APPLICABILITY AND IMPLEMENTATION OF U.S. GREEN BUILDING COUNCIL RATING SYSTEM (LEED) IN EGYPT
CASE STUDIES: LEED CERTIFIED & REGISTERED BUILDINGS IN EGYPT

By

SOHA MOHAMED EL YAMANY MOHAMED EL YAMANY

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
ARCHITECTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT

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First, I thank Allah the most gracious and the most merciful for guiding me and blessing me with patience and knowledge to finish this work.

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Last but not least I would like to thank my parents, my whole family and friends who have supported me during this work.

DEDICATION

I Dedicate My thesis Work to:

My Father: Mohamed El-Yamani Mohamed
Who have always supported me and encouraged me to be a better person

My Mother: Fawzia Mohamed Tawfik
Who have always been there for me and loved me unconditionally

My Sisters: Noha and Maha
Who have always helped me to go through hard times

My Whole Family and Friends
Who believed in me

May Allah Bless Them All

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LIST OF ABBREVIATION

ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.
BOD	Basis of Design
CFC	Chlorofluorocarbon
CIR	USGBC Credit Interpretation Request
FE	Fuel Efficient
FTE	Full Time Equivalent
GBCI	Green Building Certification Institute
HCFC	Hydroflourocarbon
IAQ	Indoor Air Quality
IDP	Integrated Design Process
LE	Low Emitting
LEED®	Leadership in Energy and Environmental Design®
LEED AP®	LEED® Accredited Professional
MPR	Minimum Program Requirements
OPR	Owner Project Requirements
SRI	Solar Reflectance Index
TBL	Triple bottom line
USGBC	United States Green Building Council
VOC	Volatile Organic Compounds

ABSTRACT

Building design, construction and operation have substantial impacts on the environment, economy and society which represent the three pillars of the triple bottom line that forms sustainability. A lot of resources are used during the life cycle of any building such as land, energy, water and raw materials. Buildings generate a lot of wastes that goes to landfill and a lot of harmful emissions that affects occupants, land, water and atmosphere. Property owners, designers, and contractors always have to overcome a lot of challenges in order to fulfill building occupants' needs and owner requirements while keeping their negative impacts on the environment, economy and society to the minimum.

Green Building practices can substantially reduce or eliminate negative environmental impacts through high-performance, market-leading design, construction, and operations practices[1], thus with the rising trends and needs to be sustainable, and the remarkable growth of sustainability in the construction market, a lot of sustainable building rating systems have emerged, including the LEED (Leadership in Energy & Environmental Design) rating system.

The LEED Green Building Rating Systems are voluntary, consensus-based, and market driven. It is designed for rating new and existing commercial, institutional, and residential buildings. [2]

The purpose of this research is to contribute to a better understanding of the concept and implementation of LEED green building rating system and its role for achieving sustainability in building construction in Egypt.

Since most of the practical studies made on LEED are performed on other markets than the Egyptian due to the fact that LEED Certification is fairly new in Egypt Therefore, In this research the key principles of managing a LEED project will be discussed, by going through the steps of the whole process of acquiring the LEED Certificate for projects starting with design, passing with construction and documentation, and ending with building maintenance and post occupancy.

Then the research will discuss the implementation of LEED credits in Egypt, by going through three LEED Registered and Certified projects in Egypt which represent the ideal case studies for this research, at the end of this study the researcher will come up with a conclusion and state the appropriate recommendations that may help, from the researcher point of view, in upgrading the Egyptian construction market, and making it more sustainable.

[1] **USGBC**. USGBC official web site. 2012. ON.06 December 2012 <https://new.usgbc.org/>.
[2] **USGBC**. Rating Systems : LEED. ON.1 December 2012 <https://new.usgbc.org/leed>.

Research Problem

According to the USGBC LEED projects directory there is only two LEED Certified projects and 14 registered projects in Egypt[1] , these numbers can show us the limited number of LEED projects in Egypt.

Being involved with the project in the Design Development and Construction stages plays a critical role in understanding how and why certain LEED points are being attempted, and allows for a new perspective to be given to the design team from the construction team point of view ,the construction team can provide feedback to the architect and engineers as to how certain elements of the design can work within the project budget or if there are other means and methods to accomplish the design intent at reduced cost or with greater efficiency .

Today, many researches and studies revolve around building assessment tools and LEED, but most of these studies discuss the implementation of LEED Internationally or in Middle East in general, Hence LEED rating system is considered as a new research material to be discussed from a local point of view.

Therefore the research main problem is to create a strategy that overcome the difficulty of Implementation of the LEED rating system in Egyptian projects due to lack of sustainable culture among the owners of the projects , the lack of the practical experience regarding the LEED rating system , and the mismanagement of projects during design and construction stage .

Finally it is about presenting a method to integrate between the design stage credits and the construction stage credits of LEED rating System in order to reach to a sustainable successful project with minimal cost impact.

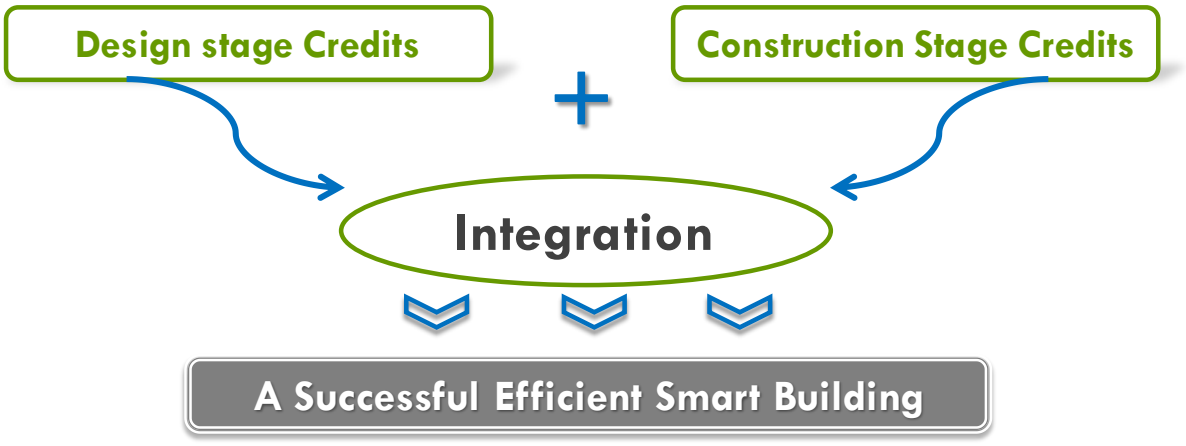


Figure 1: Research Problem
Source: Researcher

[1] USGBC. LEED Projects & Case Studies Directory. ON.10 March 2013 <http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx>.

Research Objectives

Main Goal:

The main purpose of this study is to investigate the use of LEED rating system as an environmental rating tool to obtain a building that performs environmentally efficiently on Egyptian grounds; this is achieved through:

Sub Goals:

- Shedding light on the importance of the assessment tools especially the LEED rating system.
- Stating and explaining the LEED rating system with its main components and common related idioms.
- Connecting between academic research and practical implementation of LEED rating system in Egypt through analyzing practical case studies **(Fig 2).**
- Discussing the best managerial approach to implement LEED practices.
- Defining the role of all the project parties contributing in the implementation of LEED credits.
- Guiding both the design team and the construction team through the entire project to achieve the targeted LEED credits.
- Explaining the LEED credits implementation through all the project stages.
- Discussing how to integrate between construction stage and design stage to reach to the anticipated results.
- Highlighting the most appropriate credits that can be implemented in Egyptian projects.
- Highlighting the challenges facing Egyptian projects to achieve LEED and accordingly achieving sustainability in general.

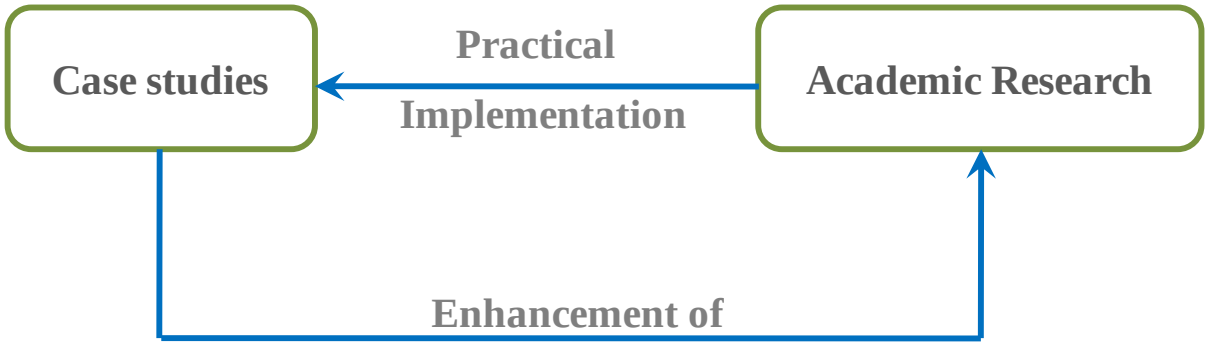


Figure 2: Research Objective
Source: Researcher

Research Questions

The research intends to answer many questions regarding the implementation of LEED rating system in Egypt, These questions can be divided into:

Main Question:

- How to implement the LEED rating System on Egyptian Project?

Sub Questions:

- What is the role of a LEED coordinator?
- What are the responsibilities of the design team, the contractor and the suppliers in the LEED process?
- What are the Main problems facing Projects in Egypt Regarding the achievement of some LEED credits?
- What are the most achievable credits of LEED in Egyptian projects?
- How to balance between the design stage credits and the construction stage credits to reach to the optimum application of LEED credits?
- What are credits that have the most significant effect on project cost?
- What is the effect of using a multinational rating system as LEED on the Egyptian local construction market?
- What are the challenges facing the development of the Egyptian local construction market towards sustainability?

Research Methodology

In order to fulfill the research objectives, the researcher will follow three different approaches alternately.

First, a theoretical approach will be used in the first chapter to discuss the literature back ground of building construction, green buildings and their relevance to the environment, economics and society, then in chapter two the same theoretical approach will be used to go through the LEED rating system history and its types, components, involved parties, LEED local and international market.

Second, a comparative analysis approach will be used in chapter three to compare between the traditional design approach and the integrated design approach, the same comparative approach is used again in chapter four to compare between three case studies and their application of LEED rating system.

Third, a deductive approach is used in chapter three to understand the best way to deal with the LEED rating, and the best approach to implement and manage a LEED project. The same approach is used again in chapter four to conclude the most applicable credits of LEED rating system in Egypt after analyzing three Egyptian case studies. Finally in chapter five the researcher discuss the challenges facing the promotion of the Egyptian construction market towards sustainability and deduce the steps needed to promote the Egyptian construction market.

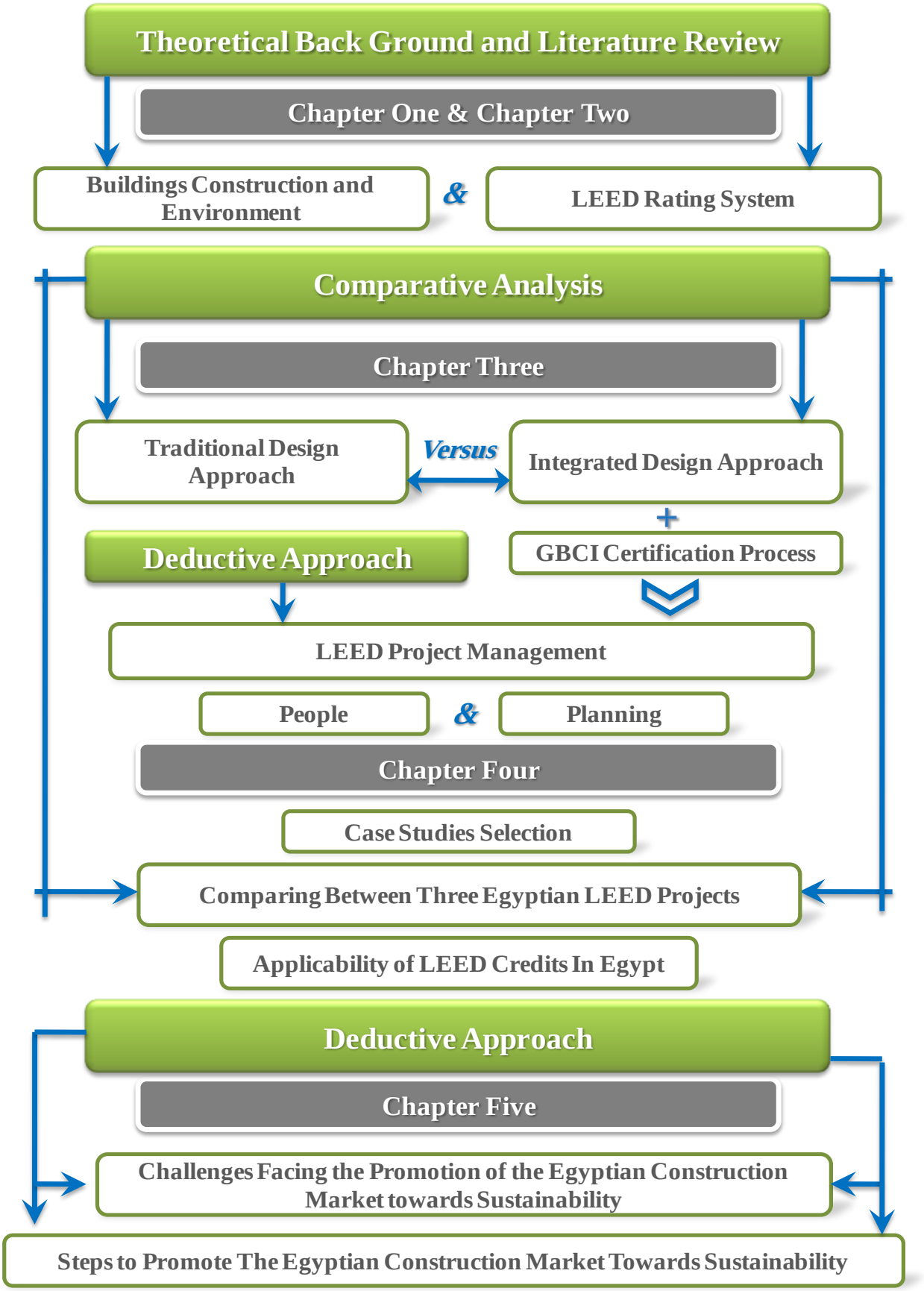
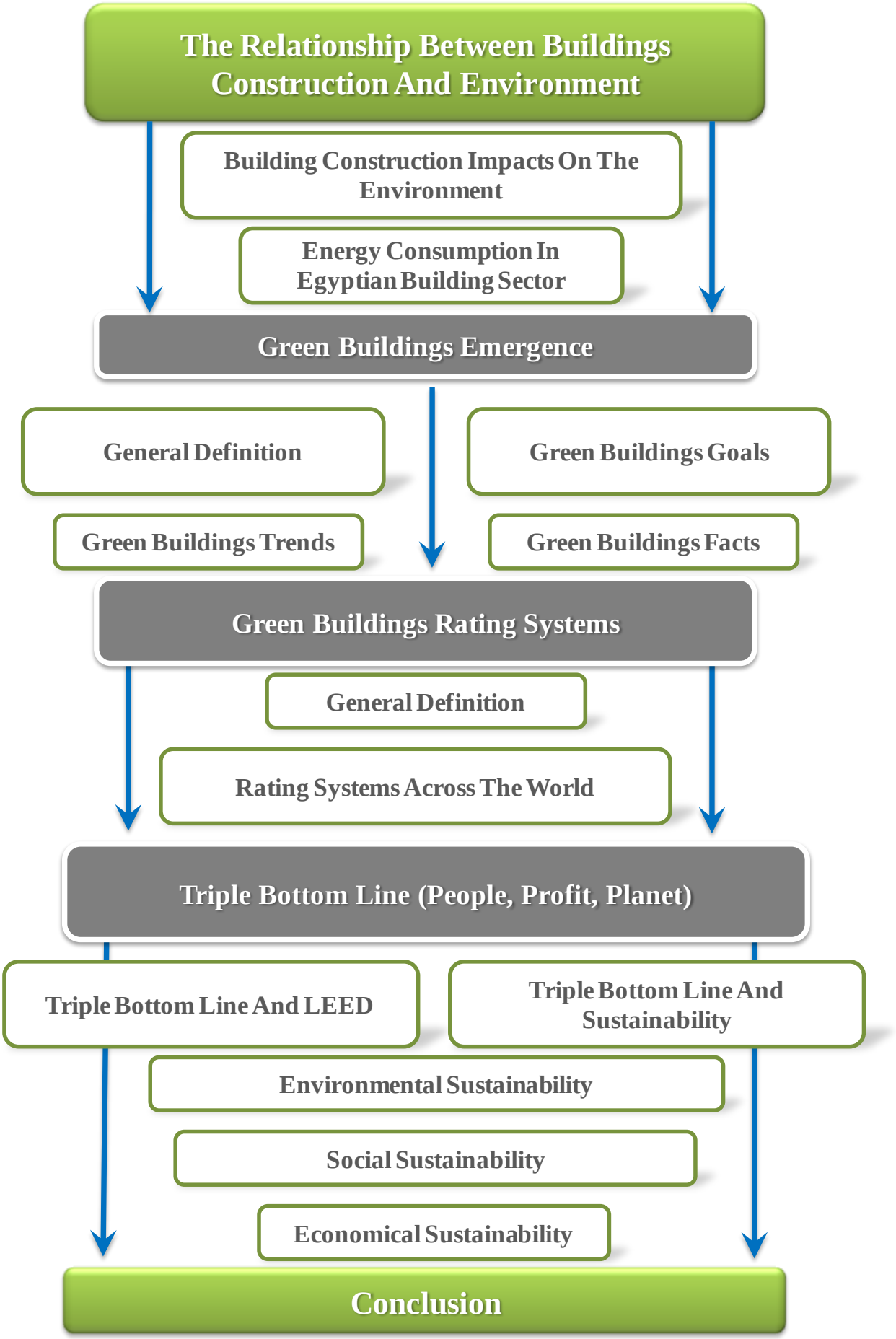


Figure 3: Research Methodology
Source: Researcher

Chapter One

Introduction To The Relationship Between Buildings and Environment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Building Construction Impacts On The Environment
Energy Consumption In Egyptian Building Sector
Green Buildings Emergence
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Green Buildings Goals
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Social Sustainability
Economical Sustainability
Conclusion

CHAPTER 1: INTRODUCTION TO THE RELATIONSHIP BETWEEN BUILDINGS AND ENVIRONMENT

Around half of all non-renewable resources consumed by mankind are used in construction, making it one of the least sustainable industries in the world[1]. Mankind has always searched for perfection and comfort through manipulating the surrounding environment to better suits its needs. Therefore today most of our daily life activities are carried out in and on constructions in one way or another: we live in houses, we travel on roads, and we work and socialize in buildings of all kinds. The current human civilization depends on buildings of all kinds, and yet our planet can't keep up with the current level of resource consumption nor the pollution associated with the construction industry.

