School (ABS) in Jordan.
- Terakki Tepeoren - Elementary School in Turkey.
- HISD Milby (Charles H milby) High School in USA.
- LICEO Europeo La Moraleja Ed.c in Madrid.

Analysis of the Case Studies

Evaluation of 1st Category: Residential Buildings

Trellis House

- LEED BD+C: Multifamily midrise v3 –LEED 2008
- Platinum Certification (91.5)
- Area (323,839 sq. ft)

Trellis House provided the first LEED Platinum BD+C: Multifamily Midrise project in Washington, DC. By including a verdant roof and - anti patio aspects, the concept negates the urban heat impact from previous program development, and also enhances the area's wellness by conducting volunteer restoration work to replace sewer pipes and subsoil tainted by pollution. It's a compact, walkability area with enough transit options and social attractions, as well as easy access to training and play. People can park their bikes to encourage alternative modes of transportation.

Figure 7.

Trellis House

Sourcce: https://www.usgbc.org/projects/trellis-house

The effort aims to save a little then 21% higher energy than the standard building while using 30% less water. Apart from growing machines, evaluation and outcomes. Apart from increasing machines, the findings were assessed to guarantee that any such airstream and wastewater fan capabilities achieved technical requirements and supplied occupant with a clean indoor atmosphere. Local, minimal, and high-performance parts were employed.

Figure 8.

Trellis House Interior View

Sourcce:https://www.apartmentfinder.com/District-Of-Columbia/Washington-Apartments/Trellis-House-Apartments-557tpfp

Soyak Soho Building

- LEED BD+C: New Construction
- Gold Certification (63 Points)
- Area(5000m2)

The Soho project is located in Zincirlikuyu, Turkey and houses 77 modern flats and offices of 4 thousand square meters, all residence and concierge service are offered and the residence section of the 7-floor. Developed under the name Soyak Holding by architect mutlu cilingiroglu (Camlibel, 2014). The multi-apartment residential (Residence &Office) project located on a land of approximately 5 thousand square meters and project provides housing services to the middle group. The structure represents a combination of innovation and quality of life, and its materials are made up of a combination of cheaper and sustainable materials such as wood blended with steel and glass furnishings (see Figure 3.6). The used materials do not only work towards blending modern architectural designs with quality but also contribute toward reducing building costs. Sustainability of materials is also connected to the reduction in the use of environmentally degrading materials that contribute to environmental deterioration (Robar, 2018).

1. Building Features (hydrophone, Generator, Fire escape, Lift, freight, elevator, Lobby, Reception, sprinkler system)
2. Housing Properties (Built-in white goods, intercom systems, central heating, heat allocator, Split climate, Smart home systems, Residence services)
3. Construction techniques (Building inspection done, ground survey has been done, Conforms to earthquake regulations, Compliant with insulation regulation)

Figure 9.

Soyak Soho.

Sourcce:https://residenceindex.com/en/proje/467/soho-residence.html

Meanwhile, the Soyak Soho project obtained a LEED Gold Certificate for contributing to improving building occupants' comfort and quality of life. In addition, its design caters for several social and cultural activities, which are other vital elements of sustainable building designs (Marchi, L, 2021; Shan & Hwang, 2018).

Quare Equinox 3.

- LEED BD+C: Multifamily midrise v4 –LEED V4
- Silver Certification (52)
- Area (74,840 sq ft)

Beautiful buildings, wide spaces, and easy education opportunities, shops, public transportation, and the town center. The Quartier Greenwich provides a genuine community setting for both leisure and active activities. My leisure, your way of life Banlieue Greenwich is a healthy-living community that offers a broad range of new townhomes, stacked homes, and 6-story flats that are ingeniously mixed with a magnificent natural park, childcare, and bike lanes. It is also

strategically located in Pointe-commercial, Claire's sporting, economic, and residential areas. Colleges and day-cares are only a short distance away. Locals have easy right to a basic bus routes, train line, highways, and also the airports.

Figure 10.

Square Equinox 3

Source: https://www.usgbc.org/projects/square-equinox-3

Figure 11

Square Equinox 3 Interior View

Sourcce:https://www.ecohome.net/find/properties-for-sale/leed-condos-square-equinox-quartier-greenwich/

Liberty Warehouse Apartment

- LEED BD+C :Multifamily midrise V3-LEED 2008
- Certified Certification (50.5)
- Area (430,315 sq ft)

Figure 12.

Liberty Warehouse Apartments Top View

Source: https://www.homes.com/property/liberty-warehouse-foster-st-durham-nc-27701/id-1000038627832/

The work encompasses supervising the deconstruction of an extant 250,000-SF tobacco facility. The obstacles were salvaging, stabilizing, and using the existing old bricks in to construction. One medieval wall was much more than 50 feet in height and had been near to a civic area and playgrounds. High building constructed on a prior work infill lot, minimizing its environmental impact, built can provide access to the public space, crop failure crops set up to retain potable water, waste generation was rerouted from dumpsites, shaping positive behavior tends to result in less wood becoming used while renovation, three - quarters of roof covering was known to be highly simply a reflection to minimize energy supply and reduce community heat.

- The watering system is extremely efficient; each unit has unique new air intake controls; and all blowers are High Efficiency certified.
- The structure includes approximately 30 resilience techniques that manage various possible pollution problems.
- The apartment is non-smoking, with sign pointing residents to dedicated smoking locations more than 25 feet from door.
- Excellent community funds are provided within a quarter mile of the facility this project was created with the goal of earning LEED Certification .The USGBC grading system examines a building's environment quality and supports economic transition to green development.

- Building trash was saved from dumps by 80%.
- To decrease energy consumption and the neighbourhood temperatures will increase, 75% of roof covering was engineered to be highly polished.
- HVAC dust systems were checked to ensure that there was no cooling / heating leak.
- The building has recharging points, and 5% of the car parks are dedicated for low-emission vehicle.
- In comparison to the architectural norm, the structure is 15% more efficient.

Evaluation of 2nd Category: Commercial Building

Mesheireb Properties Headquarters.

- LEED ID+C Commercial Interiors V4 – LEED V4
- Platinum Certification (90)
- Area (56,018 sq ft)

Interior construction and design shown in (Figure 15.) below were examined based on using LEED standards (Robar, 2018). Msheirib's Eco-Friendly Village initiative aims to save operating costs and carbon emissions by producing less trash and utilizing significantly less water. The construction manager is responsible for ensuring that every facility within the advancement receives a Gold or Platinum rating from the US Green building for the globally renowned LEED certified system, making it the country's first maintainable centre city restoration build.

Figure 13.