1.1. Building Impacts on the Environment

Buildings have a major impact on the environment over their entire life cycle. Responsible for 40% of worldwide energy flow and material use, conventional buildings have been identified as the largest source of green-house gas emissions, even more than that of the transport and industry sector. They affect urban air quality and contribute to climate change. They are also hazardous to health at times[2]. During their life cycle, conventional buildings harm the environment in many ways such as:

- Resources such as ground cover, forests, water, materials and energy are depleted during the life cycle of a building.
- Indiscriminate use of building materials without giving a thought to the environment which increase the demand of the raw materials instead of the recycled materials.
- Most of the building materials are sourced from great distances adding to their embodied energy.
- Building design and landscaping are designed in a way that consumes a lot of potable water instead of using efficient water fixtures or recycled grey water or rainwater for example.
- Buildings have energy-consuming systems for lighting, space conditioning, water heating and hi-tech controls to add to the comfort and convenience of the occupants, all these system consume more energy, which increase the Co2 footprint of the building.
- Conventional buildings designers are not normally concerned to provide the building with waste management and recycling systems.

[1]willmottdixongroup. "willmottdixongroup : Sustainability: Responsible business: Technical Library." 21 september 2010. Briefing Note 33 - The Impacts of Construction and the Built Environment. ON.20 October 2012 <http://www.willmottdixongroup.co.uk/assets/b/r/briefing-note-33-impacts-of-construction-2.pdf>.

[2] CopperWiki. CopperWiki : Green Building. 5 February 2010. 20 October 2012 <http://www.copperwiki.org/index.php?title=Green_building>.

- Most of these buildings are not designed to provide a healthy environmental indoor quality as they lack indoor air quality and day light access.

Table 1-1: Impacts of the Built Environment
Source: United States Environmental protection Agency[1]

Aspects of Built Environment	Consumption	Environmental Effects	Ultimate Effects
• Siting • Design • Construction • Operation • Maintenance • Renovation • Deconstruction	• Energy • Water • Materials • Natural resources	• Waste • Air pollution • GHG emissions • Water pollution • Indoor pollution • Heat islands • Storm water runoff • Noise	• Harm to human health • Environmental degradation • Loss of resources

1.1.1. Building Construction Input: Natural Resources

The construction industry is an aggressive user of natural resources, including materials, water, energy and fertile land, which are the basis for our life on Earth. However, humanity's rapidly growing consumption of these resources is causing severe damage. Our climate is changing; fresh water reserves, fish stocks and forests are shrinking; fertile land is being destroyed and species are becoming extinct. In order to continue to thrive on this planet, our lifestyles will need to become more sustainable, so that we are able to protect our natural resource base and the fragile eco-systems on our planet.[2]

Table 1-2: Estimate of global resources used in buildings
Source: P., Lovins, E and Lovins, H, et al., Natural, Capitalism: Creating the next Industrial Revolution, Little Brown and Co., 1999, pp 369

Resources	Percentage
Energy	45 %–50 %
Water	50 %
Materials for buildings and roads (by bulk)	60 %
Agricultural land loss to buildings	80 %
Timber products for construction	60 % (90 % of hardwoods)

[1] United States Environmental protection Agency ,"Green Buildings : Basic Information", EPA Home : Green Buildings : Basic Information , United States Environmental Protection Agency official Site , ON 23 OCT 2012 , < http://www.epa.gov/greenbuilding/pubs/about.htm>

[2] Sustainable Europe Research Institute (SERI), Austria and GLOBAL 2000 and others "Over Consumption- our use of the world's natural resources", Friends of the Earth Europe : Publications , On 1.Nov.2012 , <http://www.foe.co.uk/resource/reports/overconsumption.pdf>

Coral reef destruction	50 % (indirect)
Rainforest destruction	25 % (indirect)

1.1.2. Buildings Construction Output: Pollution

Building Construction causes pollution. The construction business in many countries is responsible for nearly a third of all industry-related pollution incidents. There is no construction which does not have an environmental impact. The main aspect of construction is making buildings of varied uses be it for residential, commercial, industrial, recreation, healthcare or any other purposes.[1]

Pollution can be defined in many ways: Pollution arising from the built environment (sewage, waste etc.); pollution caused during the manufacture of materials and products; pollution and hazards from the handling and use of materials or from the site itself; and other construction and operationally related activities. The design and construction phases involve the specification of materials, and the use of plant, processes and techniques. Most also involve extensive disturbances to the existing environment, whether on green field or previously developed sites.[2]

Table 1-3: Estimate of global pollution that can be attributed to buildings
Source: Mark T. Brown, and Eliana Bardi 2001

Pollution	Percentage
Air quality (cities)	23 %
Climate change gases	50 %
Drinking water pollution	40 %
Landfill waste	50 %
Ozone depletion	50 %

1.1.3. Buildings Impacts in Egypt

According to the Annual Report of the Egyptian Electricity Holding Company Residential and Commercial sectors consume more than 50% annually of the total electricity used in Egypt.[3]

[1] Rehan Ahmed , "Construction & Environment " ,Kingdom of Bahrain Ministry of Municipalities Affairs and Urban Planning : Documents : Municipal Conference2012, ON.31. OCT 2012 , <http://websrv.municipality.gov.bh/mun/docs/MunicipalConference2012/Day1_25thapril/papers/15.%20Rehan%20Ahmed.pdf>

[2] Op cit., Briefing Note 33 - The Impacts of Construction and the Built Environment.

[3] "Egyptian Electricity Holding company annual report 2010/2011", Egyptian Ministry of Electricity and Energy, ON 20.Oct.2012 <http://www.moee.gov.eg/english/Takareer/2010-2011.pdf>

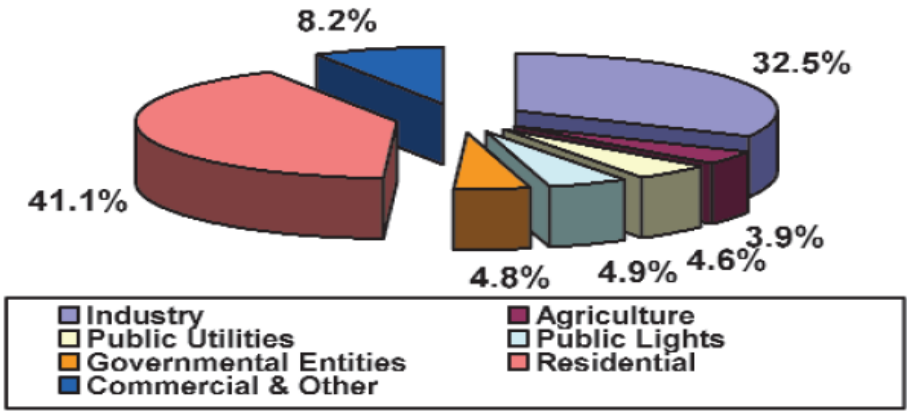

Figure 1-1: Energy sold by Purpose of usage in 2010/2011
Source: Egyptian Electricity Holding company annual report 2010/2011

1.2. Green Buildings

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the design team, the architects, the engineers, the suppliers, the contractors, and the client at all project stages.[1]

1.2.1. Green Buildings Evolution

Green building design principles have been around for thousands of years. Examples in history and vernacular architecture all over the world show that buildings were designed and built in accordance to the surrounding natural climatic conditions.

Actually, sustainable buildings were passively designed and oriented to maximize the benefits of sunlight and wind, with an envelope that is adaptable to the local climate and with building systems and components that are energy, water, and resource efficient. However, with the emergence of heating and air conditioning systems in the twentieth century, there was a tremendous shift in the way buildings were designed. Designer didn't take the external climate conditions into their considerations anymore, as they become dependent on HVAC systems to do this job.

Modern buildings became isolated from the external environment and started consuming energy created by burning fossil fuels, like coal and oil. Buildings became one of the major sources of consumption of energy in the world. During the 1970s, because of the energy crisis, there was a push to build energy efficient buildings. Incentives were provided to use solar technologies, and there was a growing concern about environmental issues arising from depletion of resources. But the movement was considered more of a trend and it soon died out in the 1980s with the growth in the economy and the falling oil prices. Despite these early efforts, green never really became a part of modern architectural vocabulary. With no serious

[1] Yan Ji and Stellios Plainiotis (2006): Design for Sustainability, Beijing: China Architecture and building Press.

efforts made toward energy efficiency, the last thirty years have seen a tremendous increase in consumption of energy and resources by the building sector.[1]

Today, the building community has realized the impact of buildings on the environment and the great role it plays in energy consumption, climate change and global warming; great efforts are made since then in order to minimize the buildings impacts on the environment. One of the most significant factors that have transformed the building industry is the emergence of several green building rating systems such as LEED which will be discussed later on.

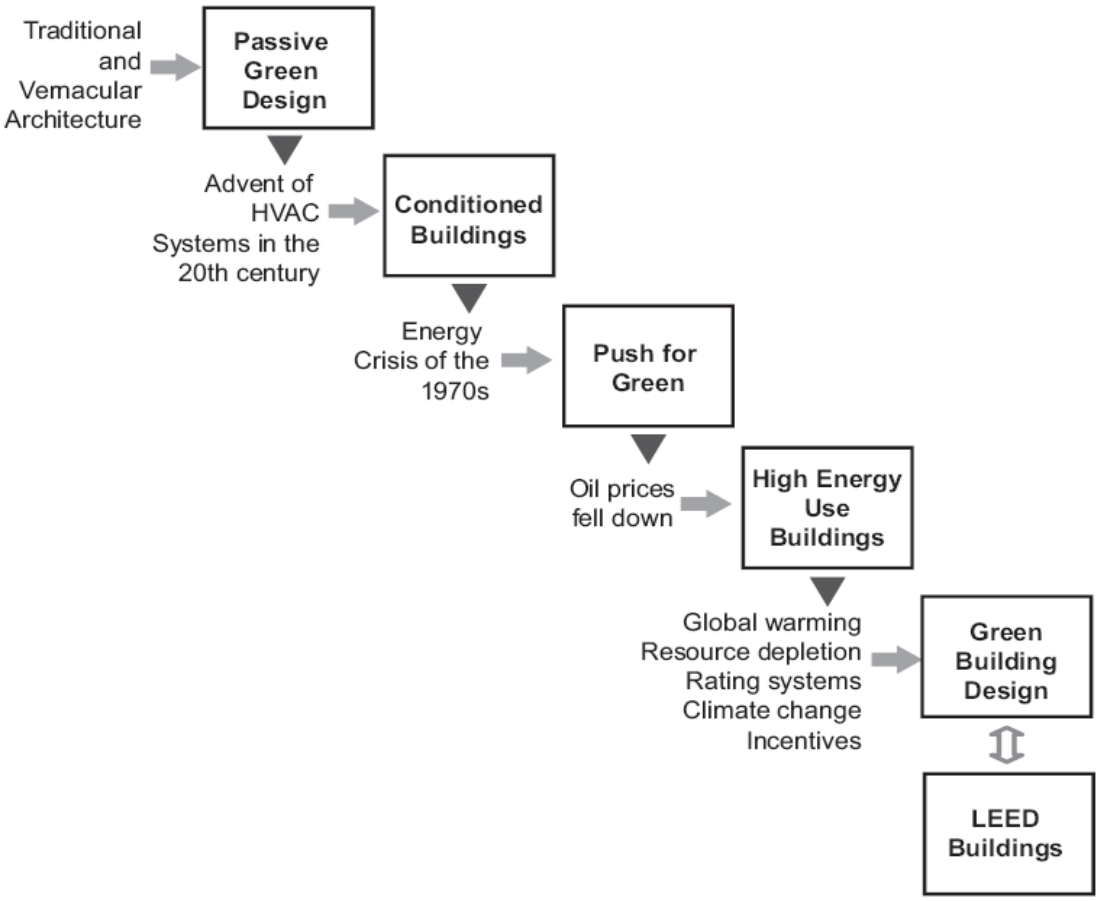

Figure 1-2 : Evolution of Green Buildings
Source: Yellamraju ,2010

1.2.2. Green Buildings Goals

The main objectives of sustainable design are to avoid unnecessary resource depletion of energy, water, and raw materials; prevent environmental degradation caused by buildings and infrastructure throughout their life cycle; and create built environments that are livable,

[1] Yellamraju, V. LEED-New Construction Project Management . McGraw-Hill Professional, September 21, 2010.

comfortable, healthy, safe, and productive,[1] while the definition of sustainable building design is constantly changing, **seven** fundamental principles persist:

1.2.2.1. Optimize Site

Sustainable buildings start with proper site selection, including consideration of the reuse of existing buildings. The location, orientation, and landscaping of a building affect the local ecosystems, transportation methods, and energy use characteristics of the building. Smart growth principles should be incorporated in the project development process, whatever the scale of development. Whether designing a new building or retrofitting an existing building, site design must integrate with sustainable design to achieve a successful project.[2]

1.2.2.2. Optimize Energy Use

Green buildings often include measures to reduce energy consumption – both the embodied energy required to extract, process, transport and install building materials and operating energy to provide services such as heating and power for equipment. It is essential to reduce demand, increase efficiency, and utilize renewable energy. The use of passive measures such as orientation, air tightness, solar shading, thermal mass, and natural ventilation, must be considered from the outset; we must work with the natural environment, rather than against it, to reduce operating energy use, designers also use details that reduce air leakage through the building envelope (the barrier between conditioned and unconditioned space). They also specify high-performance windows and extra insulation in walls, ceilings, and floors.[3]

1.2.2.3. Protect and Conserve Water

Reducing water consumption and protecting water quality are key objectives in sustainable building. One critical issue of water consumption is that in many areas, the demands on the supplying aquifer exceed its ability to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site. The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing. Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads.[4]

The use of non-sewage and grey water for on-site use such as site-irrigation will minimize demands on the local aquifer. Fresh water is an increasingly scarce resource. A sustainable building should reduce, control, and/or treat site runoff, use water efficiently, and reuse or recycle water for on-site use when feasible.[5]

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[1] Willmottdixongroup. "willmottdixongroup : Sustainability: Responsible business: Technical Library." Vers. 1. December 2012. Briefing Note 32 – Sustainable Design. ON.1 November 2012 <http://www.willmottdixongroup.co.uk/assets/b/r/briefing-note-32-sustainable-design-2.pdf>.

[2] The Whole Buiding Desigh Guide (WDBG) Sustainable Committee a Program of the US National Institute of Building Sciences (NIBS). Design Guidance : Design Objectives :Sustainable. 15 November 2012. ON.28 December 2012 <http://www.wbdg.org/design/sustainable.php>.