Mesheireb Properties Headquarter

Source: https://www.marhaba.qa/msheireb-properties-showcase-flagship-project-cityscape-qatar-2018

Whenever the Msheireb design teams opted to reconstruct Doha's heart, they made certain that it is all taken into account. The landscape This new invention been created specifically to give cool leisure in the face of the hot local environment. The urban planning of to maximize the level of natural shade, the Msheireb's urban architecture features tall narrow alleys, layers of ornamental barriers, wide roof awnings, and other unique ways. With a total of 193,000 square meters of business space and 105,000 square meters of store outlets, Rooftop solar panels paired with a smart grid would minimize the core of Doha's greenhouse gases. Msheireb Downtown Doha also features residences, mosques, hotels, and local cultural entities. The city provides convenient space with over 10,000 vehicle parking spots spread across six subterranean levels, as well as a route discovering app that assists guests in quickly locating the car parking. The Msheireb Downtown Doha project incorporates smart city technologies. Msheireb District Doha has a greater population of LEED Certified Points may be gained for storing and collecting recycling, using renewable power, and reducing indoor water consumption. This is a critical part in building city more viable.

Figure 14.

Mesheireb Properties Headquarter Roof Solar Panels On the Roof Top

Source: http://rha-studio.com/msheireb1b.shtml

Cummins Beijing New Office

- LEED ID+C: Commercial Interiors v4-LEEDV4
- Gold Certification (65)
- Area(11,181 Sq ft)

Cummins Beijing New Office located in LSH Centre achieved LEED Gold under LEED Commercial Interiors v4. Totaling 11,181 square feet. This LEED achievement is an integrated result of Cummins's continuing commitment on sustainability, mutual effort of the project team and comprehensive process management. Cummins a worldwide powerhouse that designs, produces, sells, and maintains fuel and renewable energy engines, as well as electro electrical machinery and associated systems and technologies. The project benefits from this practice in various ways, including mature neighborhood community facilities, good base building systems to support energy saving and indoor environmental improvement measures, etc. The project places much emphasis on energy efficiency.

Shan, M. (2018). From design perspective, energy efficient HVAC zoning and controls, lighting control with daylight/occupancy sensors on the other hand, the system installation, testing and commissioning process were managed in a rigorous way to ensure delivery of energy savings. While minimizing its negative impact on the globe by saving energy and water and using materials responsibly the project never compromises occupants' health and comfort. CO2 levels in the office are monitored in each occupied zones and the feedbacks are used to control the outdoor air volume. Paints, adhesives, furniture and other related materials used in the renovation work are with zero or low VOC emissions.

Figure 15.

Cummnis Beijing new Office

Source: https://www.usgbc.org/projects/cummins-beijing-new-office

JLL Orange County

- EED ID+C: Commercial Interior, LEED V4
- Silver Certification (50)
- Size (34,200 sq ft)

The project cut indoor water use by 44%. Lighting power was reduced by 40% as part of the energy-saving efforts. The makeover featured Energy Star compatible equipment and appliances. Daylight and motion detectors were integrated for productivity. The mode of production rigorous basic and improved commissioning to guarantee that the architectural systems operate effectively and precisely as envisioned throughout the planning phase. A great emphasis was placed on choosing the material that was suited for human health and welfare. Furthermore, low emission paints, varnishes, adhesives, and sealants were employed to improve favorable indoor climate.

Figure 16.

JLL Orange County

Source: https://www.ocregister.com/2021/02/19/real-estate-news-jll-consolidates-2-oc-offices-into-new-irvine-campus/

JLL Irvine relocated its headquarters to Irvine, California, where a variety of uses are all within easy reach of the property, fostering pedestrian movement and community connectedness. The site is a one-of-a-kind campus-style company facility that combines workplace and health. The facility is mostly made up of office sections, with a huge conference hall that connects to a began to enter companies

conduct and break area JLL displayed dedication and expertise by attaining the Project Team LEED pilot credit for Environmental Equity.

Figure 17.

Interior View

Source: https://www.ocregister.com/2021/02/19/real-estate-news-jll-consolidates-2-oc-offices-into-new-irvine-campus/

Circuito Costarica CoE Johnson Control

- LEED ID+C Commercial Interiors V4 –LEED V4
- Certified Certification (48)
- (Area 35,411 sq ft)

Figure 18.

Circuito Costarica CoE Johnson Control

Source: https://www.usgbc.org/projects/circuito-costa-rica-coe-johnson-controls

The circuito costa Rica CoE Johnson control Limits project, located in Forum 1 Business Park, was done purposefully with an Environment and market, concentrating on wanting to locate an efficiency interior for consumers, creating a go of direct sun, and seeking views to spruik theory for the 311 worker who operate in the field. In during construction phase, proper measures were employed, and 69 percent of the cost generated was removed from dumps.

Figure 19.

Interior View

Source: https://www.usgbc.org/projects/circuito-costa-rica-coe-johnson-controls

Evaluation of 3rd Category: Hospital Buildings

Hospital Fraternidad–Muprespa Habana

- LEED BD+C: Healthcare V3-LEED 2009
- Platinum Certification (86)
- Area (91,138 Sq ft)

The Hospital Fraternidad- Muprespa Habana, based in Madrid (Spain), specializes in trauma surgery and meets the needs of its affiliated enterprises under the Spanish Government Pension government - sponsored health benefits. It comprises 50 private rooms, 16 consultation rooms, a surgical section with three digital operating rooms, and radiology including neuroimaging and computed tomography (CT). Its architecture reflects Fraternidad-core Muprespa's values: expert quality, technology, transparency, digitalization and ecological responsibility. This last concept was realized with the LEED Health Certificate, which was awarded at the Platinum level in 2019. It will be the first institution in Europe (and Spain) to get this honor. The goal of obtaining the LEED Certified was to provide a more sustainable environment. Healthy architecture, with a highly efficient in the use of

resources - the land itself, energy, water-, limiting harmful goods and sulphur dioxide, decreasing the environmental effect during production, and, encouraging the use of local services to decrease environmental footprint One of most important statistic is that the Hospital saves 43 percent more energy than a comparable facility.

The goal with these buildings was to provide a healthier environment for its tenants. The first group consists of patients, as well as their families and associates and for the hospital's health experts. Based on the guidance of the USGBC will be quite a task, since the standards for certificate satisfaction were pretty high. The complete team - realty, product development, and real estate business - was able to learn and adopt the best techniques in the development of green solutions throughout procedure. All through the project phases, all vendors given sufficient supplies for the hospital's building and thereby certified it. One of the advantages of the LEED Certification is that it promotes steady learning in the building sector. Hospital Fraternidad- Muprespa Habana may be proud of its activities to realize more effective resource organization and a healthier population for its patients and clinicians.

Figure 20.