[3] Wikipedia. Green building : From Wikipedia, the free encyclopedia. 16 December 2012. ON.28 december 2012 < http://en.wikipedia.org/wiki/Green_building#Energy_efficiency>

[4] Ibid. Wikipedia. Green building

[5] Op.cit : Briefing Note 32 – Sustainable Design, P.2

1.2.2.4. Use Sustainable Products

A sustainable building must be constructed of materials that minimize life-cycle environmental, social and economic impacts such as climate change, resource depletion, and human toxicity and have been produced in a responsible and ethical way. Sustainable materials have a reduced effect on human health and the environment and contribute to improved worker safety and health, reduced disposal costs, and achievement of sustainability targets. Unfortunately these products may have a slightly higher capital cost but we must always consider this against the whole life cost and the whole life value of the building legacy.[1]

1.2.2.5. Enhance Indoor Environmental Quality

The Indoor Environmental Quality of a building has a significant impact on occupant health, comfort, and productivity. Among other attributes, a sustainable building maximizes day lighting; has appropriate ventilation, acoustic and moisture control; and avoids the use of materials with high Volatile Organic Compounds (VOCs) and ionizing radiation emissions.[2]

1.2.2.6. Resources conservation and Sustainable Waste Management

Conserving resources is a cornerstone of green building techniques. There are many ways to conserve resources during the building process. For example, selecting materials that have at least some recycled content can conserve natural resources and virgin materials. Minimizing construction waste can ease the impact on landfills and resources.[3]Construction waste management practices start with on site waste separation and Source reduction[4], and end with reusing of the materials (on site or off site) and Recycling.

1.2.2.7. Optimize Operational and Maintenance Practices

No matter how sustainable a building may have been in its design and construction, it can only remain so if it is operated responsibly and maintained properly. Ensuring operations and maintenance (O&M) personnel are part of the project's planning and development process will help retain the green criteria designed at the onset of the project. [5]Every aspect of green building is integrated into the O&M phase of a building's life. The addition of new green technologies also falls on the O&M staff. Although the goal of waste reduction may be applied during the design, construction and demolition phases of a building's life-cycle, it is in the O&M phase that green practices such as recycling and air quality enhancement take place.[6]

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[1] Ibid.

[2] Ibid

[3] The US National Center for Appropriate Technology (NCAT). Smart Communities Network: Green Building Principles. ON.28 December 2012 <http://www.smartcommunities.ncat.org/buildings/gbprinc.shtml>.

[4] Source reduction, or waste prevention, refers to practices that reduce the amount of materials entering the waste stream, including changes in the design, manufacture, purchase or use of materials.

[5] The Whole Building Design Guide (WDBG) Sustainable Committee a Program of the US National Institute of Building Sciences (NIBS). Home: Design Guidance: Design Objectives : Sustainable : Optimize Operational and Maintenance Practices. 09 October 2012. ON.29 December 2012 <http://www.wbdg.org/design/optimize_om.php>.

[6] Op Cit. ,Wikipedia, Green building

Whole Life Costing (WLC) and Life Cycle Assessment (LCA) principles must be applied and facilities should be designed to include meters to monitor energy and water use and waste generation, in the building and on site. This data can then be used to set reduction targets, measure and report results to all stakeholders. This must be supported by a Soft Landings approach and Post Occupancy Evaluation (POE).[1]

1.2.3. Green Building Facts

A Green Building is similar to a conventional building in terms of external looks and functionality. However, it has many tangible and intangible benefits to the owner of the building, the occupants and to the environment, below are green building facts compared with normal buildings[2] :

- 35% reduction in potable water use
- 50% savings in overall energy consumption
- 88% reduction in lighting consumption
- 80% of materials used are either recycled or recyclable
- Zero water discharge building
- 90% of building daylight
- 75% of occupants have outside view

1.2.4. Green Building Rating Systems

In the last few years there has been a growing interest in green buildings and green materials, and a general movement towards a more sustainability built environment. The media has played an important role in this movement. As the public has become more aware of environmental issues, they have also been overwhelmed by marketers claiming that their products and buildings are green, sustainable and environmental. [3] This emerging interest required the need to define greenness, and minimize green-washing[4]. Here came the necessity of assessment tools, as with the help of their certification, they promote the definition of the environmental buildings in the market .They inform people how environmentally a building is, clarify the extent to which green components have been incorporated , and identify sustainable principles, practices and techniques that have been implemented.[5]

[1] Op.cit : Briefing Note 32 – Sustainable Design, P.2

[2] "Green Building E Book CEES", College of Energy, environmental & sustainability : Free Resources , College of Energy , environment & Sustainability , ON 22 June 2012 , < http://www.cees-edu.org/free-green-energy-resources-reports-surveys.php>

[3] McKay, J. "Green Assessment Tools:The Integration of Building Envelope Durability." 11th Canadian Conference on Building Science and Technology. Banff , Alberta: Morrison Hershfield Limited, Vancouver, BC, 2007.

4 When a company, government or other group promotes green-based environmental initiatives or images but actually operates in a way that is damaging to the environment or in an opposite manner to the goal of the announced initiatives. This can also include misleading customers about the environmental benefits of a product through misleading advertising and unsubstantiated claims.

[5] Kubba, S. LEED practices , certification and accreditation handbook. United Kingdom: Elsevier Inc., 2010.

1.2.4.1. Definition

Green rating systems are tools that help to ensure that sustainable buildings, communities and projects are developed in an integrated manner, and that the appropriate experts are involved in the process.[1] Rating systems were primarily developed to assess, or measure specific aspects of a building, regarding sustainability goals. Once measured, buildings could be more easily compared with current and past building practices and other green buildings.[2] Below (Table 1-1) are some examples of the most famous and currently used rating systems across the world.

Table 1-4: Rating Systems across the world
Source: Various

Country	**Rating System**
United States	Leadership in Energy and Environmental Design (LEED)
Canada	LEED Canada
India	LEED India and Indian Green Building Council (IGBC) Rating System
United Kingdom	Building Research Establishments Environmental Assessment Method (BREEAM)
Australia	Green Star
New Zealand	Green Star NZ
South Africa	Green Star SA
Germany	German Sustainable Building Certification
Canada	Green Globes
Japan	Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)
Malaysia	Green Building Index
Singapore	Green Marks
Abu Dhabi	The Pearls Rating System For Estidama
Qatar	QSAS (The Qatar Sustainability Assessment System)
Egypt	Green Pyramid Rating System (under development)

[1] The Emirates Green Building Council (EmiratesGBC). Green Building Rating Tools. ON.12 January 2013 <http://www.emiratesgbc.org/index.php/academy/green-building-rating-tools>.

[2] Op.Cit., McKay, J , 2007

1.2.5. Green Buildings Trends

The concept of green building or sustainable design has gained great strength in recent years due to a combination of environmental and economic pressures that are compelling building owners to consider green and energy efficient design, technologies, and approaches as a necessity, not as a luxury.[1]

As building efficiency trends continue to gain fame and acceptance in 2012, facility owners and building managers everywhere are searching for ways to not only build new facilities, but also modernize existing structures to maximize their investments, while still providing safe, productive, and flexible structures. Emerging technologies are appearing regularly, which is expanding the ability for owners to increase efficiency while also improving their physical environments. As these new technologies mature and are refined, their first cost is reduced, and the economic reasons to move forward with these ideas become more acceptable and financially feasible, below are the top ten green building trends that have been reported to occur in 2012 and likely to continue into 2013.

1.2.5.1. The Focus on Existing Buildings Will Intensify

Despite recent improvements in energy efficiency being made in new build, it is important that the existing building sector also take action to meet sustainability targets. The objectives and challenges of such action will reduce the risk of this sector from becoming discarded due to high energy use and poor environmental performance.[2]

In the US, the fastest growing rating tool in 2010 was the Leadership in Energy and Environmental Design (LEED) for Existing Buildings program. Also to help the industry green its existing stock, the Green Building Council in Australia (GBCA) is developing the Green Star – Performance rating tool, which will assess the operational performance of existing buildings against the nine current Green Star categories.[3] It is expected that this tool will help to revolutionize the industry.[4]

1.2.5.2. Zero Net Energy Buildings (ZNEB) Will Gain Traction

A zero net energy building (ZNEB) is one that is optimally efficient, and over the course of a year, generates energy onsite, using clean renewable resources, in a quantity equal to or greater than the total amount of energy consumed onsite.[5] Zero net energy buildings are already being designed and constructed in Canada, China, Iran, Ireland, Malaysia, The Netherlands, Norway, Singapore, Switzerland, United Arab Emirates, United Kingdom and

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[1] Brandt Companies. Best Strategies for Energy Efficient Buildings : Green Building Trends of 2012. 02 April 2012. On.29 December 2012 <http://www.brandt-companies.com/blog/green-building/>.

[2] Hyde R., Groenhout N., Barram F,Yeang K. Sustainable Retrofitting of Commercial Buildings. Routledge, 2012.

[3] Green Star is a voluntary environmental rating system for buildings in Australia. It was launched in 2003 by the Green Building Council of Australia.The system considers a broad range of practices for reducing the environmental impact of buildings and to showcase innovation in sustainable building practices, while also considering occupant health and productivity and cost savings, it will be discussed later in this chapter .

[4] Romilly Madew, Chief Executive GBCA. Ten Trends for Green Building. 07 Novemeber 2011. 29 December 2012 <http://designbuildsource.com.au/ten-trends-green-building>.

[5] Massachusetts Energy and Environmental Affairs. Home: Energy, Utilities & Clean Technologies: Energy Efficiency: Zero Net Energy Buildings (ZNEB). ON.29 December 2012 <http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/zero-net-energy-bldgs/>.

United states,[1] Zero-net-energy designs for new buildings become increasingly commonplace, in both residential and commercial sectors, as LEED and ENERGY STAR ratings become too common to confer competitive advantage.[2]

1.2.5.3. Building Products and Materials Will Become Greener

As the growing global economy expands the demand for raw materials, it is no longer sensible to throw away much of what we consider construction waste. Using a "cradle-to-cradle" approach, the "waste" from one generation can become the "raw material" of the next. In most construction projects, building materials are evaluated and selected based on performance, aesthetics, and cost. The emerging trends with "green" or environmentally preferable products, these traditional selection parameters are expanded to include both health and environmental impacts.[3]

Organizations such as InterfaceFLOR, which is recognized as the world's most sustainable carpet manufacturer, has implemented a take-back and recycling program to ensure its products have a useful 'second life'.[4]

1.2.5.4. Affordable Green Will Be the Norm.

Many people associate green with higher costs – but that's changing. New business models, technologies and high performance materials are bringing green within reach. In addition facilities built to green standards cost less to operate due to energy efficiency.

1.2.5.5. Solar power use in buildings will continue to grow

We live in a country with more sunny days than anywhere else on the planet, yet we are lagging behind Asia, Europe and North America in installation of solar photovoltaic panels. Expect this to change, as we begin to see solar, wind and photovoltaic routinely integrated into buildings and used as a building material, rather than simply being installed on top. And many of these renewable energy sources won't be large. Micro-turbines are already becoming popular in Asia, and we'll see more Australian innovation in this area as we recognize the benefits of integrated small systems over one giant, geographically remote power source.

1.2.5.6. Governments Focus On Energy Efficiency And Sustainability Will Improve

Governments all over the world are stepping up their mandates for green buildings for both their own buildings and the private sector. The desire to reduce carbon emissions by going green will lead more government agencies to require green buildings. New schools and

[1] Wikipedia. Zero-energy building : From Wikipedia, the free encyclopedia. ON.29 December 2012 <http://en.wikipedia.org/wiki/Zero-energy_building>.

[2] Coastal Green Air. Top 10 Green Building Techniques and Technology. ON.29 December 2012 <http://coastalgreenair.com/energy-savings-systems/top-10-green-building-techniques-and-technology/>.

[3] John Amatruda, RA. Home :Design Guidance : Design Objectives : Sustainable : Use Greener Materials : Evaluating and Selecting Green Products. 26 April 2012. ON.30 December 2012 <http://www.wbdg.org/resources/greenproducts.php?r=env_preferable_products>.

[4] Op Cit : Ten Trends for Green Building

hospitals will be built to the highest environmental standards as community demands and government priorities shift towards sustainability.

1.2.5.7. The Economic Path Will Turn to Green Growth

The climate change crisis convinced many countries that a different kind of economic growth is needed. In response, many governments are putting in place measures aimed at a green recovery. Together with innovation, going green can be a long-term driver for economic growth, through, for example, investing in renewable energy and improved efficiency in the use of energy and materials.[1] The term green growth has been used to describe national or international strategies.

Green growth strategies can help economies and societies become more resilient as they work to meet demands for food production, transport, housing, energy and water. Strategies can help mitigate the impacts of adverse shocks by reducing the intensity of resource consumption and environmental impacts, while alleviating pressure on commodity prices. Green growth also offers competitive advantages to those countries that commit to policy innovations. The global market for green goods and services is vast and growing fast, offering countries the dual benefit of prosperity and job creation.[2]

1.2.5.8. Blue Is The New Green

It's not all about energy. Building designers and managers are taking steps to reduce water consumption through the use of water saving fixtures, rainwater recovery systems and innovative new water technologies. Lot 12, TradeCoast Central,[3] for instance, gained a Green Star innovation point for its shared, precinct non-potable water storage and distribution system. The system reduces potable water consumption by 80 per cent – the equivalent of more than 10,000 liters a day – and the only potable water used within the precinct is for kitchens, Showers and Hand Basins.

1.2.5.9. The Demand for Green Communities, Cities And Infrastructure Will Grow

Beyond the building envelope, we're already seeing the conversation shifting – and we are looking at how to green our communities and cities. Buildings are part of larger systems. In the future we will no longer view our buildings in isolation, but as interconnected pieces of a larger community. Green Stars- Communities and LEED for neighborhood are currently two of the most important rating tools for the sustainability of large scale communities and neighborhoods.

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[1] The Organisation for Economic Co-operation and Development (OECD). OECD Home : Green growth and sustainable development : OECD work on green growth . ON.07 January 2013 <http://www.oecd.org/greengrowth/oecdworkongreengrowth.htm>.

[2] Wikipedia. Green growth : From Wikipedia, the free encyclopedia. ON.07 January 2013 <http://en.wikipedia.org/wiki/Green_growth>.

3 Lot 12 Trade Coast Central became the first Green Star Industrial facility in Australia when it achieved a 4 Star Green Star - Industrial PILOT rating in April 2010.

1.2.5.10. The Demand of Smart Buildings and Building energy Management systems will continue to grow

The smart building industry has been busy over the last few years, smart buildings employ a wide range of technologies that improve efficiency and connect buildings to each other as well as to the grid using intelligent, information and communication technology (ICT)-based devices and networks. Many of the technologies required for qualifying as a smart building, such as energy efficient heating, ventilation, and air conditioning (HVAC) systems and sub-meters, are mature. Others, such as building energy management systems (BEMSs) and building information modeling (BIM), are evolving rapidly and offer some of the most impactful innovations that the building industry has witnessed in years. The challenge that integrators face today, however, is tying these systems together in a way that maximizes profitability and leverages the strengths that each service provider in the smart building ecosystem brings to the table.

The one certainty is that demand for smart building technologies will continue to grow. The value proposition for many of these technologies has been demonstrated and a growing number of building owners are starting to adopt them with positive results. As the technology continues to evolve, improve, and decrease in cost, efficient and intelligent technologies will start to become an even more pervasive fixture in buildings worldwide.[1]

1.3. The Triple Bottom Line: Profit, People and Planet

The phrase "the triple bottom line" was first coined in 1994 by John Elkington, the founder of a British consultancy called SustainAbility. His argument was that companies should be preparing three different (and quite separate) bottom lines. One is the traditional measure of corporate profit—the "bottom line" of the profit and loss account. The second is the bottom line of a company's "people account"—a measure in some shape or form of how socially responsible an organization has been throughout its operations. The third is the bottom line of the company's "planet" account—a measure of how environmentally responsible it has been. The triple bottom line (TBL) thus consists of three Ps: profit, people and planet. It aims to measure the financial, social and environmental performance of the corporation over a period of time. Only a company that produces a TBL is taking account of the full cost involved in doing business.[2]

1.3.1. Triple Bottom Line and sustainability

Triple bottom line (TBL) is a holistic concept of sustainability where 'environmental', 'social' and 'economic' considerations are identified and considered concurrently in decision making.[3] In another explanation, the Triple Bottom Line is considered a powerful business

[1] Bloom E., Gohn B. "Pike Research Joins Navigant." 2012. Smart Buildings: Ten Trends to Watch in 2012 and Beyond. ON.07 January 2013 <http://www.pikeresearch.com/wordpress/wp-content/uploads/2012/05/SB10T-12-Pike-Research.pdf>.

[2] The Economist. Triple bottom line. 17 November 2009. On.19 January 2013 <http://www.economist.com/node/14301663>.

[3] "Tourism and Events Queensland (TEQ)." FactSheet 1.2 : Sustainability, Triple Bottom Line and 'Greenwash'. ON.19 January 2013 <http://www.tq.com.au/fms/tq_corporate/industrydevelopment/Factsheet%201_2-Sustainability%20TBL%20and%20Greenwash.pdf>.

philosophy. A corporation that is sustainable by this definition enjoys profits while improving the lives of the people it is connected to and protecting the environment. With this kind of forward-thinking, a sustainable business is set up for long term success.[1]

1.3.2. Triple Bottom Line and LEED

LEED measures and enhances the design and sustainability of buildings based on a "triple bottom line "approach. USGBC has adapted the triple bottom line to establish metrics and rating systems to measure and recognize building projects based on their performance in the three corresponding dimensions of sustainability: society, the environment, and the economy. Projects certified under the LEED rating systems demonstrate, through compliance with range of requirements, that they have addressed elements that balance and enhance all three areas of triple bottom line, all three dimensions of sustainability.[2]

1.4. Conclusion

According to The United Nations Environment Programme, Buildings use about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 1/3 of Green House Gas (GHG)[3] emissions.

- Residential and commercial buildings consume approximately 60% of the world's electricity
- Existing buildings represent significant energy saving opportunities because their performance level is frequently far below current efficiency potentials
- Investment in building energy efficiency is accompanied by significant direct and indirect savings, which help offset incremental costs, providing a short return on investment period.
- Building sustainably will result in healthier and more productive environments.

However, The awareness of the environmental challenges and the importance of green construction and sustainable development have been growing vastly in the past few decades , There is an increasing demand, in both the private and public sectors, to understand sustainable construction practices. This demand is driven by a realization that sustainable practices make sense to both owners and operators. The practices not only help the environment but can also improve economic profitability and improve relationships with stakeholder groups.

That's why the need of having a way to assess sustainability has grown very fast in order to avoid green-washing and to be able to identify sustainable buildings, products and

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[1] Bailey, L. Defining Sustainability: Triple Bottom Line. 26 April 2012. On.19 January 2012 <http://hagermanconstruction.blogspot.com/2012/04/defining-sustainability-triple-bottom.html>.

[2] USGBC. Green Building and LEED Core Concepts guide. 1st Edition. United States Green Building Council Store, 2009.

3 The main cause for climate change: Green house gases allow sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. Over time, the amount of energy sent from the sun to the Earth's surface should be about the same as the amount of energy radiated back into space, leaving the temperature of the Earth's surface roughly constant.

organizations, over the past two decades interest has grown in developing indicators to measure sustainability. Sustainability is presently seen as a delicate balance between the economic, environmental and social health of a community, nation and of course the earth (Triple bottom Line).

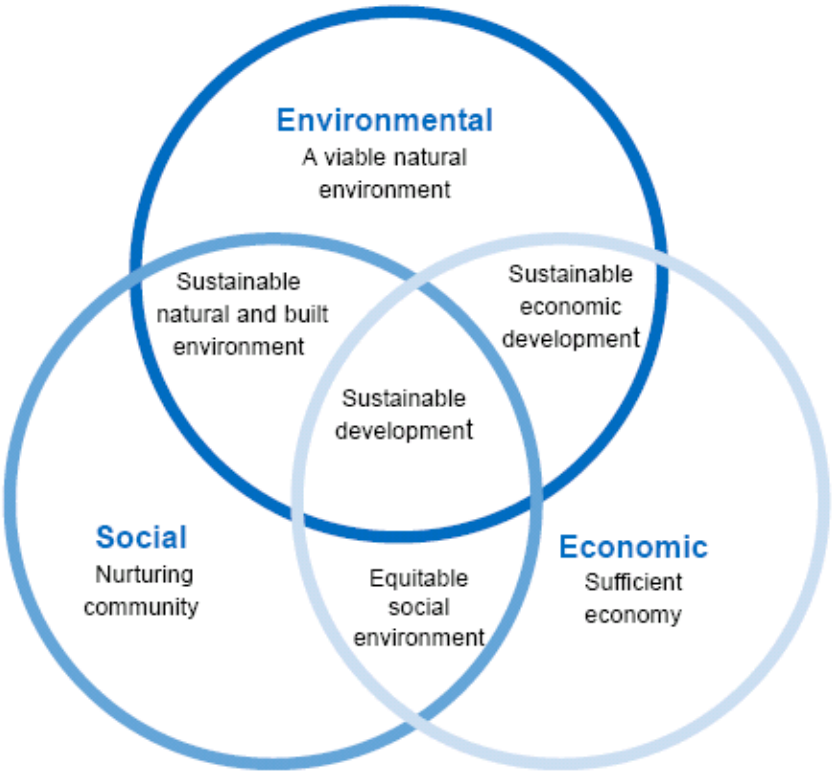


Figure 1-3 : Triple Bottom Line
Source: http://www.townofeagle.org/index.aspx?NID=254

- ***Environmental Sustainability:*** Sustainability is essential to stop the continual depletion of the natural environment. Throughout history humans have tried to conquer or master nature, with the result that humans have destroyed much of the earth's vast resources. However, to achieve sustainability it is essential to accept that humans are dependent on the natural environment for their own survival and wellbeing. Without a healthy natural environment, it is impossible to have a healthy society or economy.
- ***Social Sustainability***: Social Sustainability is the core element of Sustainability. Some may argue differently, but essentially sustainability is about creating and maintaining quality of life for people. Financial and Environmental factors are important, but they are both means to the end, rather than ends in themselves. Therefore, by working towards financial and environmental sustainability, we are already working towards social sustainability. However, the social element of sustainability does have a number of its own distinct criteria. Directly social sustainability involves protecting the mental and physical health of all stakeholders, encouraging community, treating all stakeholders fairly, and providing essential services. These elements are essential because a healthy society cannot be developed and maintained if the population are in poor health.
- ***Economical Sustainability****:* Financial or Economical Sustainability is essential for two reasons. Firstly, the majority of businesses will not pursue sustainability unless

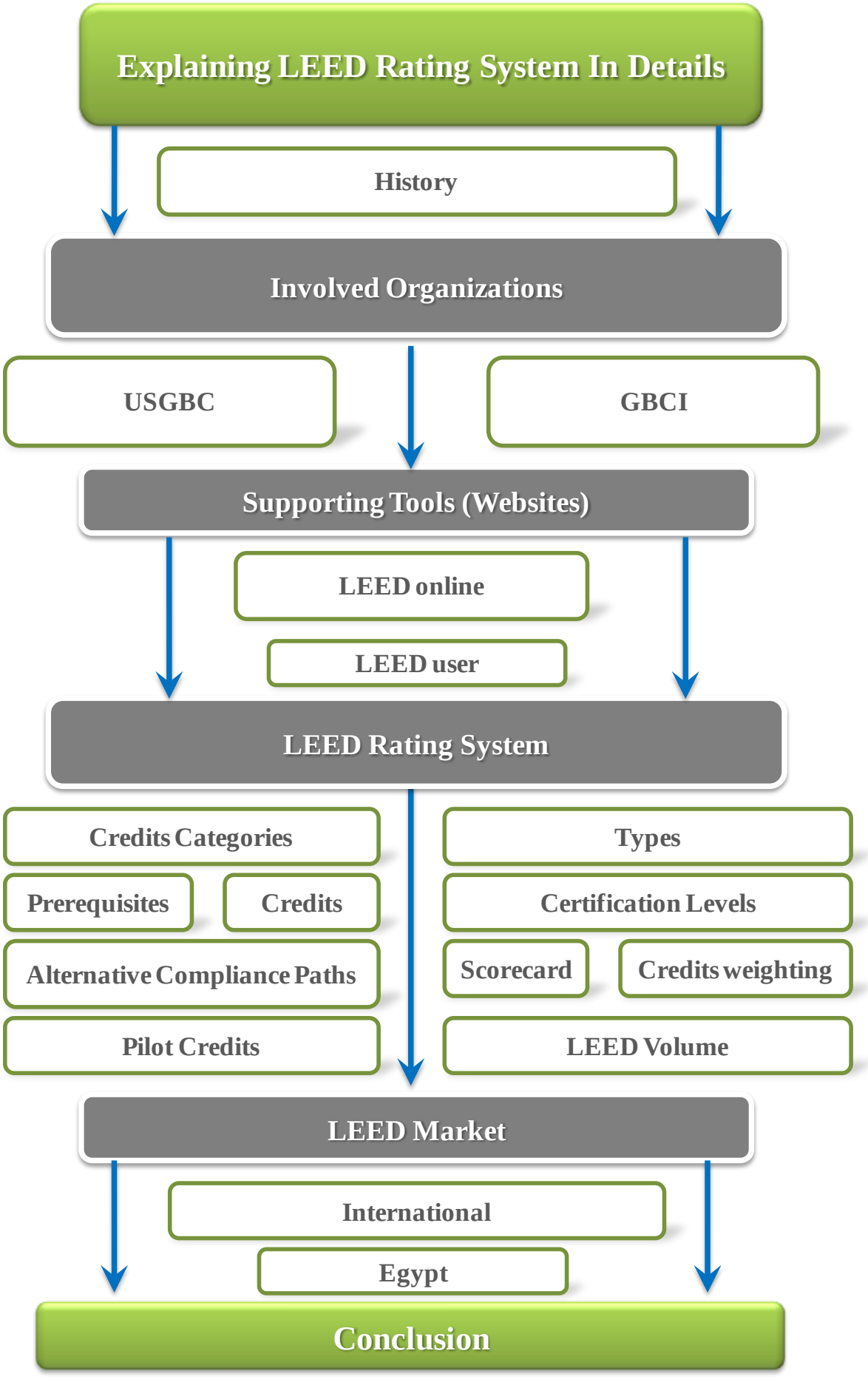
they see it as offering them financial benefits. Secondly, financial wealth is an important element of quality of life. However, contrary to traditional belief, the goal of financial profit does not have to be in conflict with the goals of social and environmental profit. Carefully designing products within their business, social and environmental systems can result in solutions that have long term financial viability and consistently generate financial profit and wealth. All of this can be achieved without damage to society or the environment and can potentially even generate profit in these areas.

LEED Rating System, amongst a lot of emerging assessment tools, uses the three basics of sustainability (People, Profit, and Planet) to assess building performance throughout Design and Construction stages of the building, The LEED building rating system, or Leadership in Energy and Environmental Design, is a series of environmentally sustainable construction guidelines that result in the creation of sustainable, high performance buildings. Under this rating system, a project or building earns a series of credits for various building features that lead to sustainable building performance. In turn, a building or project then receives a Certified, Silver, Gold or Platinum LEED accreditation.

LEED rating system **Economical benefits** include utility savings from energy and water efficiency, while the **Environmental benefits** include contribution to decreased ecological damage through supporting improved construction practices, improving environmental awareness and decreased material, water and energy use. **Social benefits** include healthier communities due to improved indoor air quality of buildings, closer proximity to green spaces, walking and biking trails.

CHAPTER TWO

LITERATURE Review: LEED RATING SYSTEM


Explaining LEED Rating System In Details
History
Involved Organizations
USGBC
GBCI
Supporting Tools (Websites)
LEED online
LEED user
LEED Rating System
Credits Categories
Types
Prerequisites
Credits
Certification Levels
Alternative Compliance Paths
Scorecard
Credits weighting
Pilot Credits
LEED Volume
LEED Market
International
Egypt
Conclusion

CHAPTER 2: LITERATURE REVIEW: LEED RATING SYSTEM

LEED (Leadership in Energy and Environmental Design) is a voluntary, consensus-based, market-driven program that provides third-party verification of green buildings. From individual buildings and homes, to entire neighborhoods and communities, LEED is transforming the way built environments are designed, constructed, and operated. Comprehensive and flexible, LEED addresses the entire lifecycle of a building.

LEED projects have been successfully established in 135 countries. International projects, those outside the United States, make up more than 50% of the total LEED registered square footage. LEED unites the world in a single global community and provides regional solutions, while recognizing local realities.[1]

2.1. LEED History in Brief

LEED was developed by the USGBC during a three-year process from 1995 to 1998. The first version, Known as LEED 1.0, was issued in 1998 as a beta version. Twenty buildings were certified using LEED 1.0 to attain a rating that originally was Platinum, Gold, Silver, or Bronze.

LEED 2.0 was issued in 2000 as a dramatically changed version of LEED 1.0 and offered to the wider commercial and institutional building market as a final, operational building assessment system. LEED-NC 2.1, the next edition of LEED, issued in 2002, started the process of issuing rating products for specific building types. For example, in the case of the version for new construction, the descriptor NC was added to the title. LEED-NC 2.1 was virtually identical to LEED 2.0, except that it had greatly simplified documentation requirements. LEED-NC 2.2, issued in 2005, discarded manual documentation submissions and shifted to an internet portal for this purpose, USGBC LEED-Online.

LEED 3.0 was released 2009 with several major changes to its structure and was an overall change for all LEED building assessment products. Additional points were awarded to projects that focused on regional issued established by local USGBC chapters. A whole new version of LEED-Online was released to facilitate easier communication between the project teams and the certifying bodies. The website Interface allows the team to better manage project details and upload supporting files in order to submit data for each of the credits they are seeking. [2]

A new version of LEED, called LEED v.4, is scheduled for release in the near future, the next update to the rating systems (LEED v4) will open up LEED to a wider range of building types and manufacturing industries, delivering the benefits of green building up and down the supply chain. It will advance environmental footprint issues, like climate change, and encourage optimization of energy and water use.[3]

[1] USGBC. Rating Systems : LEED. ON.1 December 2012 <https://new.usgbc.org/leed>.

[2] Op Cit.,(Kibert, Charles J., 2012) P.144

[3] OP Cit., USGBC

This new version will adopt the latest American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and other standards and reshape the overall structure of the LEED rating system.[1]

2.1.1. LEED Canada

In 2003, the Canada Green Building Council received permission to create LEED Canada-NC v1.0, which was based upon LEED-NC 2.0. This version was updated and released on June 21, 2010 to LEED Canada NC 2009.[2]

The Canadian rating systems are an adaptation of the US Green Building Council's (USGBC) LEED Green Building Rating System, tailored specifically for Canadian climates, construction practices and regulations. The rating systems are adapted to the Canadian market through an inclusive process that engages CaGBC members, stakeholders and experts representing the various sectors of the Canadian industry.[3]

2.1.2. LEED India

Indian Green Building Council (IGBC) was formed by Confederation of Indian Industry (CII) in the year 2001, and it has licensed the LEED Green Building Standard from the U.S. Green Building Council on April 2011[4] and currently is responsible for certifying LEED-New Construction and LEED-Core and Shell buildings in India. There are many energy efficient buildings in India, situated in a variety of climatic zones. One of these is RMZ Millenia Park, Chennai, India's largest LEED gold-rated Core & Shell green building.[5]

2.2. United States Green Building Council (USGBC)

USGBC is made up of tens of thousands of member organizations, chapters and student and community volunteers that are moving the building industry forward in a way that has never been seen before. They are a diverse group of builders and environmentalists, corporations and nonprofits, teachers and students, lawmakers and citizens. Today we are 77 chapters, 13,000 member organizations and 181,000 LEED professionals strong that share the same vision of a sustainable built environment for all within the next generation.[6]

The U.S. Green Building Council (USGBC) is a nonprofit organization committed to a prosperous and sustainable future for our nation through cost-efficient and energy-saving green buildings. USGBC works toward its mission of market transformation through its

[1] Op Cit.,(Kibert, Charles J., 2012) P.144

[2] Wikipedia. Leadership in Energy and Environmental Design : From Wikipedia, the free encyclopedia. 05 December 2012. ON.06 December 2012 <http://en.wikipedia.org/wiki/Leadership_in_Energy_and_Environmental_Design>.

[3] CaGBC. Canada Green Building Council : LEED . ON.06 December 2012 <http://www.cagbc.org/AM/Template.cfm?Section=LEED>.

[4] Wikipedia. Green building in India from Wikipedia, the free encyclopedia. 13 August 2012. On.26 December 2012 <http://en.wikipedia.org/wiki/Green_building_in_India>.

[5] Wikipedia. Indian Green Building Council From Wikipedia, the free encyclopedia. 29 September 2012. ON.26 December 2012 <http://en.wikipedia.org/wiki/Indian_Green_Building_Council>.

[6] USGBC. About USGBC - US Green Building Council-Overview. 2012. ON. 06 December 2012 <https://new.usgbc.org/about>.