Hospital Fraternidad- Muprespa Habana

Source: https://www.usgbc.org/projects/hospital-fraternidad-muprespa-habana

David H.Koch Center New york –Presbyterian

- New york –Presbyterian David H.Koch Ctr
- Gold Certification (60)
- Size (733,922 Sq ft)

New York Presbyterian's Manhattan ambulatory care facility's design decreases stress and improves the patient experience. With its levels of transparent bottom and screen front of bottle wood, the building shows a warm, friendly facing into the area. A daylight central lobby 40 feet high invites clients and her families away from the city's noise and congestion. From there, a stunning stair leads to the second living room-like space with quiet zones, couches, and dining areas. On higher-level levels, the light, airy entrances and circulatory areas tend to stress patient comfort. The cancer care facilities are on the 4th floor, instead of below ground, as is customary in many hospitals, and cancer drug is available at the infusion center just down a hall.

Figure 21.

David H. Koch Canter

Source**:** https://www.hok.com/projects/view/newyork-presbyterian-david-h-koch-center-2/

Patients can enjoy city vistas and the healing effects of natural light. A green roof may hold up to six inches of rain water and aid to cool the structure by covering 30% of the roof's surface. The high tower skin and elevated mechanical systems are intended to reduce energy consumption by 18.7 percent and water consumption by 30%. The eye-catching outside facade, made up of double or even insulated glass and an enclosed wood screen, considerably lowers solar glare, heat gain, and the requirement for solar or modesty screening. The robust design allows the building to

remain operational in the event of an extreme weather event or a power outage in the city.

Figure 22

Interior David H. Koch Canter

Source**:** https://www.hok.com/projects/view/newyork-presbyterian-david-h-koch-center-2/

Designing an ecologically friendly building became part of the task, with the assumption that more advanced equipment will be included into future outpatient care spaces. Because of the building's long-span architectural structure and large floor-to-floor heights, whole levels may be altered with minimal disruption to hospital services. Retractable façade panels allow for the addition of additional medical equipment as needed. It was the initial project for getting LEED Healthcare certification in New York City, and the initial project for receiving LEED Gold under Healthcare grading system in New York State. A green roof, elevated exterior, and an excellent tensile system built for continuing operation during weather events and city power outages are among the buildings sustainable and resilient design characteristics.

KMCWC NICU Building

- LEED BD+C: Healthcare V3-LEED 2009
- Silver Certification (51)
- Area(189,293 sq ft)

Diamond Head Tower, the second stage of Kapi'olani Medical Center for Women & Children (KMCWC) renovation, includes a new Nicu Unit (NICU) and Paediatric Inpatient Unit (PICU). As Hawaii's only maternal, infant, and paediatric specialty hospital, the rehabilitation of the stranded, 4.4-acre site and new building adds 24 beds, totalling to 70 rooms sized for family. The PICU has gotten larger to 26 isolated acuity adjustable rooms. The island's location presented several environmental obstacles for the building, including land use concerns with an urban site (the campus is located at a busy crossroads and near to a major motorway), recycling garbage, and ensures effective energy and water consumption for the facilities.

Figure 23.

KMCWC NICU Building

Source:https://www.usgbc.org/projects/kmcwc-nicu-picu-building

Figure 24.

KMCWCNICU Building, Lobby View

Source: https://www.usgbc.org/projects/kmcwc-nicu-picu-building

Heat recovery cooling systems, electricity neon and LED lights, and smart lighting were among the methods adopted. In utility areas, ultrasound alarm systems are installed. A linked reduced voltage relay switch system involves all municipal lights and external illumination. Interiors cells in the retina regulate interior locations where sunlight is abundant. A 65.5kw solar system saves $18,589 in power per year. Indigenous resources add a sense of connection. The rock, sea, and environment are fundamental to Hawaiian culture, serving as symbols for birth, life, and health. Engineers utilised regional (17.7 percent) recycled (30.5 percent) or fast renewable or FSC-certified resources (92.4 percent) Low VOC furniture were selected. The general folded plate of the structure's facade depicts a shell and the protecting habitat it offers for the form of life inside. The low-e indigo glass lets in 42 percent of illumination while blocking off heat. The introduction of low-flow fixtures decreases water use by 32%, resulting in a saving of 720,000 gallons. The urban heat loss is observed by using illumination roofs and landscaping elements. The scenery brought together all of the site's utilitarian features into a single, seamless setting. Appealing outdoor areas provide ties to nature, which have been shown to enhance health problems.

SIH Cancer Center

- LEED BD+C: Healthcare V3-LEED 2009
- Certified Certification (44)
- Area (43,515 sq ft)

Two radiotherapy vaults, medical oncologist injection spaces, health clinic rooms, office, a small lab, a small gym, conference halls, commercial shops, and a small self-service dining commons are among the features of the new 44,000 sq ft cancer center. The Cancer Center creates a soothing and relaxed environment for patients, employees, and visitors by utilizing organic elements, natural lighting, and vistas of the natural elements. Thanks to the owner's and construction team's commitment to developing and creating a plan that fits sustainability aims. This includes beginning out the building with a series of Certification workshops and design endosperm, continued by a consistent focus on sustainability problems throughout design and planning process.

Figure 25.

SIH Cancer Center

Source:https://www.usgbc.org/search?Search+Library=%22SIH%20Cancer%20Center%22 Water

Conservation The team implemented solutions that using less than 20 percent overall than the building's water usage baseline (not including irrigation). The structure was built to utilize as little drinking water as possible for medical devices cooling. Safe to drink water consumption is only permitted in emergency incremental backups and where municipal regulations necessitate it.

Figure 26.

Interior View

Source: https://www.usgbc.org/search?Search+Library=%22SIH%20Cancer%20Center%20%22

- Developed Energy Efficiency: When comparing the planned sustainable building rate to the base structure rating, the project shows a 10% decrease.

- Control of Refrigerants: In the building's heating, ventilation, heating and cooling, and refrigeration systems, no chlorofluorocarbon-based compressed gases are employed.
- Recyclables Storing and Pickup: All through campus, there are easily available facilities for the collecting and disposal of recycled waste.
- Air Quality Indoors: The pollution levels inside this facility are critical. The building's ventilation satisfies the stringent standards Ventilation of Medical Centres, Section 6 through 8. Smoking is forbidden in the building and on campus, ensuring that people do not come into contact with ambient cigarette smoke when employing, arriving, or exiting the institution.

Evaluation of 4th Category: Schools Buildings

Amman Baccalaureate School(ABS).

- LEED BD+C: Schoolsv3-LEED 2009
- Platinum Certification (80)
- Area(46,867 sq ft)

Figure 27.