LEED green building program, robust educational offerings, a nationwide network of chapters and affiliates, the annual Greenbuild International Conference & Expo, and advocacy in support of public policy that encourages and enables green buildings and communities.[1]

2.2.1. USGBC History with LEED

The U.S. Green Building Council (USGBC), co-founded by Mike Italiano, David Gottfried and Rick Fedrizzi in 1993, is a non-profit trade organization that promotes sustainability in how buildings are designed, built, and operated. USGBC is best known for the development of the Leadership in Energy and Environmental Design (LEED) green building rating systems and Green build, a green building conference and expo that promotes the green building industry, including environmentally responsible materials, sustainable architecture techniques and public policy.[2]

The Success of LEED is the result of a long, careful development process that occurred between 1995 and 1998. The earliest attempts at formulating an assessment system , dating from 1993, were conducted under the sponsorship of the standards structure of the American Society for Testing and Materials (ASTM).This first effort at developing a US rating system was handed over to the then newly formed USGBC in 1995.A pilot version of LEED was issued for beta testing in 1998 , and the first operational market version was published in 2000.Perhaps the most important decision of the USGBC members developing LEED that ensured its success was that the green building should be market-driven rather than being required by regulations ,meaning that the building owners would be the ultimate authorities contributing to the program's success. For commercial green buildings, this meant that they would have to distinguish themselves in the market by having higher resale value than comparable buildings.[3]

A second significant decision in the development of LEED was to create a broad consensus-based process during its formulation. LEED was produced by a cross section of the USGBC's membership during a long, slow, and diligent three-year process that sought to produce a green building rating system that would meet the needs of the wide range of participants in building industry. The engagement of so many contributors ensured acceptance when the rating system was completed. In addition, the US Department of Energy (DOE) offered critical funding in the form of grants to support LEED's development.

The USGBC was, and continues to be, a nonprofit, nongovernmental organization whose membership is drawn from diverse public and private stakeholders. LEED building assessment products continue to enjoy a high degree of success, largely as a result of the collaborative, consensus-based approach that marks both the products and the contemporary US green building delivery system. [4]

[1] USGBC. USGBC official web site. 2012. ON.06 December 2012 <https://new.usgbc.org/>

[2]Wikipedia, U.S. Green Building Council From Wikipedia, the free encyclopedia. 04 October 2012 . ON.06 December 2012 <http://en.wikipedia.org/wiki/U.S._Green_Building_Council>.

[3] Kibert, Charles J. Sustainable Construction: Green Building Design and Delivery. 3rd Edition. John Wiley & Sons, 2012: P.143

[4] Ibid , P.143

2.2.2. USGBC Chapters

The USGBC chapter network exists only in the United States and U.S. territories. USGBC is part of a global network of Green Building Councils which provide options for green building involvement outside the United States. Chapter membership allows local citizens to enhance their careers, give back to their communities and promote the collective mission of transforming the built environment within this generation.[1]

USGBC has 77 chapters where More than 30,000 members have joined USGBC chapters nationwide (inside the us) . Chapters provide individuals with opportunities at the local and regional levels for active involvement and leadership, while also offering learning, networking and other professional development activities.[2]

2.2.3. USGBC Members

USGBC's national members are organizations across the globe. Any organization that shares USGBC goal of a more sustainable built environment should join the USGBC community.

USGBC national member organizations come from every industry – from big companies and small businesses to nonprofits and governments – and the benefits of membership extend to all full-time employees. They are part of a vibrant and diverse community which offers unlimited new opportunities for connecting individuals and businesses with the people, information and ideas they need to be part of the rapidly growing green building industry.[3]

USGBC now offers a membership structure with just four dues levels: Organizational, Silver, Gold and Platinum. These new dues packages make things simple, allowing any organization to choose the membership level and price point best suited to its needs, the dues for each package is as follow:[4]

- Organizational membership $300/year: 1,853.55 EGP / year
- Silver membership $1,500/year: 9,267.75 EGP / year
- Gold membership $5,000/year: 30,892.50 EGP / year
- Platinum membership $20,000/year : 123,570 EGP / year

2.3. Green Building Certification Institute (GBCI)

The Green Building Certification Institute (GBCI) is a third-party organization that provides independent oversight of professional credentialing and project certification programs related to green building. GBCI is committed to ensuring precision in the design, development, and implementation of measurement processes for green building performance (through project certification) and green building practice (through professional credentials and certificates).

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[1] USGBC. USGBC Official website : About Chapters. ON.09 December 2012 <http://www.usgbc.org/DisplayPage.aspx?CategoryID=24>.

[2] USGBC. USGBC New official web site : Community : Chapters. 2012. ON.09 December 2012 <https://new.usgbc.org/community/chapters>.

[3] USGBC. USGBC: About Membership. ON.26 December 2012 <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=267>.

[4] USGBC. USGBC membership: Four Simple Levels. ON. 26 December 2012 <http://new.usgbc.org/community/members>.

Established in 2008 to administer certifications and professional designations within the framework of the U.S. Green Building Council's LEED® Green Building Rating Systems™, GBCI continues to develop new programs and offer the marketplace validation that building certifications and professional designations have met specific, rigorous criteria.[1]

2.3.1. GBCI History

Up until 2008, the USGBC administered building certifications and professional designations in-house. In 2008, a nonprofit organization, the Green Building Certification Institute (GBCI), was founded to provide a balanced third-party certification in order to be recognized by the American National Standards Institute (ANSI).

The GBCI is responsible for managing all aspects of LEED professional credentialing including exam development, registration delivery, and maintenance, to ensure ongoing excellence and that LEED professionals are proficient in the field. In addition, the GBCI is responsible for managing the LEED project certification program by conducting technical reviews and analysis of submissions to verify and evaluate projects based on how well they have met the requirements of the various LEED rating systems.[2]

2.3.2. LEED Professional Credentials (Exams)

The LEED Professional Exams are administered by the Green Building Certification Institute (GBCI) for professionals seeking to earn credentials and certificates. The exams test knowledge based on the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating Systems.[3]

The LEED Professional Credentials were developed to encourage green building professionals to maintain and advance their knowledge and expertise. A LEED Professional Credential provides employers, policymakers, and other stakeholders with assurances of an individual's current level of competence and is the mark of the most qualified, educated, and influential green building professionals in the marketplace. All the LEED Professional Credentials require adherence to the LEED Professional Disciplinary and Exam Appeals Policy and require ongoing credential maintenance requirements either through continuing education and practical experience or through biennial retesting. Starting in 2009, newly credentialed individuals must maintain their credential on a two-year cycles; if not, they expire. There are three tiers in the LEED Professional Credentialing program:

2.3.2.1. Tier 1: LEED Green Associate

LEED Green Associate credential is for professionals who want to demonstrate green-building expertise in non-technical fields of practice; GBCI offers the LEED Green Associate credential. A LEED Green Associate demonstrates a core understanding of green-building practices and principles and the LEED green-building certification program to support sustainable design, construction, and operations.[4]

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[1] GBCI. The Green Building Certification Institute Official page : About GBCI. ON.07 December 2012 <http://www.gbci.org/org-nav/about-gbci/about-gbci.aspx>.

[2] Op Cit.,(Kibert, Charles J., 2012) P.149

[3] Wikipedia. LEED Professional Exams : From Wikipedia, the free encyclopedia. 29 March 2012. On.11 December 2012 <http://en.wikipedia.org/wiki/LEED_Professional_Exams>.

[4] USGBC. USGBC Official Website : LEED : Credentials : LEED Green Associate. 2012. ON.11 December 2012 <https://new.usgbc.org/leed/credentials/leed-ga/overview>.

- **Eligibility:** There are no eligibility requirements for the LEED Green Associate exam. However, GBCI recommends that candidates have exposure to LEED and green building concepts through educational courses, volunteering, or work experience prior to testing.[1]
- **Test:** LEED Green Associates earn their credential by passing a two-hour, computer-based exam comprising 100 randomly delivered multiple-choice questions, Individuals must score at least 170 out of 200 in order to pass ,Then GBCI requires 15 continuing education hours every two years to maintain the credential.
- **Exam Fees**: Application: $50 (307.55 EGP), Full exam: $150 (922.65 EGP) and $200 for non-members (1230.20 EGP), Maintenance: $50 (307.55 EGP) every two years.

2.3.2.2. Tier 2: LEED AP (with specialty)

LEED-AP-with-specialty credentials build upon the original LEED AP credential by adding the ability to specialize in a particular segment of the green-building industry. Becoming a LEED AP with specialty is a two-step process: Candidates must pass the Green Associate exam to demonstrate general knowledge and pass a second exam aligning with their area of practice. The two tests can be taken at once, or a candidate can become a LEED Green Associate first and take the LEED AP specialty exam at a later date.

Specialties demonstrate focused expertise in a specific area of green-building practice, signifying a depth of understanding of specific LEED rating systems grouped by the building type or life-cycle stage they address. The LEED AP specialty tracks are:[2]

- LEED AP Building Design + Construction (LEED AP BD+C)
- LEED AP Operations + Maintenance (LEED AP O+M)
- LEED AP Interior Design + Construction (LEED AP ID+C)
- LEED AP Homes
- LEED AP Neighborhood Development (LEED AP ND)

The LEED AP credential affirms your advanced knowledge in green building as well as expertise in a particular LEED rating system. All LEED AP with specialty credential holders are required to maintain their credential through continuing education.

- **Eligibility:** To take the LEED AP exams, the candidate must have previous experience within three years of the application submittal date, on a LEED®-registered or certified project. This work experience must be documented through LEED Online or in the form of a letter of attestation from a supervisor, client, or project manager and must describe the candidate's involvement on the project as a consultant, public or private sector personnel who review projects pursuing LEED certification as part of an approval process, contracted worker, member of the LEED Project Team, LEED Homes Provider, LEED Reviewer, LEED for Homes Green Rater, or staff member of a Certifying Body (CB).[3]
- **Test:** The LEED AP exams consist of two parts, the LEED Green Associate exam and the applicable LEED AP specialty exam; each part contains 100 randomly

[1] GBCI. "USGBC :LEED: Credential : LEED Green Associate Overview." November 2012. LEED Green Associate Candidate Handbook. ON.11 December 2012 <https://new.usgbc.org/sites/default/files/LEED-Green-Associate-candidate-handbook_0.pdf>.

[2] USGBC. USGBC Official Website : LEED : Credentials : LEED AP. 2012. ON.11 December 2012 <https://new.usgbc.org/leed/credentials/leed-ap/overview>.

[3] GBCI. "USGBC :LEED: Credential : LEED Green Associate Overview." november 2012. LEED AP Building Design + Constructin Candidate Handbook. ON.11 December 2012 <https://new.usgbc.org/sites/default/files/BD+C-Candidate-Handbook.pdf>.

delivered multiple choice questions and each part must be completed in 2 hours. Individuals must score at least 170 out of 200 in order to pass. Candidates have to memorize performance thresholds (percentages of energy savings for example) and perform calculations during the exam, Then GBCI requires 30 continuing education hours every two years.

- **Exam Fees**: Application: $100 (615.10EGP), Full exam: $300 (1845.30 EGP) and $450 for non-members (2767.95 EGP) , Specialty only (for LEED Green Associates): $150 (922.65 EGP) and $250 (1537.75 EGP) for non-members, Maintenance: $50 (307.55 EGP) every two years .

2.3.2.3. Tier 3: LEED Fellow

The LEED Fellow designates the most exceptional professionals in the green building industry. LEED Fellows are a highly accomplished class of individuals nominated by their peers and distinguished by the caliber of their contributions to advancing the field of green building.[1]

- **Nomination process:** The nominator, the individual nominating a Fellow, must be a LEED AP with specialty who is in good standing and has 10 or more years of professional green building experience. The nominator can only nominate one LEED Fellow for each class, and cannot be currently nominated themselves.
- **Evaluation:** The criteria for assessing LEED Fellow nominees are based on five major dimensions of green building and sustainability that have been identified as mastery elements. The application process allows nominees to document their green building and sustainability knowledge, skills and abilities in four of the five mastery elements. One of the elements must be Technical Proficiency, and the nominee may choose the other three elements from Education and Mentoring, Leadership, Commitment and Service, and Advocacy.

***Technical Proficiency*:** A LEED Fellow is highly proficient technically. He or she is experienced and knowledgeable in the application of multiple LEED rating systems and has provided significant contributions to LEED projects. A LEED Fellow is adept at identifying technical or procedural solutions to green building challenges and has demonstrated a sustained level of accomplishment for at least ten years.

Education and Mentoring: A LEED Fellow provides education, training and mentoring—sharing knowledge about LEED, sustainability and green building with others, both inside and outside of his or her own organization.

Leadership: A LEED Fellow is a leader in his or her own organization and in the field of green building. He or she plays an important role in instituting and applying sustainability practices and procedures within his or her own organization as well as within clients' projects and the community.

Commitment and Service: A LEED Fellow demonstrates a history of commitment and service to green building. This can include contribution and service to GBCI and USGBC or other Green Building Councils, as well as community service that has furthered green building or sustainability.

Advocacy: A LEED Fellow is a longstanding advocate for sustainable ideas, concepts and technologies related to or promoting green building or sustainability. He or she delivers presentations and speeches and writes articles or books explaining green building and

[1] USGBC. USGBC official website : LEED : Credentials : LEED Fellow Overview. 2012. ON.11 December 2012 <https://new.usgbc.org/leed/credentials/leed-fellow>.

sustainability. A LEED Fellow also proactively encourages the adoption and use of LEED rating systems with clients, communities or government entities.

2.4. LEED Online

Over time, the LEED building rating system has shifted from requiring hard copy documentation for certification to an Internet-based system known as LEED-Online. Project teams can submit all their documentation online in an easy-to-use format.

LEED Online is the primary resource for managing the LEED documentation process. Through LEED Online, project teams can manage project details, complete documentation requirements for LEED credits and prerequisites, upload supporting files, submit applications for review, receive reviewer feedback, and ultimately earn LEED certification. LEED Online provides a common space where members of a project team can work together to document compliance with the LEED rating system. With the exception of projects registered under LEED for Homes, all projects must be certified using LEED Online.[1]

2.5. LEED User

LEEDuser is an independent, third-party tool which the U.S. Green Building Council (USGBC) supported in its development. The official LEED credit language and the LEEDuser.com domain are owned by USGBC and used by permission. [2]

LEEDuser helps LEED professionals and beginners to certify their building project with support for the key commercial and institutional LEED rating systems, with tips, checklists, sample documentation, forums, and more Through a group of LEED accredited professionals.

Either a seasoned professional or a new user to a rating system, LEEDuser can save time and money by providing frank advice on how to accomplish each credit requirement with templates and examples and an action checklist for each credit.

2.5.1. LEEDUser Team

LEEDuser is a membership-based resource published by BuildingGreen, Inc.[3] Which is an independent company focused on providing high-quality information to help the design and construction industry improve the environmental performance of buildings. The BuilingGreen editorial staff behind LEEDuser includes:[4]

- Tristan Roberts, LEED AP BD+C, Editorial Director
- Nadav Malin, LEED AP BD+C, President
- Alex Wilson, LEED AP, Founder and Executive Editor

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1 GBCI. GBCI : About LEED Online. ON.07 December 2012 <http://www.gbci.org/main-nav/building-certification/leed-online/about-leed-online.aspx>.

2BuildingGreen, Inc. LEEDuser official website. 2012. ON.08 December 2012 <http://www.leeduser.com/>.

[3] BuildingGreen, Inc. is an independent publishing company committed to providing accurate, unbiased, and timely information designed to help building-industry professionals and policy makers improve the environmental performance, and reduce the adverse impacts, of buildings. , < http://www.buildinggreen.com>

[4]BuildingGreen, Inc. LEEDuser official website : Meet the LEEDuser Team. 2012. ON.08 December 2012 <http://www.leeduser.com/content/meet-leeduser-team>.

2.5.2. What is the Difference between LEEDuser and LEEDonline?

LEED Online is the official website, run by the Green Building Certification Institute (GBCI), where LEED project teams go to complete documents for LEED certification. In a few words, LEEDuser is an independent website offering supporting information, including templates, spreadsheets, and sample completed documentation forms, to give project teams the necessary support. LEEDuser also offers a forum (online public discussion board) [1]

2.5.3. LEEDuser Forum

The forum is a public space that is accessible to anyone. LEEDuser members have full forum access, and anyone can post to the forum by signing up for a guest LEEDuser account using a valid email address. LEEDuser encourage people to share their LEED questions, comments, lessons learned, and tips in this space, and to answer others' questions.[2]

2.5.4. LEED User Membership

LEEDuser is an information resource design to help individuals and teams achieve LEED certification on projects. It is a membership-based resource published by BuildingGreen, Inc. It has three types of member ship:[3]

- Monthly Individual Membership : 9.95 $ = 61.00 EGP
- Annual Individual Membership : 99.95 = 612.79 EGP
- Annual Team Membership (up to 10 members) : 349.95 $ = 2145.54 EGP

2.6. LEED Rating System Types

The LEED rating systems are tools for encouraging, evaluating, and recognizing green buildings and neighborhoods, with the ultimate goal of market transformation. Comprehensive and flexible, LEED is relevant to buildings in any stage in their life cycles. New Construction, the ongoing operations and maintenance of an existing building, and a significant tenant retrofit to a commercial building are all addressed by LEED rating systems.

The rating systems and their companion reference guides help teams make the right green building decisions for their projects through an integrated process, ensuring that building systems work together effectively. Updated regularly, the rating systems respond to new technologies and policies and to changes in the built environment through an ongoing, consensus-based refinement process. The LEED rating systems address the following types and scopes of projects:

[1] BuildingGreen, Inc. LEEDuser : Frequently Asked Questions. 2012. ON.08 December 2012 <http://www.leeduser.com/content/frequently-asked-questions>.

[2] Ibid.

[3] Op.cit LEEDuser official website .

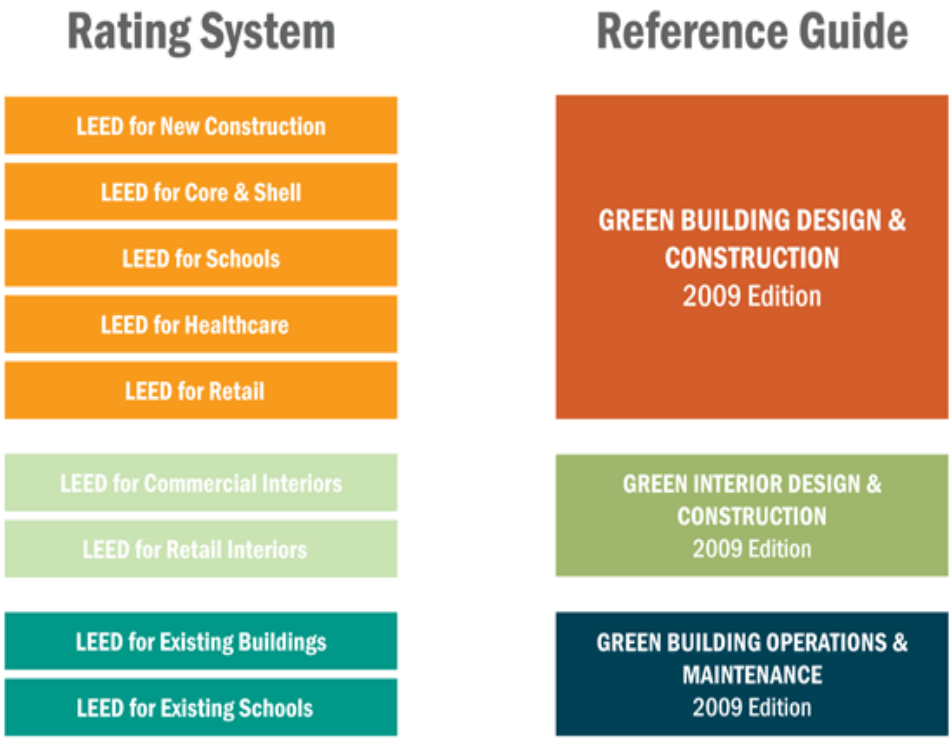

Figure 2-1 : LEED Rating Systems and Reference Guides
Source: USGBC

2.6.1. LEED for New Construction and Major Renovations:

LEED for New Construction & Major Renovations takes an integrative approach to producing buildings that are designed to be efficient and have a lower impact on their environment. LEED (for New Construction) v1.0 was released in 2000 as the first LEED rating system geared towards new commercial office buildings. Today, LEED for New Construction is applied to many building types including offices, libraries, churches, hotels and government buildings. [1]

LEED for New Construction addresses design and construction activities for both new buildings and major renovations of existing buildings, which includes major HVAC improvements, significant envelope modifications, and major interior rehabilitation.

While primarily focused on design and construction, LEED for New Construction also helps lay the foundation for sustainable operations and maintenance practices once the project has been completed. Upfront planning for green operations and maintenance can help building owners and operators ensure that the building performs to its full potential.

2.6.1.1. Who Should Use The LEED for New Construction and Major Renovations

LEED for New Construction was designed primarily for new construction office buildings, but it has been applied to many other building types. Commercial occupancies include (but are not limited to) offices, retails and service establishments, institutional

[1] USGBC. USGBC Official Website : LEED Rating system : New Construction. 2012. ON .08 December 2012 <https://new.usgbc.org/leed/rating-systems/new-construction>.

buildings (libraries, schools, museums, places of worship, etc.), hotels and residential buildings of four or more stories.[1]

2.6.2. LEED for Schools

LEED for Schools addresses design and construction activities for both new school buildings and major renovations of existing school buildings.

The LEED for Schools Rating System recognizes the unique nature of the design and construction of K-12 schools[2]. Based on LEED for New Construction, it addresses issues such as classroom acoustics, master planning, mold prevention, and environmental site assessment. By addressing the uniqueness of school spaces and children's health issues, LEED for Schools provides a unique, comprehensive tool for schools that wish to build green, with measurable results. LEED for Schools is the recognized third-party standard for high performance schools, that are healthy for students, comfortable for teachers, and cost-effective for budgets.[3]

2.6.2.1. When to use LEED for Schools?

LEED for Schools must be used for the construction or major renovation of an academic building on K–12 school grounds. Other projects on a school campus may qualify under 2 or more LEED rating system project scopes; for example, nonacademic buildings on a school campus, such as administrative offices, maintenance facilities, or dormitories, are eligible for both LEED for New Construction and LEED for Schools. Projects involving postsecondary academic buildings or prekindergarten buildings may also choose to use either LEED for New Construction or LEED for Schools.[4]

2.6.2.2. What makes schools different from other building types?

- ***Children's health issues:*** Schools play the crucial role of providing healthy, safe environments for children to learn. Because children breathe more air in proportion to their bodies than adults, environments for children must be carefully designed to minimize indoor pollutant exposure.
- ***Educational mission****:* As learning environments, schools can demonstrate the importance of efficiency and conservation. LEED for Schools offers an opportunity to integrate environmental issues into the curriculum, allowing the built environment to become an interactive teaching tool.

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[1] USGBC,"USGBC : Resources." LEED For New Construction Frequently Asked Questions. ON.08 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=3352>.

2 K–12 Definition by Wikipedia: (pronounced "k twelve", "k through twelve", or "k to twelve") is a designation for the sum of primary and secondary education. It is used in the United States, Canada, Philippines and Australia. P–12 is also occasionally used in Australia. The expression is a shortening of Kindergarten (K) for 4–6-year-olds through twelfth grade (12) for 18–19-year-olds, the first and last grades of free education in these countries

[3] USGBC, LEED For Schools : Frequently Asked Questions . ON. 07 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5020>.

[4] USGBC. "USGBC : Resources." November 2008. LEED 2009 for Schools New Construction and Major Renovations Rating System For Public Use and Display. ON. 07 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5547>.

- ***Complex programmatic spaces:*** Schools combine many functions into a relatively small space; from classrooms to gymnasiums, cafeterias to machine shops, the job of school designers is particularly complex. LEED for Schools gives project teams guidance on the specific needs of unique space types.

2.6.3. LEED for Healthcare

The LEED for Healthcare Rating System recognizes the unique nature of healthcare facilities while maintaining close alignment to LEED for New Construction. Healthcare buildings often have strict regulatory requirements, 24/7 operations, and specific programmatic demands that make pursuing LEED NC difficult. The LEED for Healthcare Rating System acknowledges these differences by both modifying existing credits and creating new, Healthcare-specific credits. For example, most of the Indoor Environmental Quality credits have been modified to align the need for infection control, to protect patients from contaminants, and the strict code regulations on ventilation with green building strategies. Overall, 6 prerequisites and 25 credits were modified and 3 perquisites and 15 credits were added to the rating system.[1]

2.6.3.1. The foundation of LEED for Healthcare

The LEED for Healthcare rating system represents a culmination of seven years of close collaboration between the Green Guide for Health Care (GGHC) and USGBC. GGHC, a joint project of *Health Care without Harm* and *Center for Maximum Potential Building Systems*, has helped to streamline the LEED for Healthcare development schedule by aligning with the LEED for New Construction rating system's organizational structure. The GGHC is the first voluntary, self-certifying toolkit of green building best practices customized for the healthcare sector. The GGHC conducted a robust pilot program that included more than 100 health care facilities that informed the development of the LEED for Healthcare rating system.[2]

2.6.3.2. When to use LEED for Healthcare?

The healthcare sector represents a wide variety of building types. This rating system is appropriate for buildings that serve individuals who seek medical treatment, including licensed and federal inpatient care facilities, licensed and federal outpatient care facilities, and licensed and federal long term care facilities. These are considered LEED for Healthcare 'designated' uses. Buildings with other kinds of medically related uses, such as unlicensed outpatient facilities, medical, dental and veterinary offices and clinics, assisted living facilities and medical education & research centers are examples of 'non-designated' uses, and may use LEED for Healthcare at the project team's discretion.[3]

[1]USGBC. LEED For Healthcare : Frequently Asked Questions. ON.07 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=8652>.

[2]USGBC . "USGBC : Resources." LEED 2009 for HealthCare For Public Use and Display. On.07 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=8878>.

[3] Op Cit : LEED For Healthcare : Frequently Asked Questions

2.6.4. LEED for Existing Buildings: Operations & Maintenance (EBOM)

LEED for Existing Buildings: Operations & Maintenance encourages owners and operators of existing buildings to implement sustainable practices and reduce the environmental impacts of their buildings over their functional life cycles. Specifically, the rating system addresses exterior building site maintenance programs, water and energy use, environmentally preferred products and practices for cleaning and alterations, sustainable purchasing policies, waste stream management, and ongoing indoor environmental quality.[1]

2.6.4.1. When to use LEED for Existing Buildings: Operations & Maintenance (EBOM)

LEED for Existing Buildings: Operations & Maintenance was designed to certify the sustainability of ongoing operations of existing commercial and institutional buildings. All such buildings, as defined by standard building codes, are eligible for certification under LEED for Existing Buildings: Operations & Maintenance and include offices, retail and service establishments, institutional buildings (libraries, schools, museums, churches, etc.), hotels, and residential buildings of 4 or more habitable stories.

LEED for Existing Buildings: Operations & Maintenance provides owners and operators of existing buildings an entry point into the LEED certification process and is applicable to the following:[2]

- Building operations, processes, systems upgrades, minor space-use changes, and minor facility alterations or additions; and
- Buildings new to LEED certification as well as buildings previously certified under LEED for New Construction, LEED for Schools, or LEED for Core & Shell; these may be either ground up new construction or existing buildings that have undergone major renovations.

LEED for Existing Buildings: Operations & Maintenance is targeted at single buildings, whether owner occupied, multitenant, or multiple-building campus projects. It is a whole-building rating system; individual tenant spaces are ineligible.

2.6.4.2. LEED EBOM special considerations

- **Performance Period:** Under the EBOM Rating System, buildings must prove compliance within a performance period. This continuous (unbroken) period shows that all of the building systems are in order and are operating properly. The goal is to measure systems' efficiency. Initial certification requires a minimum performance period of three months (except when specific credits require a longer period for compliance) and a maximum of 24 with no gaps. Performance periods for each credit must end within a week of each other. Figures from the performance period must be submitted within 60 days of completion.[3]

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[1] USGBC. "USGBC official web site : LEED : Rating Systems : Existing Buildings." Existing Buildings. ON.08 December 2012 <https://new.usgbc.org/leed/rating-systems/existing-buildings>.

[2] USGBC. "USGBC : Resources." 1 November 2011. LEED 2009 for Existing Buildings: Operations & Maintenance Rating system For public use and Display. ON. 08 December 2012 <https://new.usgbc.org/sites/default/files/LEED_2009_Rating_EBOM_11_2011.pdf>.

[3]USGBC. LEED for Existing Buildings: Operations & Maintenance Recertefication Guide. Washington DC: U.S. Green Building Council, November 2012.

- **Recertification:** With all other rating systems, once the certification is complete, it's done. There's no more work that needs to be done to maintain their status. The EBOM Rating System is a little different and requires that a building be recertified every five years or sooner. The performance period for recertification is the entire period between initial certification and the current application. [1]

2.6.5. LEED for Core & Shell

LEED for Core & Shell development is a green building system that was designed to provide a set of performance criteria for certifying the sustainable design and construction of speculative developments and core and shell buildings. Broadly defined, core and shell construction covers base building elements, such as the structure, envelope and building-level systems, such as central HVAC, etc. The LEED for Core and Shell system recognizes that the division between owner and tenant responsibility for certain elements of the building varies between markets.[2] LEED for Core and Shell is designed to be complementary to LEED for Commercial Interiors and LEED for Retail: Commercial Interiors.

2.6.5.1. When to use LEED for Core and Shell?

LEED for Core & Shell can be used for projects in which the developer controls the design and construction of the entire core and shell base building (e.g., mechanical, electrical, plumbing, and fire protection systems) but has no control over the design and construction of the tenant fit-out. Examples of this type of project can be a commercial office building, medical office building, retail center, warehouse, and lab facility.[3]

2.6.5.2. Precertification

Precertification is unique to LEED for Core & Shell and provides formal recognition by GBCI that the owner or developer has established LEED for Core & Shell certification as a goal. It gives core and shell building owners and developers a marketing tool to attract potential tenants and financiers who recognize the benefits of a LEED-certified building. Precertification generally occurs early in the design process and is based on declared goals and the intent to use green strategies, systems, and/or features, not actual achievement of these features.

2.6.6. LEED for Commercial Interiors

LEED for Commercial Interiors is the recognized system for certifying high-performance green tenant spaces that are healthy, productive places to work; are less costly to operate and maintain; and have a reduced environmental footprint. It gives tenants and designers, who do not always have control over whole building operations, the power to make sustainable

[1] Green Associate Exam Preparation Study Guide. 2009.

[2] USGBC. "USGBC : Resources." LEED For Core & Shell Frequently Asked Questions. ON.14 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=3355>.

[3] USGBC. "USGBC : Resources." 06 July 2012. LEED 2009 for Core and Shell Development Rating System for Public use and Display. ON.14 December 2012 <https://new.usgbc.org/sites/default/files/LEED%202009%20Rating_CS-GLOBAL_07-2012_8c.pdf>.

choices. Making these choices during tenant improvements and interior renovations can dramatically affect the indoor environment.[1]

LEED for Commercial Interiors was designed to work hand-in-hand with the LEED for Core & Shell rating system, used by developers to certify the core and shell of a project and prepare the building for environmentally conscious tenants.

2.6.6.1. When to Use LEED for Commercial interiors?

LEED 2009 for Commercial Interiors addresses the specifics of tenant spaces primarily in office, retail, and institutional buildings. Tenants who lease their space or do not occupy the entire building are eligible.[2]

2.6.7. LEED for Retail

LEED for Retail is designed to guide and distinguish high-performance retail projects, including banks, restaurants, apparel, electronics, big box and everything in between.

LEED for Retail recognizes the unique nature of the retail environment and addresses the different types of spaces retailers need for their product lines. Compared with other commercial buildings, retail has different occupancy characteristics and hours of operation, different parking and transportation considerations, and different process water and energy consumption. Retail projects also may be part of a larger multi-tenant retail complex, where certain issues are addressed at the site level rather than by the project itself.[3]

LEED for Retail provides two options for projects seeking certification:

- **New Construction & Major Renovations:** Addresses specifics for the construction or major renovation of a retail building. A major renovation includes major HVAC improvements, significant envelope modifications and major interior rehabilitation.
- **Commercial Interiors:** Addresses the specifics of tenant spaces where a retailer is retrofitting an existing building, and the shell of the building is outside of the tenant's control. Individual tenants may seek LEED for Retail: Commercial Interiors certification for their spaces whether the rest of the building is LEED-certified or not. And it works hand-in-hand with LEED for Core & Shell.

2.6.8. LEED for Homes

LEED for Homes is a green home rating system for ensuring that homes are designed and built to be energy and resource efficient and healthy for occupants. LEED can be applied to single and multi-family homes and is intended for both market-rate and affordable housing.[4] LEED for Homes promotes the design and construction of high-performance homes – energy efficient, resource efficient and healthy for occupants. A home that achieves LEED certification has been designed to maximize fresh air indoors, minimizing exposure to

[1] USGBC. USGBC : LEED : Rating Systems : LEED for Commercial Interiors. 2012. ON.15 December 2012 <https://new.usgbc.org/leed/rating-systems/commercial-interiors>.

[2] USGBC. "USGBC : Resources." LEED For Commercial Interiors Frequently Asked Questions. ON.15 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=3354>.