Amman Baccalaureate School (ABS)

Source: https://www.usgbc.org/projects/abs-randa-kawar-ib-college-building

- The Project is Non-Residential building its school (Education)
- Floor area: 4564m2
- Stories: Four stories
- Construction type: Concert
- Building construction: 2014
- Air conditioning system and the ventilation is (Mechanical ventilation system without heat recovery) and Primary lighting system (LED) Light emitting diode lamps.
- Energy management services international (HVAC), Shading services.
- (Type of shading system installed), Technical building system Ventilation system (Mechanical ventilation system heat recovery) Primary room cooling system – centralized multi-split system – based on a single outdoor unit supplying several indoor units.

Terakki Tepeoren- Elementary School

- LEED BD+C School v3 - LEED 2009
- Gold Certification (61)
- Area (97,829 sq ft)

Terakki Foundation Schools is based in Tuzla, Turkey and has been offering kindergarten, primary, middle, and high school since 2014 (Terakki, n.d). the elementary school has 25 high school classrooms, 16 middle school classrooms and 16 primary school classrooms. Terakki uses an environmentalist approach to combine technological innovations and modern architecture with modern education (see Figure28).

Figure 28.

Terakki Tepeoren - Elementary School Building

Source: https://www.terakki.org.tr/en/terakki-

The building received the International LEED Gold Certificate for using its environmentally sensitive buildings in creating a healthier and sustainable future (Terakki, n.d). This was accorded based on their buildings' regional priority loans, lands of sustainable, efficiency of water, atmosphere and energy, resources and materials, quality of interior, and innovative designing (Robar, 2018; Terakki, n.d). The buildings were designed in consideration of their surrounding environments and thus, contributing to enhancing sustainability. In addition, there is sufficient daylight in all the classrooms and this makes it more conducive for students to learn as the learning environment is comfortable and pleasant. According to Robar (2018), sufficient daylight entering the classrooms reduces electrical energy used for heating and cooling purposes.

Moreover, there is sufficient classroom ventilation that helps in improving protection from pollen particles and dust, reducing the effects of carbon dioxide and increasing the supply of fresh air through improved air filtration. The campus is designed to harness rainwater so as to improve sustainable water management initiatives and to date, it has collected 2000 tonnes of water in cisterns for reuse (Terakki, n.d). In addition, the campus has photovoltaic panels important for improving the supply of energy to the buildings. Besides, solar energy helps in reducing energy costs and shortage problems leading to improved sustainability outcomes. provide a significant amount of electricity.

HISD Milby (Charles H milby)

- LEED BD+C: Schoolsv3-LEED 2009
- Silver Certified (53)
- Area (267,813 sq ft)

Milby High School, one of Houston's first high schools, was built in 1926. The 1926 facade and superstructure, as well as 40,000 square feet of the previous school floor area, were conserved a historic landmark. This tactic lowered the projects ecological impact by ensuring the survival of the components used, and it also serves to show building practices utilized to keep those people comfy before air conditioners. The limited budget resulted in minimalism, Interiors that are significant and ecological, with visible brick and concrete framework. The structure's visible bones and veins also have an instructional role. On-site tests include sunlight irradiance, solar irradiance transmitted through windows, soil temperature in planted areas, CO2 levels, particulates (PM10 and PM2.5), and methanol. Thermal comfort, interior air purity, acoustic, light and vistas, transit to/from campuses, navigation, education, and other topics were addressed in student surveys as well as design elements Teachers and administrators were questioned in person about comparable themes, as well as student behaviours in comparison to the previous school. The effectiveness of daylight factor and the architectural objective of openness within the school were two of the most important learning lessons.

Figure 29.

HISD Milby (Charles H milby) High School

Source: https://www.usgbc.org/projects/hisd-milby-high-school

The effectiveness of lighting and the architectural objective of openness within in the school were two of the most important lesson learned - well below the acceptable thresholds established by the WELL Building Standard and LEED rating system.

Figure 30.

HISD Milby (Charles H milby) High School Interior Design

Source: https://www.usgbc.org/projects/hisd-milby-high-school?view=overview

LICE Europeo La Moraleja Ed.c.

- LEED BD+C: Schoolsv3-LEED v4
- Certified Certification (47)
- Area (1500 m2)

Liceo europeo continuing to refurbish and develop its interiors and external buildings to better learner - oriented. An impressive achievement has underway, which comprises the development of a green architecture LEED school v4 with children can Imagine, Question, and Find, effective instructional features We grow through being active. The structure is intended to be the first LEED School.

Figure 31.

LICEO EuropeoLaMoralejaEd.c

Source: https://www.isolanaahorroenergetico.es/leed-edificio-c-liceo-europeo-madrid/

Figure 32.

LICEOEuropeoLaMoralejaEd Class Room

Source:https://www.lamiradanorte.com/el-liceo-europeo-prepara-sus-instalaciones-para-el-regreso-de-los-alumnos

Responsible Sites, Reduce Environmental Impact, Heat and Atmospheric, Equipment and Materials, Indoor Environment, and Design development are the important environmental qualities of this building type. The idea of 'sustainable buildings' has already been projected based on the concepts of sensible design, needed lighting system, sound levels, thermal management, air, and other factors that increase learners' quality of life and production Work environments that are open and transparent in which to collaborate, such as classroom, labs, libraries, and technological rooms. The LEED accreditation is a global acknowledgment that emphasizes our duty to the individual and community.

Table 5.

LEED Certified Residential, Commercial, Hospital and School Buildings

Building type	Project name	Certified level	LEED Version System	Country	Building image
Residential	Trellis House Project Area: (323,839 sq ft) Last certified: October 19,2018	Platinum (91.5)	LEED BD+C: Multifamily Midrisev3 - LEED 2008	Columbia,USA	
	Soyak Soho Building Project Area:(177,300 sq st) Last date certified: August 07,2014	Gold (63)	LEED BD+C: New Constructionv3 - LEED 2009	Sisli,Turkey	
	Square Equinox 3 Project Area:(74,840 sq ft) Last date certified: August 16,2021	Silver (52)	LEED BD+C: Multifamily Midrisev4 - LEED v4	Quebec,Canada	

Table 5.*LEED Certified Residential, Commercial, Hospital and School Buildings (continued).*

	Liberty ware house Apartment Project Area:(430,315 sq ft) Last date certified: March 06,2018	Certified (50.5)	LEED BD+C: Multifamily Midrisev3 - LEED 2008	North Carolina,USA	
Commercial	Msheireb Properties Headquarters Project Area:(56,018 sq ft) Last date certified: June 18,2019	Platinum (80)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Doha, Qater	
	Cummins Beijin New Office Project Area:(11,181 sq m) Last date certified: February 25,2018	Gold (65)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Beijing, China	
	JLL Orange Country Project Area:(34,200 sq ft) Last date certified: August 02,2021	Silver (50)	EED ID+C: Commercial Interior ,LEED V4	California USA	

Table 5.*LEED Certified Residential, Commercial, Hospital and School Buildings (continued).*

	Circuito costa Rica CoE Johnson Controls Project Area:(35,411 Sq ft) Last date certified: September 18,2020	Cerified (48)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Santa Ana,Costa Rica	
Hospital	Hospital Fraternidad Muprespa Habana Project Area:(91,138 sq ft) Last date certified: April 04, 2019	Platinum (86)	LEED BD+C: Healthcarev3 - LEED 2009	Madrid,Spain	
	David H. Koch Center NewYork-Presbyterian Project Area:(733,922 Sq ft) Last date certified: December 02,2019	Gold (60)	LEED BD+C: Healthcarev3 - LEED 2009	New York,USA	

Table 5.*LEED Certified Residential, Commercial, Hospital and School Buildings (continued).*

	KMCWC NICU PICU Building Project Area:(189,293 sq ft) Last date certified: November 14, 2017	Silver (51)	LEED BD+C: Healthcarev3 - LEED 2009	Hawaii,United States	
	SIH Cancer Center Project Area:(43,515 sq ft) Last date certified: October 03, 2016	Certified (44)	LEED BD+C: Healthcarev3 - LEED 2009	Illinois,United States	
School	Amman Baccalaureate School (ABS) Project Area:(5880 m2) Last date certified: March 12, 2017	Platinum (80)	LEED BD+C: Schoolsv3 - LEED 2009	Amman,Jordan	
	Terakki Tepeören - Elementary School Project Area:(97,829 sq ft) Last date certified: November 02, 2018	Gold (61)	LEED BD+C: Schoolsv3 - LEED 2009	Istanbul,Turkey	

Table 5. *LEED Certified Residential, Commercial, Hospital and School Buildings (continued).*

	HISD Milby High School Project Area:(267,813 sq ft) Last date certified: January 31, 2018	Silver (53)	LEED BD+C: Schoolsv3 - LEED 2009	Texas,United States	
	Liceo Europeo La Moraleja Ed. C Project Area:(1500 m2) Last date certified: August 31, 2021	Certified (47)	LEED BD+C: Schoolsv4 - LEED v4	Alcobendas,Madrid	

CHAPTER IV

Methodology

Research Design

The study investigates commercial green buildings from Middle East and Asia countries, Turkey, Qatar, Jordan, UAE, Kuwait, Pakistan, Israel, Saudi Arabia and Bahrain. Certification level, LEED version and the country are displayed within the evaluation table. A qualitative evaluation is made for each case of building about the criteria that make it LEED certified.

Research Context

Turkey

According to Climate Change Knowledge Portal (n.d), Turkey is located between the temperate zone and subtropical zone and has what is known as a Mediterranean climate where winters are rainy and mild while summers are hot and dry. However, other climate conditions such as the Marmara Climate which shows the features of a climate transition between the Mediterranean, the Black Sea and Terrestrial climates, and a Terrestrial Climate where temperature differences between day and night, and winter averaging 4°C and summer are huge averaging 27°C (Climate Change Knowledge Portal, n.d). Annual precipitation averages about 400 millimeters (Climate Change Knowledge Portal, n.d). Meanwhile, the World Bank reports that Turkiye had a population of 85.402 million in 2021 (World Bank, n.d).

With regards to architecture, Turkish architecture has been predominantly known as Ottoman architecture which reached its peak during the Ottoman period (All About Turkey, n.d). The Ottoman architecture was influenced by Arab, Byzantine and Seljuk, architecture with the first Ottoman period being from 1300-1453 (All About Turkey, n.d). However, several cities in Turkiye such as Istanbul now enjoy an increase in modern residential and commercial architectural designs. Turkiye's population is relatively high and this has significantly influenced the design and construction of both residential and commercial buildings with a vertical expansion method being widely used countrywide. The attainment of LEED certification comes in the wake of promoting good and acceptable architectural designs that are environmentally friendly and sustainable (All About Turkey, n.d). Hence, the need to promote energy efficiency, sustainable land use and water management practices are highly encouraged in Turkiye.

Qatar

Green buildings in recent years, there has been considerable growth in the green construction industry in Qatar, with the introduction of numerous world-class energy - efficient systems. Qatar offers unique knowledge and insights to provide on the system's local relevance and applicability. The LEED system has been authorized in a number of Middle Eastern nations. One of the key focuses of Qatar's National Strategy is sustainability.Green building' ultimate goal is to lessen the total impact of the building on human health and the natural world. This may be fostered through making better use of water, energy, and other materials, as well as guaranteeing occupant safety.improving employee quality and wellnessSustainable buildings may offer Qataris with a variety of social, economic, and environmental advantages. By employing rainwater collection, sewage water recycling, and renewable energy, green buildings may help with conserving, resource management, and reducing carbon emissions.

The Qatar National Conference Centre, for example, will serve as a model for all future sustainable buildings in Qatar. With a growing population and a deteriorating environment, it is critical that we choose a strategy that is appropriate for the challenges of our time. It is encouraging to see that Qatar has recognized the value of green design and the financial rewards that come with it. Qatar has a Subtropical Dry Arid (Desert) climate. Minimal desert. On average, evaporation surpasses precipitation, although it is less than half of potential evaporation. The typical temperature is higher than 18°C (64°F). Qatar has a desert environment with little yearly rainfall and significant humid in the summer. Furthermore, there may be significant fluctuations in highest and lowest temperatures, particularly in the country's interior. The finest seasons to visit Qatar are in the spring and autumn. During that time of year, the mean temperature is not particularly high, and the afternoons are comfortable.

Jordan

Jordan is a Middle Eastern nation that features the famed Dead Sea. Jordan's climate is characterized by dry and hot summers, with the hottest setting in August hovering around 50 degrees Celsius. Coldest months, with values range from 0.5 to 10 degrees C, while August is the warmest, with values range of 10 to 35 degrees C during the day that the mean temperature might approach 40 degrees Celsius. Jordan is confronted with the issue of limited water resources, which is exacerbated by rising population, growing urbanization, and economic problems. It is observed that their common climatic

circumstances present opportunities for utilizing latent energy efficiency measures; nonetheless, the current building stock is more reliant on means of mechanical (Elgendy 2010). They are arranged in order of importance based on their percentage of LEED-certified projects under discussion, as shown below (Ismaeel, 2019).