[3] USGBC. USGBC : LEED : Rating Systems : LEED for Retail. 2012. ON.15 Decemebr 2012 <https://new.usgbc.org/leed/rating-systems/retail>.

[4] USGBC. "USGBC : Resources." Frequently Asked questions : LEED for Homes. ON.16 December 2012 <http://www.usgbc.org/Showfile.aspx?documentID=2352>.

airborne toxins and pollutants. It also has the potential to use 20-30% less energy—and some up to 60% less—than a home built to code. And less energy use means lower utility bills every month.[1]

2.6.8.1. LEED for Homes International Pilot

The U.S. Green Building Council's LEED for Homes rating system was officially launched in February 2008. Up until this point, certification under the LEED for Homes rating system has been limited to the United States and U.S. territories. As a response to growing international interest in residential green building and LEED for Homes, USGBC has decided to launch an international pilot. Starting with a focus on the Middle East and China, project teams building in these areas may now apply to the upcoming international pilot. Project teams from outside these regions may apply to the international pilot but only projects of significant scale will be accepted.[2]

2.6.8.2. LEED for Homes Green Rater Program

A Green Rater is an individual who works as a part of the LEED for Homes Provider team (and may be in-house staff or subcontractor) to perform field inspections and performance testing. Green Raters may work closely with the individual project teams to assist the design and construction professionals in meeting their sustainability goals.[3]

Providers provide quality assurance oversight for each Green Rater. LEED for Homes Providers are local organizations selected by USGBC based on demonstrated experience and expertise in supporting builders in the construction of high-performance, sustainable homes in their market.[4]

Green Raters are responsible for:

- Providing on-site verification services on a LEED for Homes registered project
- Assembling the Project Submittal Package and submitting it for certification review
- Verifying that the home is designed and built to the rigorous requirements of the LEED for Homes rating system through onsite verification.
- Green Raters must be involved with the project from the design phase (prior to a preliminary rating) and throughout the construction process.
- Project teams interested in participating in the LEED for Homes program must contact a LEED for Homes Green Rater.

2.6.9. LEED for Neighborhood Development

LEED for Neighborhood Development integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design .Whole

[1] USGBC. USGBC Official Web Page : LEED : Rating Systems : Homes : Overview. ON.17 December 2012 <http://new.usgbc.org/leed/rating-systems/homes/>.

[2] USGBC. "USGBC : Resources." U.S. Green Building Council : LEED for Homes International Pilot. ON.16 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=8679>.

[3] USGBC. "USGBC : Resources." LEED for homes v2008 - 01/01/2010 - present. ON.16 December 2012 <https://new.usgbc.org/sites/default/files/LEED%20for%20Homes%20Rating%20System.pdf>.

[4] USGBC. USGBC Official Web Page : LEED : Rating Systems : Homes : Green raters. ON.16 December 2012 <http://new.usgbc.org/leed/rating-systems/homes/green-rater>.

neighborhoods, portions of neighborhoods, multiple neighborhoods—there is no minimum or maximum size for a LEED for Neighborhood Development project.[1]

Unlike any other LEED for Neighborhood Development, developed in collaboration with *Congress for the New Urbanism* [2] and *the Natural Resources Defense Council* [3], emphasizes elements that bring buildings and infrastructure together and relates the neighborhood to its local and regional landscape.

Although LEED for Neighborhood Development was developed as a rating system for U.S. land use practices and may not be suited to aspects of land use development in other countries International projects can register and pursue certification under LEED-ND, but may face challenges pursuing certain credits. To address these challenges in the future, USGBC is requesting feedback from international projects using LEED-ND to determine if the rating system encourages regionally appropriate and culturally sensitive planning and design decisions outside of the U.S. This program is an opportunity for international projects to provide feedback and for USGBC to learn from the international application of the rating system. All international projects are required to participate in this program, except for Canadian projects (though they are also encouraged to participate).[4]

2.6.10. How to Choose The Appropriate Rating System For Your Project?

The USGBC has developed the LEED rating system selection guidance on its own website. This guidance was developed to explain what type of project each LEED rating system was written for. It provides general guidance for project teams to consider in order to make a reasonable decision before registering their project, this guidance is applicable for all rating systems except for LEED For Schools ,LEED for Healthcare ,and LEED for neighborhood projects , because they are very specific projects and must certify under these rating systems.

- ***Step 1 - Choose a rating system based on construction type:*** Determine which construction type the project falls into. Be sure to consider the building in its entirety or the complete interior space, is it complete construction, core and shell construction, interior construction, or Limited construction (Existing building)
- ***Step 2 - Choose a rating system based on space usage type*:** If there are multiple rating systems applicable to the construction type, choose one based on space usage type, is it commercial interior, Retail, school, or homes…. Etc.
- ***Step 3 - Make a decision:*** When several rating systems may be appropriate, use the 40/60 rule ,If the correct rating system is not obvious, for example, if different parts of

[1] USGBC. USGBC : LEED : Rating Systems :Neighborhood. ON.17 december 2012 <http://new.usgbc.org/leed/rating-systems/neighborhoods>.

[2] States The Congress for the New Urbanism (CNU) is The primary organization promoting the New Urbanism in the United ,it is the leading organization promoting walkable, mixed-use neighborhood development, sustainable communities and healthier living conditions

[3] The Natural Resources Defense Council (NRDC) is a New York City-based, non-profit, non-partisan international environmental advocacy group, with offices in Washington, D.C., San Francisco, Los Angeles, Chicago, and Beijing. Founded in 1970, NRDC today has 1.3 million members and online activists nationwide and a staff of more than 400 lawyers, scientists and other policy experts.

[4] USGBC. "USGBC : Resources." LEED for Neighborhood Development International Frequently Asked Questions (FAQ). ON.17 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=7586>.

the project are undergoing different kinds of construction or are serving different space usage types, carefully review the rule below

The "***40/60 rule***" provides guidance for making a decision when several rating systems appear to be appropriate for a project. To use this rule, first 'assign' a rating system to each square foot of the building based on the guidance above

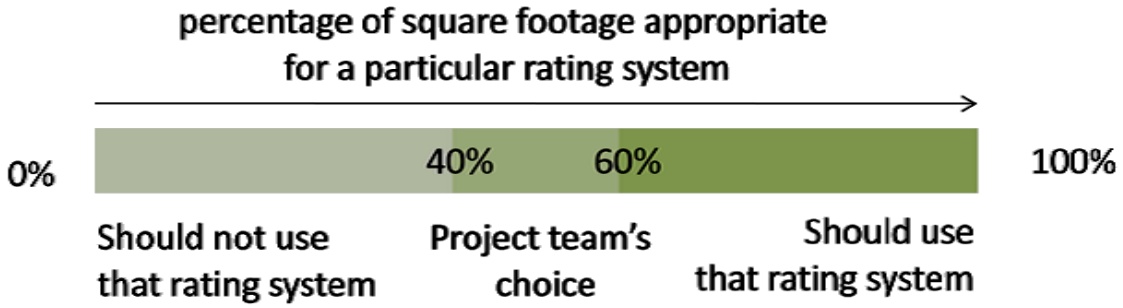


Figure 2-2 : Rule 40/60
Source: USGBC

- If a rating system is appropriate for less than 40% of the gross floor area of a LEED project building or space, then that rating system should not be used.
- If a rating system is appropriate for more than 60% of the gross floor area of a LEED project building or space, then that rating system should be used.
- Project teams with buildings and spaces that do not fall into the scenarios described in the previous points must independently assess their situation and decide which rating system is most applicable.

2.7. LEED Volume

The LEED Volume Program is for organizations planning to certify a large number of design and construction projects or existing buildings. It works by establishing verifiable guidelines that streamline the certification process without compromising LEED's rigorous standards. This new program dramatically increases the efficiency of LEED certification and lowers the associated costs.[1]

2.7.1. Who should use LEED Volume?

The Volume Design & Construction certification process is for companies planning at least 25 ground-up or interior construction projects. Because of their prototypical approach to building and an ongoing commitment to expansion, retailers and hoteliers are particularly well suited for the LEED Volume Program.[2]

[1] USGBC. USGBC officiac website : LEED Volume Program - NEW. 2012. ON.09 December 2012 <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2267>.

[2] GBCI. GBCI official website : LEED Certification: Volume Program. 2012. ON.09 December 2012 <http://www.gbci.org/main-nav/building-certification/leed-certification/volume.aspx>.

2.7.2. Main Goals of LEED Volume

- Preserve the integrity of the LEED certification system
- Leverage uniformity in building design, construction, and management to achieve economies of scale and reduce costs for program participants
- Encourage building owners to integrate LEED practices and documentation into organization-wide practices

2.7.3. Benefits of LEED Volume program

- Savings from a more comprehensive LEED implementation process
- Economies of scale based on uniform building design and construction, or operations and maintenance practices
- Lower costs than those associated with traditional LEED certification

2.8. LEED Rating System main Components

Rating systems are groups of requirements for projects that want to achieve LEED certification. Each group is geared towards the unique needs of a project or building type. LEED is flexible enough to apply to all project types including healthcare facilities, schools, homes and even entire neighborhoods. Projects earn points to satisfy green building requirements within each of the LEED credit categories, projects must satisfy prerequisites and earn points. The number of points the project earns determines its level of LEED certification.[1]

2.8.1. LEED Minimum Program Requirements (MPRs)

The MPRs list the basic characteristics that a project must possess to be eligible for certification under the LEED 2009 rating systems, therefore defining a broad category of buildings and spaces that the LEED 2009 rating systems were designed to evaluate. USGBC staff and committee members developed them, with the LEED Steering Committee (LSC) officially approving them in April 2009. In November 2009, the LSC and the USGBC Executive Committee approved of additional MPR language that clarified, but did not add to, the existing requirements. When new rating system versions become available, the MPRs will be completely revised and re-approved.[2]

LEED 2009 Minimum Program Requirements **Apply to** LEED 2009 for New Construction and Major Renovations, LEED 2009 for Core & Shell development, LEED 2009 for Schools, LEED 2009 for Commercial Interiors, and LEED 2009 for Existing Buildings: Operations & Maintenance, LEED for Retail – New Construction, LEED for Retail – Commercial Interiors, LEED for Healthcare ,LEED 2009 Minimum Program

[1] USGBC. LEED Rating System Overview. 16 November 2012 <https://new.usgbc.org/leed/rating-systems>.

[2] USGBC. "USGBC : Resources." 1 Sebtember 2011. LEED 2009 MPR Supplemental Guidance revision 2. ON.13 December 2012 <https://new.usgbc.org/resources/leed-2009-mpr-supplemental-guidance-revision-2-september-2011>.

Requirements **Do not Apply to** LEED for Homes, LEED for Neighborhood Development, or any LEED rating system adopted prior to 2009., The seven MPRs are as below : [1]

- Must Comply with Environmental Laws.
- Must Be a Complete, Permanent Building or Space
- Must Use a Reasonable Site Boundary
- Must Comply with Minimum Floor Area Requirements.(22 m2 gross floor area for commercial interior projects and 93 m2 gross floor area for the rest of the rating systems)
- Must Comply with Minimum Occupancy Rates (at least one Full Time Equivalent)
- Must commit to sharing whole-building energy and Water usage data
- Must comply with a minimum building area to site area ratio (more than 2 %)

2.8.2. Rating System Requirements (Prerequisites and Credits)

Each LEED rating system is comprised of a series of Prerequisites and Credits organized across a series of categories.

- ***Prerequisites:*** Each version of LEED contains unique prerequisite requirements that must be satisfied in order to achieve certification. The phrase or term "prerequisite" refers to a mandatory project characteristic, measurement, quality, value, or function as identified within the LEED rating system. Prerequisites represent the key criteria that define green building and neighborhood development performance. Each project must satisfy all specified prerequisites outlined in the LEED Rating System under which it is registered. Failure to meet any prerequisite will render a project ineligible for certification. [2]
- ***Credits:*** Each project must satisfy a combination of credits necessary for the specific level of certification desired. The phrase or term "credit" means a project characteristic, measurement, quality, value, or function as identified within a LEED rating system. Each credit represents a particular facet of sustainability that contributes to overall green building and neighborhood development design and construction. Credits are selected and pursued at the option of a LEED project team. Credits are arranged in a series of categories. Each credit is associated with a specific number of points. Projects must be awarded a minimum number of points outlined in the LEED rating system under which it is registered to achieve a particular level of certification, such as LEED Certified™, LEED Silver™, LEED Gold™, or LEED Platinum™. [3]

2.8.3. Main LEED Categories

- ***Sustainable sites credits*** encourage strategies that minimize the impact on ecosystems and water resources.
- ***Water efficiency credits*** promote smarter use of water, inside and out, to reduce potable water consumption.

[1] USGBC. "USGB : Resources." 1 January 2011. LEED v2009 Minimum Program Requirements. ON.13 December 2012 <https://new.usgbc.org/sites/default/files/Jan2011_Minimum_Program_Requirements.pdf>.

[2] GBCI. 27 April 2009. LEED Certification Policy Manual. ON.09 March 2013 <http://www.gbci.org/Libraries/Certification_Resources/LEED_ND_Certification_Policy_Manual.sflb.ashx>.

[3] Ibid

- ***Energy & atmosphere credits*** promote better building energy performance through innovative strategies.
- ***Materials & resources credits*** encourage using sustainable building materials and reducing waste.
- ***Indoor environmental quality credits*** promote better indoor air quality and access to daylight and views.

2.8.4. Additional LEED for Neighborhood Development Credit Categories

- **Smart location & linkage credits:** promote walkable neighborhoods with efficient transportation options and open space.
- **Neighborhood pattern & design credits:** emphasize compact, walkable, vibrant, mixed-use neighborhoods with good connections to nearby communities.
- **Green infrastructure & buildings credits:** reduce the environmental consequences of the construction and operation of buildings and infrastructure.

2.8.5. Additional LEED for Homes Credit Categories

- ***Location & linkage credits:*** encourage construction on previously developed or infill sites and promotes walkable neighborhoods with access to efficient transportation options and open space.
- ***Awareness & education credits*****:** encourage home builders and real estate professionals to provide homeowners, tenants and building managers with the education and tools they need to understand and make the most of the green building features of their home.

2.8.6. Two bonus credit categories

- ***Innovation in design or innovation in operations credits:*** address sustainable building expertise as well as design measures not covered under the five LEED credit categories. Six bonus points are available in this category.
- ***Regional priority credits:*** address regional environmental priorities for buildings in different geographic regions. Four bonus points are available in this category.

2.8.7. Pilot Credits Library

The LEED Pilot Credit Library is an established component of USGBC's existing process of ongoing credit research and evaluation. LEED pilot credits are, first and foremost, learning opportunities. Pilot credits provide focused, real-time project team feedback that is invaluable to LEED rating system development. This real-world project testing creates vital professional and experiential feedback loops for the volunteers who serve as LEED credit authors to learn from. Pilot testing also allows for informed decisions to be made about the technical merit and feasibility of potential LEED ideas and aids LEED credit authors in the development of smarter, more-effective LEED strategies.[1]

[1] USGBC. "USGBC Official Website." April 2012. Pilot Credit - FAQs. ON.08 December 2012 <http://www.usgbc.org/ShowFile.aspx?DocumentID=7572>.

The LEED Pilot Credit Library facilitates the introduction of new prerequisites and credits to LEED, and increases opportunities for stakeholders to engage in the development of the LEED rating system. This process allow USGBC to test and refine credits through LEED project evaluations to be incorporated into credit development alongside the ballot process, and introduced into LEED.

Project teams may register for multiple pilot credits; Pilot credits are used in the Innovation and Design/Innovation and Operations category of the rating system, and will use the ID/IO credit template when applying for the credit in LEED-Online. The template and submittal documentation must be uploaded to LEEDOnline for review, as well as submitted to Pilot Credit Working Group.[1]

2.8.8. Global Alternative Compliance Paths

U.S. Green Building Council (USGBC) has released a new alternative set of Global Alternative Compliance Paths (ACPs) for international commercial projects seeking LEED green building certification using the 2009 versions of the rating systems, according to a company release. Global ACPs are used for international projects to verify compliance with LEED standards.

Alternative Compliance Paths (ACPs) to LEED credits provide additional options or approaches that address unique circumstances and accommodate advancements in science and technology. Projects may use none, some, or all of the LEED 2009 Global ACPs and do not need to apply them consistently across credits unless noted in the credit language. Each credit category's Overview section includes a table identifying which credits have Global ACPs.[2]

ACPs allow LEED to be more flexible and applicable to a wider range of projects. "*Global consistency and a regional approach mean providing flexibility in referenced standards while ensuring that LEED certification signifies the same level of excellence worldwide*," says Scot Horst, Senior Vice President, LEED, USGBC. "*By focusing on global standards and solutions, these Alternative Compliance Paths make LEED increasingly flexible and ensure a common language for all green buildings*."