Jordan tries to increase awareness about the need of using eco-friendly ancient design approaches. Furthermore, fuel efficiency rules are being developed to compel the use of energy absorption in residential and business structures (Gobbi, Puglisi, and Ciaramella 2016; Elgendy 2010). In addition, the Jordan Environmental Standards and Guidelines, published in 2012, give recommendations for high-efficiency constructions (Zawaydeh 2016). Furthermore, the locally constructed GBRS "building structures is being developed with the local setting and state aims in mind (Attia 2014; Shareef and Altan 2017; Ali and Al Nsairat 2009).The state is placed 74th in the globe, which is really the strongest spot when the main countries are considered This denotes current projects for Jordan is one of the world's GBCs, displaying stability and institutional standing and serving as a "Established" center since 2010. Under LEED NC V2009, the percent of LEED-certified buildings achieved the "Gold" certification.

United Arab Emirates

The climate in the UAE is affected by the Sub - tropical Dry Arid (Desert) climate. Desert of low latitude. On average, evaporate surpasses precipitation but is less than half of prospective loss. The average temperature is over 18°C (64°F). The Persian and Oman gulfs surround it. Despite the fact that the climate in the UAE is warm and dry, the interval during late October to mid-March is marked by fairly comfortable temperatures, around 27 °C.

Pakistan

Pakistan moves on with its green building strategy. Several textile companies, banks, colleges, hospitals, head headquarters, high-rise housing developments, and eco-friendly residences are intending to embrace energy-efficient construction standards in order to maintain a better future.Pakistan has 47 LEED certified buildings totaling 10.81 million square feet of green space. Pakistan's climate is arid and hot along the shore, getting gradually milder as one moves northeastward into the upland areas. The winter months are often chilly and dry. The hot season opens in March and can reach 49° C (120° F) by the end of June. Between June and September, the rainy brings a median of 38 cm

(15 in) of rain in the major rivers and up to 150 cm (60 in) in the northern regions. Rainfall can vary dramatically from year to year, and cycles of drought and floods are prevalent. The climate in majority of Pakistan is tropical or subtropical, semi-arid or desert, although in the north, towards the foot of the mountain, it is extremely wet; also, we discover a chilly location in the highlands and a freezing spot on the Himalayan peaks.

Israel

The climate of Israel is Subtropical Dry Semiarid Steppe. Dry low-latitude climate. On average, evaporation surpasses rain but is less than prospective dryness. The average temperature is over 18°C (64°F). Israel is located on the Mediterranean Sea coast, and the Negev Desert covers approximately 66% of its land area. The fall and spring seasons in Israel are nice.Winter in the northern hemisphere may be chilly and rainy. Summers in the southern region of the nation may be quite hot, with the average temperature reaching 90°F.Rainfall totals in the lowlands varies from 400 to 625 mm, while higher places receive up to 900 mm, with November accounting for almost 70% of the country's rain fall.

Kuwait

Kuwait shares its southwest border with Saudi Arabia and the northwest border with Iraq (Climates Travel, n.d). In other words, it lies between longitudes 46.30 and 49.00 east and latitudes 28.30 and 30.06 north, and. Its northwest border is with Iraq and its southwest border is with Saudi Arabia (Climates Travel, n.d). Kuwait has what is known as a subtropical desert climate, with very hot summers and very mild winters and the shines all year round (Climates Travel, n.d). The average temperature ranges from 14 ℃ in January to 38.5 ℃ in July in the capital, Kuwait City, but summer in Kuwait is windy and scorchingly hot with temperatures averaging around 47 ℃ from June to August (Climates Travel, n.d). According to Climates Travel (n.d), Kuwait experiences annual rainfall (from November to April) that is relatively above 100 millimeters (Climates Travel, n.d).

Saudi Arabia

Saudi Arabia is a country that is located in the Middle East region and shares borders with the Red Sea, north of Yemen and the Persian Gulf .It is also a sandy desert area and hence, it experiences dry and dusty summers especially dry and dusty with annual rainfall averages of between 2 to 4 inches, especially in the city of Riyadh (Country Reports, n.d). Meanwhile, Dhahran and Jeddah experience annual rainfall averages of

between 3 to 4 inches (Country Reports, n.d). Temperature ranges between 19℃ and 29℃ are experienced in winter in the coastal areas of the Red Sea while ranges of between 8℃ and 20℃ are experienced in the inland areas in summer (Climate Knowledge Portal, n.d). Saudi Arabia's 2021 recorded population was estimated to be 35.340 million by the World Bank (World Bank, n.d). Given this presented data, it can therefore be seen that the need for LEED certification is greatly high because of the high hot temperatures that require a lot of energy, especially for heating and cooling purposes. Additionally, water shortages caused by rainfall shortages as the country is surrounded by deserts imply that better water management is required for sustainable water management purposes. These problems can be made worse by its high population, which puts an increase in building units. Hence, LEED certification is highly required in Saudi Arabia and can help to address these problems. Nonetheless, Saudi Arabia is well known for its postmodern architectural style that is defined as humorous, surprised and sensual, and widely used in all parts of the country (Babsail & Al-Qawasmi, 2014).

Bahrain

Bahrain's weather is desert, warm and extremely scorching in the summer. There are two basic seasons: a colder season from December to February and a hot season from April to October, including a very hot period from May to mid-October. March and November are transitional months, with temperatures that are moderate but not excessive. The temperature difference from night and to day is small due to the impact of the sea, and moisture is high, especially when winds blow from the interior of Arabia.

CHAPTER V

Findings and Discussion

Findings: Analysis of the Case Studies in Middle East and Asia Countries

The cases chosen to be evaluated from Middle East and Asia countries are all commercial buildings. The list is below.

- Türk Ytong Yönetim Merkezi, Turkey
- The Bentley Tower Office, Qatar
- ATG Head Quarter, Jordan
- Master Card MEA HQ Offices, United Arab Emirates
- Unilever Country Head Office, Pakistan
- Palo Alto TLV Floors 33-35, Israel
- Alargan International Head Quarters, Kuwait
- ENBD Al Quds Branch, Saudi Arabia
- Citi Bank Head Quarter, Bahrain

Evaluation: Commercial Buildings in Middle East and Asia Countries

Türk Ytong Yönetim Merkezi – Turkey

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold Certification (60)
- Area (3,095sq. m.)

Ytong the Management Centre was planned and built in accordance with LEED guidelines in order to minimize the environmental impact of construction. Building running costs were decreased, facility user satisfaction was raised, and expenditures were cut by conserving energy and water.Some of the LEED-compliant ways that will facilitate and able at the Ytong Control Centre include the following:

Individual automobile usage has been decreased by picking a site adjacent to public transit services, and mass transit carbon pollution have been lowered due to chances to stimulate multiple available alternatives such as bike riding and carpooling. Energy consumption was prioritized in all construction methods that use energy.

Collection and recycling stations were installed throughout the facility, with the goal of saving more than 40% on wastewater use. Goods having a lower influence on the environment were favored from the start of manufacturing by employing material with a

"Environmental Product Declare," or EPD certificate.It was hoped that by emphasizing independent control in space heating systems, energy savings and indoor living quality would improve. Users were given with a pleasant and clean housing conditions through the claims submitted on air, fresh air, and interior outdoor thermal design; low water consumption equipment picks were one of the topics we prioritized. The initiative, which is closely associated with daylight, improves light efficiency. At about the same time, the initiative, which strives to reduce heat losses, carefully executes insulating layers.

Figure 33.

Türk Ytong Yonetim Merkezi Interior Design

Source:https://www.arkiv.com.tr/proje/ytong-turkiye-yonetim-merkezi/9540

Figure 34.

Floors are Evidences Showing for Sanitary Purposes

Source:https://www.gzt.com/arkitekt/leed-gold-sertifikali-yonetim-merkezi-ytong-binasi-3599754

Bentley Tower Office - Qatar

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold (61)
- Area (27,485 sq. ft.)

The Bentley Luxury Tower and Rooms is a service apartment building located in the West Bay, near the famous Heart Of Downtown. We are a refuge for corporate and residential tourists visiting Qatar, just a short drive from major offices, government buildings, corporations, and the Central City Mall.The principal contractor intended to adopt sustainability by obtaining LEED and GSAS certificates.

Figure 35.

Bentley Luxury Tower (Interior&Exterior)View

Source:https://the-bentley-luxury-hotel-suites.business.site/

ATG (Arab Technical Group)Head Quarter _ Jordan

- LEED ID+C: Commercial Interiors (v2009)
- Platinum Certification (74)
- Area (12,636 sq. m.)

ATG building trade firm that specializes in exporting and marketing cutting-edge technology for HVAC, renewable energy, refrigeration, and air purification systems. In its centrally positioned showrooms in the center of Amman, ATG provides a comprehensive choice of civilization brands. The company also runs fully autonomous warehouses around the country, with modern systems configured to manage, and manipulate all stored components and equipment. Run by a team of skilled engineers with vast expertise. (ATG) Headquarters was the first Jordanian corporation to be given the LEED Gold Certificates For Interior Industrial Categories. ATG is an engineering trade firm that provides high-quality goods and creative solutions for the heating, cooling, and clean energy industries.

1-Ventilation type is Heat recovery ventilation system system

2-Primary heating system for the space is Rooftop solar thermal collector

3-Three-lighting system is System of primary light.

Figure 36.

ATG (Arab Technical Group)Head Quarter

Source:https://www.buildings-mena.com/project/amman-arab-technical-group-atg-headquarter-building

Master Card MEA HQ Offices _UAE

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold Certification (67)
- Area (60,935 sq. ft.)

Figure 37.

Master Card MEA HQ Offices

Source:https://propsearch.ae/dubai/mastercard-hq-building

Development of an urban low-rise structure of (3) floors,plates is planned to boost the set's performance and improving mobility inside the extremely busy and sought-after Dubai City and Dubai Media City. Through the plan, perspectives and visible channels are also enlarged. The business represents the business structurewith glass veneers, and the lower retail shops contribute to the improvement's vitality. There are additionally three stories of parking to serve the tower's occupants and guests. Quasiparticle construction is presently progress. The project is scheduled to be finished in December 2018.

Unilever Countery Head office Karachi- Pakistan

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold Certification (64)
- Area (26,964 sq. ft.)

The Unilever headquarters were designed with their goods in mind. Normally, one could only acquire their wares through retail locations.

Figure 38.

Unilever Countery Head office Karachi (Interior view)

Source:https://asa.com.pk/projects/unilever-head-office/

Palo Alto TLV- Israel

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold Certification (69)
- Area (3,671 sq. m.)

Figure 39.

Palo Alto TLVOffice and Rest Area (Interior View)

Source:https://www.usgbc.org/projects/palo-alto-tlv-floors-33-35

The design team incorporated distinguishing components from the outside world, sorted them into a design, and assigned them various functions. Exposed brick blocks, for example, found a new use as an inside wall in a meeting room. The design idea came from the goal of bringing the bright diverse low-tech outdoors atmosphere onto the 24th level, which houses Palo Alto, one of the world's most inventive corporations.

Figure 40.

Palo Alto TLV (Interior View)

Source:https://archello.com/story/61609/attachments/photos-videos/1

Alargan International Head Quarter- Kuwait

- LEED ID+C: Commercial Interiors (v2.0)
- Platinum Certification (86)
- Area (15,345sq. ft.)

They are one of Kuwait's largest real estate development enterprises, owning residential and commercial properties across Kuwait, Omman, and Bahrain. They

developed the notion of sustainability and environmental construction at its own office in Kuwait, followed by the first LEED Platinum certification.

They handled the challenge of building for Kuwait's hot and dry environment with simple, practical solutions: high performance windows and strategic soundproofing, occupation and daylight monitoring technologies, and rooftop solar panels. They used the Arc aim of being able to track their headquarters' sustainability performance measures over a 12-month period in order to achieve LEED O&m certification. Monitoring their energy, transit, waste, water, and subjective condition between 2018 and 2019, ALARGAN uncovered various methods to enhance their performance, finally attaining a 90 percent favorable rating.from the workers They recently approved their offices as LEED v4.1 Platinum in 2019 and have assured that their workplace occupiers have a better quality of living every day.

Figure 41.

Alargan International Head Quarter

Source:https://www.alargan.com/firm/sustainability

ENBD Al Quds Branch in Saudi Arabia

- LEED ID+C: Commercial Interiorsv4 - LEED v4
- Gold Certification (71)
- Area (837 sq. m.)

LEED ID+C:CI certified buildings offer lower pollutants, a healthier environment, and lower production costs while supporting green technologies. Emirates NBD is Saudi Arabia's first bank to get the LEED Gold V4 ID+C:CI Certification, indicating that it has cut carbon emissions, improved the environmental, and decreased production while supporting green technologies.

Figure 42.

ENBD in Suadi Arabia

https://www.emiratesnbd.com/en/media-centre/media-centre-info/?mcid_en=988

Citibank Head Quarter- Bahrain

- LEED ID+C: Commercial Interiorsv4 - LEED v4

Citi Bahrain has been working in the finance system of Bahrain and the Middle East for over 45 years. Citi Bahrain is a market leader in Investment and Professional Banking Banking, as well as Consumers and Islamic Banking. Global companies with operations in Bahrain, Bahraini enterprises and investment firms, public sector businesses, and citizens are among our clientele. Financing, financial industry, advising, insurance, acquisitions, trading, and treasury services are some of the services and items we offer to asset managers. Citi's financial services division, founded in 1989, is a market leader with in local credit card industry and a telecom carrier of lenders and corporate finance solutions. Citi was the first multinational firm to establish an independently constituted Islamic bank, Citi Islamic Financial Institution ("Citi Islamic"), in Bahrain in 1996. Citi Islamic's main business is to provide modern Islamic financial and investment services to its clients worldwide.

Figure 43.

Citibank Headquarters

Source:https://www.pointbh.com/places/citibank-seef/

Table 6.

LEED certified Commercial Buildings in Middle East and Asia

Building type	Project name	Certified level	LEED Version System	Country	Building Image
Commercial	Turk Ytong Yonetim Merkrzi Project Area (3,095 sq .m) Last certified on: July 18, 2019	Gold (60)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Istanbul,Turkey	
	The Bentley Tower Office Project Area (27,485 sq ft) Last certified on: April 16, 2021	Gold (61)	LEEDID+C: Commercial Interiorsv4 - LEED v4	Doha, Qatar	

Table 6. LEED certified Commercial Buildings in Middle East and Asia (continued)

	ATG Head Quarter Project Area (12,636 sq m) Last certified on: November 05, 2019	Platinum (74)	LEED ID+C: Commercial Interiors (v2009)	Amman,Jordan	
	MasterCard MEA HQ Offices Project Area (60,935 sq ft) Last certified on: December 28, 2020	Gold (67)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Dubai,United Arab Emirates	

Table 6. LEED certified Commercial Buildings in Middle East and Asia (continued)

Unilever Country Head Office Project Area (26,964 sq ft) Last certified on: January 14, 2020	Gold (64)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Karachi, Pakistan	
Palo Alto TLV Floors 33-35 Project Area (3,671 sq m) Last certified on: April 27, 2022	Gold (69)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Tel Aviv, Israel	
Alargan International Head Quarters Project Area (15,345 sq ft) Last certified on: June 24, 2019	Platinum (86)	LEED ID+C: Commercial Interiors (v2.0)	Shuwaikh, Kuwait	

Table 6. LEED certified Commercial Buildings in Middle East and Asia (continued)

ENBD Al Quds Branch Project Area (837,sq m) Last certified on: November 24, 2021	Gold (71)	LEED ID+C: Commercial Interiorsv4 - LEED v4	Riyadh, Saudi Arabia	
Citibank Head Quarter	Under Certification	LEED ID+C: Commercial Interiorsv4 - LEED v4	Manamah, Bahrain	

Discussion

Since it was first introduced in 2000, the US Green Building Council's Leadership in Energy and Environmental Design (LEED) green building certification label has grown in popularity. Aiming to reduce negative environmental effects of buildings and ensuring energy efficiency, LEED has played an important role in spreading the green building certificate system approach worldwide.

Based on the number of credits achieved, a project earns one of four LEED rating levels: Certified (40-49 points), Silver (50-59 points), Gold (60-79 points), and Platinum (80+). The basic credit categories of LEED certification include the following: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, Location and Transportation and Regional Priority.

In the methodology chapter of the study, nine cases from nine different Middle East or Asia countries have been analysed. Two of them have Platinium, six of these samples have Gold and one another has Certified level certification. All cases are commercial buildings.

Based on the analysis, it can be concluded that all these buildings are sustainable, high performance buildings. They are designed to creating structures and using processes that are environmentally responsible, innovative and resource-efficient throughout a building's life-cycle in terms of the aspects including location, construction, material, operation, maintenance etc.

CHAPTER VI
Conclusion and Recommendations

Conclusion

Global warming and climate change is a threat for our world. Therefore the significance of making buildings more ecological is rising worldwide. It is needed to decrease the human impact on environment. Green building characteristics involve the abilities to manage the impact of building to the surrounding. In recent decades, different green building rating systems have emerged in different countries of the world. Application of green building construction systems gives clear and detailed guidelines to effectively achieve saving water as well as other sources, improving interiors' air quality and expanding the use of renewable or recycled resources etc. There is a crucial need for the applications of green building also in Middle East and Asia. In this study, LEED certificate as one of the green building rating systems is evaluated with a particular focus in Middle East and Asia region.

Within this framework, this study evaluates one of these green building rating systems, Leadership in Energy and Environmental Design (LEED) developed in USA. First chapter explains the research background and in addition the research problem, aim and objectives. In second chapter green building has been evaluated in general including the definition and its history. In chapter three, LEED certification has been discussed in particular including the international examples of LEED certified buildings. In methodology chapter, samples of LEED certified buildings from Middle East and Asia regions have been analyzed.

LEED focuses on Building Design & Construction, Interior Design & Construction, Building Operation and Maintenance, Neighborhood Development, LEED for Home, Cities and Communities and LEED Zero. As LEED rating credit categories Regional Priority (RP), Innovation & Design (ID), Indoor Environment Quality (IEA), Material and Resources (MR), Energy and Atmosphere (EA), Water Efficiency (WE), Sustainable sites (SS) and Location and Transportation (LT) are the main categories of the LEED certificate.

It was practically observed that all buildings that are LEED-certified have sustainable sites. LEED certification results in the widespread development of sites containing sustainable features aimed at protecting and restoring habitats. As such,

sustainable features like open spaces, rainwater management systems, heat island reduction methods, and light pollution reduction features are increasingly being found to be common features among several LEED-certified buildings. Therefore, this shows that LEED certification contributes to the development of sustainable sites.

On another level, LEED certification has importantly improved water and energy efficiency in buildings. This is vital, especially at a time when rising energy and water costs, and shortage problems are significantly rising. Thus, LEED certification has contributed to the reduction of energy costs, and water and energy costs problems. This is caused by the increased use of better indoor and outdoor water and energy reduction methods and tools, water and building energy metering devices, renewable energy sources, green power and carbon offsets.

Additionally, in analysed cases of Middle East and Asia countries, the buildings managed to decrease water and energy use, as well as reducing greenhouse gases to promote a cleaner environment and enhance people's health with the help of creative solutions for the heating, cooling, and clean energy.

LEED certification requires significant investment of funds for design and modeling, installation of important technology and features, especially for improving water and energy efficiency, as well as supporting sustainability programs. This involves an additional budget that building developers may not be willing and able to pay. As a result, it negatively affects the efforts to attain a LEED certification.

Recommendations

Based on the established findings, the following recommendations are made.

- Since LEED certification is associated with the development of high quality, innovative, water and energy-efficient, environmentally sustainable buildings capable of improving indoor quality and the occupants' quality of life, governments through building standards and organisations need to make it mandatory for strategic buildings to be LEED certified.
- Given that costs are preventing building developers from pursuing designs leading to the attainment of a LEED certification, financial incentives are required to motivate developers to develop sustainable building designs.

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