2.8.9. LEED Credits Weighing and Certification Level

In LEED 2009, the allocation of points between credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are defined as the environmental or human effect of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants, indoor environmental conditions. A combination of approaches, including energy modeling, life-cycle assessment, and transportation analysis, is used to quantify each type of impact. The resulting allocation of points among credits is called credit weighting.

The LEED 2009 credit weightings process is based on the following parameters, which maintain consistency and usability across rating systems:

- All LEED credits are worth a minimum of 1 point.

[1] Ibid

[2] USGBC. LEED Reference Guide for Green Building Design and Construction with Global ACPs. U.S. Green Building Council, 2012.

- All LEED credits are positive, whole numbers; there are no fractions or negative values.
- All LEED credits receive a single, static weight in each rating system; there are no individualized scorecard based on project location.
- All LEED rating systems have 100 base points; Innovation in Design (or Operations) and Regional Priority credits provide opportunities for up to 10 bonus points except for LEED for homes Which have 136 possible points , Credits points are explained in details in ***Table (2-1)***

Table 2-1: LEED Credits Weighting
Source: Research **by:** Researcher

Possible Points	LEED 2009 NC	LEED 2009 SCH	LEED 2009 HC	LEED 2009 EBOM	LEED 2009 CS	LEED 2009 CI	LEED 2009 Retail: NC	LEED 2009 Retail: CI	LEED for Homes	LEED 2009 for ND
Sustainable Site	26	24	18	26	28	21	26	21	22	
Water Efficiency	10	11	9	14	10	11	10	11	15	
Energy and Atmosphere	35	33	39	35	37	37	35	37	38	
Materials and Resources	14	13	16	10	13	14	14	14	16	
Indoor Environmental Quality	15	19	18	15	12	17	15	17	21	
Innovation in Design	6	6	6	6	6	6	6	6	11	6
Regional Priority	4	4	4	4	4	4	4	4		4
Smart Location and Linkage									10	27
Neighborhood Pattern and Design										44
Green Infrastructure and Buildings										29
Awareness & Education									3	
Total	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**136**	**110**

2.8.10. LEED Project Scorecard

A LEED project scorecard or check list is list with all LEED credits and its weighing of points; each rating system has its own scorecard that can be downloaded from USGBC official website. ***(Fig 2-3)***

A LEED scorecard is very useful for all project team, as it identifies possible targeted credits, and it also identifies credits' responsibilities for all project team, however a LEED scorecard shall be updated on monthly basis and at the end of each project phases by the LEED coordinator.

2.9. LEED Market

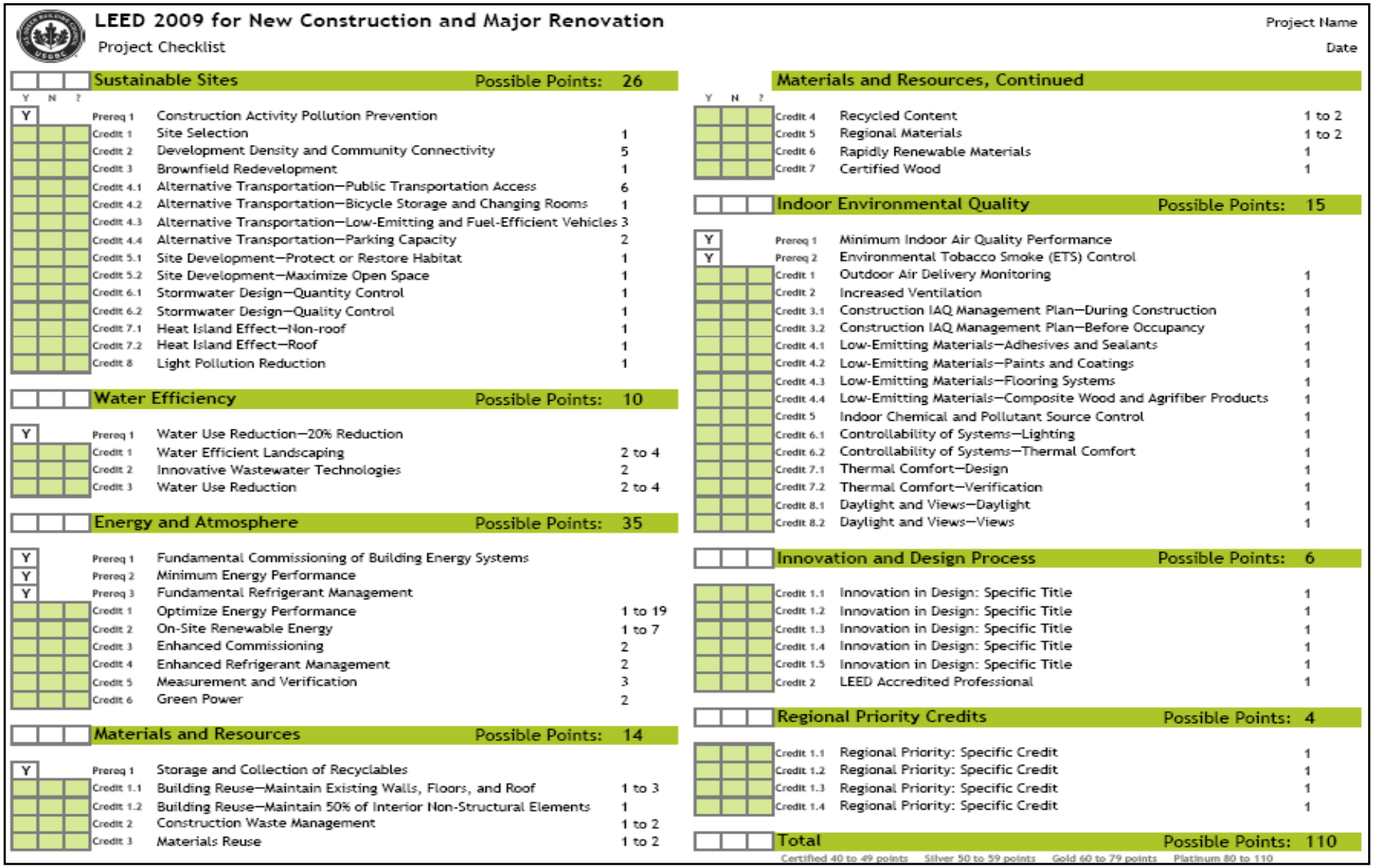
According to the Annual GREEN BUILDING IMPACT REPORT 2011, the International certified floor area grew by over 7 percent, or almost eight million ft.² (743,224 m.²) in 2011 compared to 2010. In spite of this better performance internationally on the certification front, overall the total percentage of LEED projects certifying overseas remains far below that of the United States — 16 percent for all international vs. 34 percent in the US.

A good part of this could be the fact that internationally, LEED did not really get started until 2007, with the exception of the national licensing programs for India and Canada. In addition, most projects outside the US are 3 to 4 times as large as the average US project. Bigger projects mean longer lead times, longer construction cycles, etc. It also could be argued that larger projects mean greater risk to exposure to the global construction slowdown.[1]

Table 2-2 : 2011 LEED System Share
Source: Green Building Impact Report 2011

Rating System	Certified Floor Area		
	US.	**International**	**All Projects**
EBOM	44%	22%	39%
NC (incl. Retail)	32%	28%	31%
CS	7%	27%	11%
CI	6%	5%	6%
Schools	2%	0%	2%
ND	9%	18%	10%

[1] Watson, ROB, Senior Contributor to GreenerBuildings.com. "GreenBiz : Research : Reports." 08 November 2011. Green Building Market and Impact Report 2011. On.26 December 2012 <http://www.greenbiz.com/sites/default/files/GBMIR_2011-web_0.pdf>.



LEED 2009 for New Construction and Major Renovation

Project Checklist

Project Name

Date

Y	N	?			
			Sustainable Sites	**Possible Points:**	**26**
Y			Prereq 1	Construction Activity Pollution Prevention	
			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
			Credit 6.1	Stormwater Design—Quantity Control	1
			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
			Credit 8	Light Pollution Reduction	1
			Water Efficiency	**Possible Points:**	**10**
Y			Prereq 1	Water Use Reduction—20% Reduction	
			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
			Credit 3	Water Use Reduction	2 to 4
			Energy and Atmosphere	**Possible Points:**	**35**
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
			Credit 1	Optimize Energy Performance	1 to 19
			Credit 2	On-Site Renewable Energy	1 to 7
			Credit 3	Enhanced Commissioning	2
			Credit 4	Enhanced Refrigerant Management	2
			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2
			Materials and Resources	**Possible Points:**	**14**
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Y	N	?			
			Materials and Resources, Continued		
			Credit 4	Recycled Content	1 to 2
			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1
			Indoor Environmental Quality	**Possible Points:**	**15**
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
			Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
			Credit 3.1	Construction IAQ Management Plan—During Construction	1
			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
			Credit 5	Indoor Chemical and Pollutant Source Control	1
			Credit 6.1	Controllability of Systems—Lighting	1
			Credit 6.2	Controllability of Systems—Thermal Comfort	1
			Credit 7.1	Thermal Comfort—Design	1
			Credit 7.2	Thermal Comfort—Verification	1
			Credit 8.1	Daylight and Views—Daylight	1
			Credit 8.2	Daylight and Views—Views	1
			Innovation and Design Process	**Possible Points:**	**6**
			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1
			Regional Priority Credits	**Possible Points:**	**4**
			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1
			Total	**Possible Points:**	**110**

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Figure 2-3: LEED Scorecard **Source**: USGBC

In the United States the LEED 2009 certification profile is similar to the overall certification distribution of the system, although the Platinum certification is awarded more frequently. Perhaps some of the more experienced teams increasingly are going after this coveted award.

Table 2-3 : LEED Certified Projects in US
Source: Green Building Impact Report 2011

LEED US Certification Shares	LEED 2009		All Rating Systems Since Start	
	No. of Certified Projects	Share	No. of Certified Projects	Share
Certified	193	20%	2190	22%
Silver	337	34%	3381	33%
Gold	366	37%	3981	39%
Platinum	88	9%	583	6%
Total	**984**		**10141**	

Internationally, the certification distribution is heavily skewed toward Gold and Platinum — over 60 percent of projects certified internationally got one of these levels — indicating that the global construction elite is pursuing LEED even more aggressively than the construction leaders in the US.

Table 2-4 : Non-US Project Certification Distribution
Source: Green Building Impact Report 2011

Level of Certification	No. of Certified Projects	Share
Certified	97	14 %
Silver	179	25 %
Gold	335	48 %
Platinum	91	13 %
Total	**702 Projects**	

USGBC has created a new data visualization tool, "LEED in the World," which lists the current number of both registered and certified LEED projects across the globe by gross square meters in different regions, and ranks the top 10 countries for green building. The numbers show the explosive growth of the green building movement beyond North America, demonstrating the growing global consensus about the worldwide imperative to green the built environment. Table (2-5)

Table 2-5 : Top 10 Countries with Registered & Certified Projects
Source: USGBC, April 2013

Rank	Country	No. of Projects	Floor Area (Gross Square Meter)
1	United States	44,270	595.8 million
2	China	1,156	66.5 million
3	United Arab Emirates	808	46.1 million
4	Brazil	638	18.1 million
5	India	405	6.9 million
6	Canada	383	7.9 million
7	Mexico	322	7.9 million
8	Germany	299	6.1 million
9	Turkey	194	8.9 million
10	Republic of Korea	188	15 million

2.10. LEED in Egypt

According To USGBC LEED Projects & Case Studies Directory, Egypt have 14 registered projects and only Two Certified Buildings.

- Three Projects registered under LEED New Construction Version 2.2
- Eight Projects registered under LEED New Construction Version 2009
- Two Projects registered under LEED Commercial Interiors Version 2009
- One Projects registered under LEED Core & Shell Version 2009
- One **Gold Certified** LEED New Construction Version 2.2
- One **Silver Certified** LEED New Construction Version 2009

2.11. Conclusion

US Green Building Council is a non-profit organization (formed in 1993) committed to a prosperous and sustainable future through cost-efficient and energy-saving green buildings. GBCI was established in 2008 to administer the whole LEED process. The main roles of **USGBC, GBCI, LEED online and LEED user** are illustrated in the Fig (2-4)

- **USGBC** is responsible for developing rating systems, reference guides and education program
- **GBCI** administers building certification and professional accreditation.
- Both **USGBC** and **GBCI** are linked with **LEEDONLINE** which is an online tool through which entire LEED Certification is handled. It is an online storage system where all details (credit templates, drawings, supporting documents etc) for LEED documentation are stored.
- **LEEDuser** Helps LEED professionals with the LEED certification process through LEEDuser forum and the provided templates, tips , checklists and other resources.

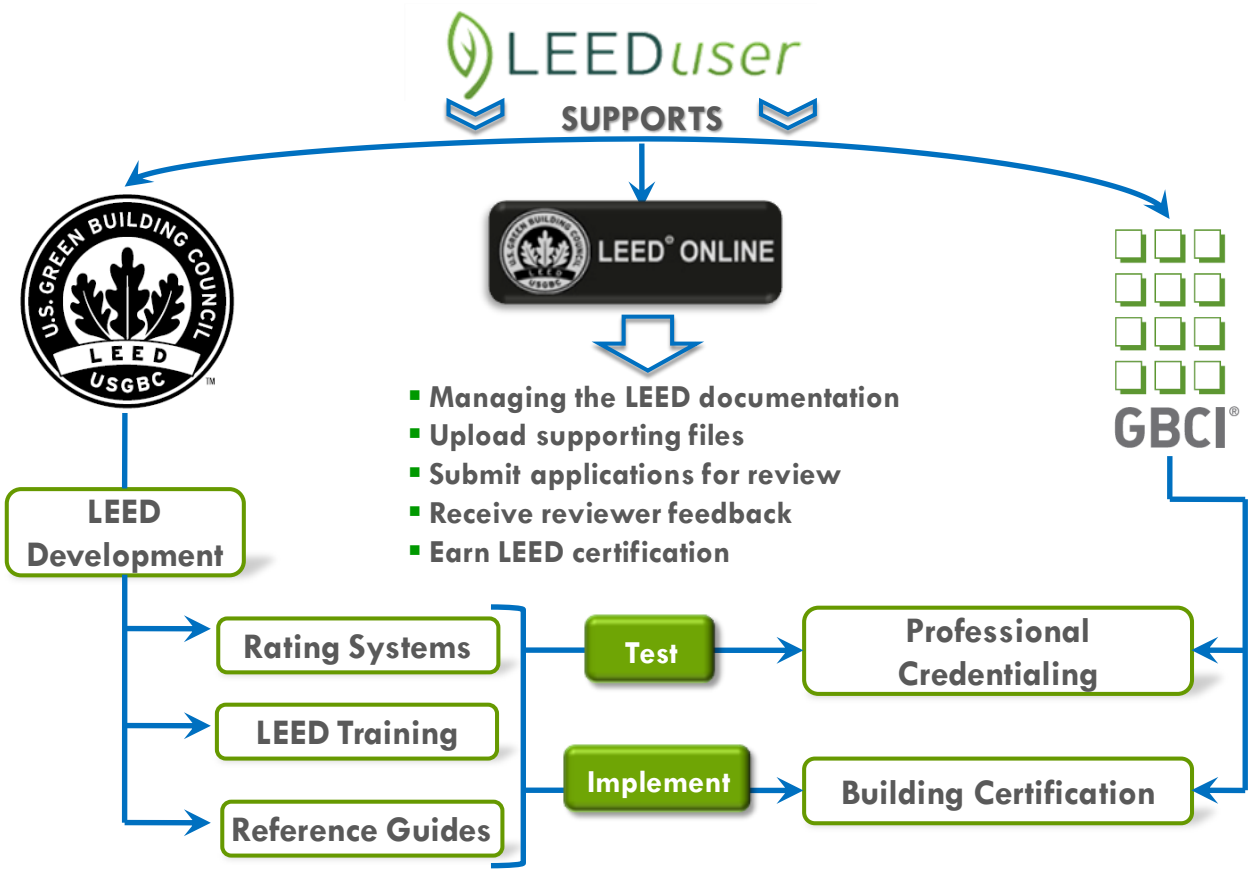


Figure 2-4 : LEED Involved Parties
Source: Research **By:** Researcher

LEED consists of a suite of ten rating systems for the design, construction and operation of buildings, homes and neighborhoods. Five overarching categories correspond to the specialties available under the LEED Accredited Professional program. That suite currently consists of:

Green Building Design & Construction

- LEED for New Construction and Major Renovation
- LEED for Core & Shell
- LEED for Schools
- LEED for Retail: New Construction and Major Renovations
- LEED for Healthcare

Green Interior Design & Construction

- LEED for Commercial Interiors
- LEED for Retail: Commercial Interiors

Green Building Operations & Maintenance

- LEED for Existing Buildings: Operations & Maintenance

Green Neighborhood Development

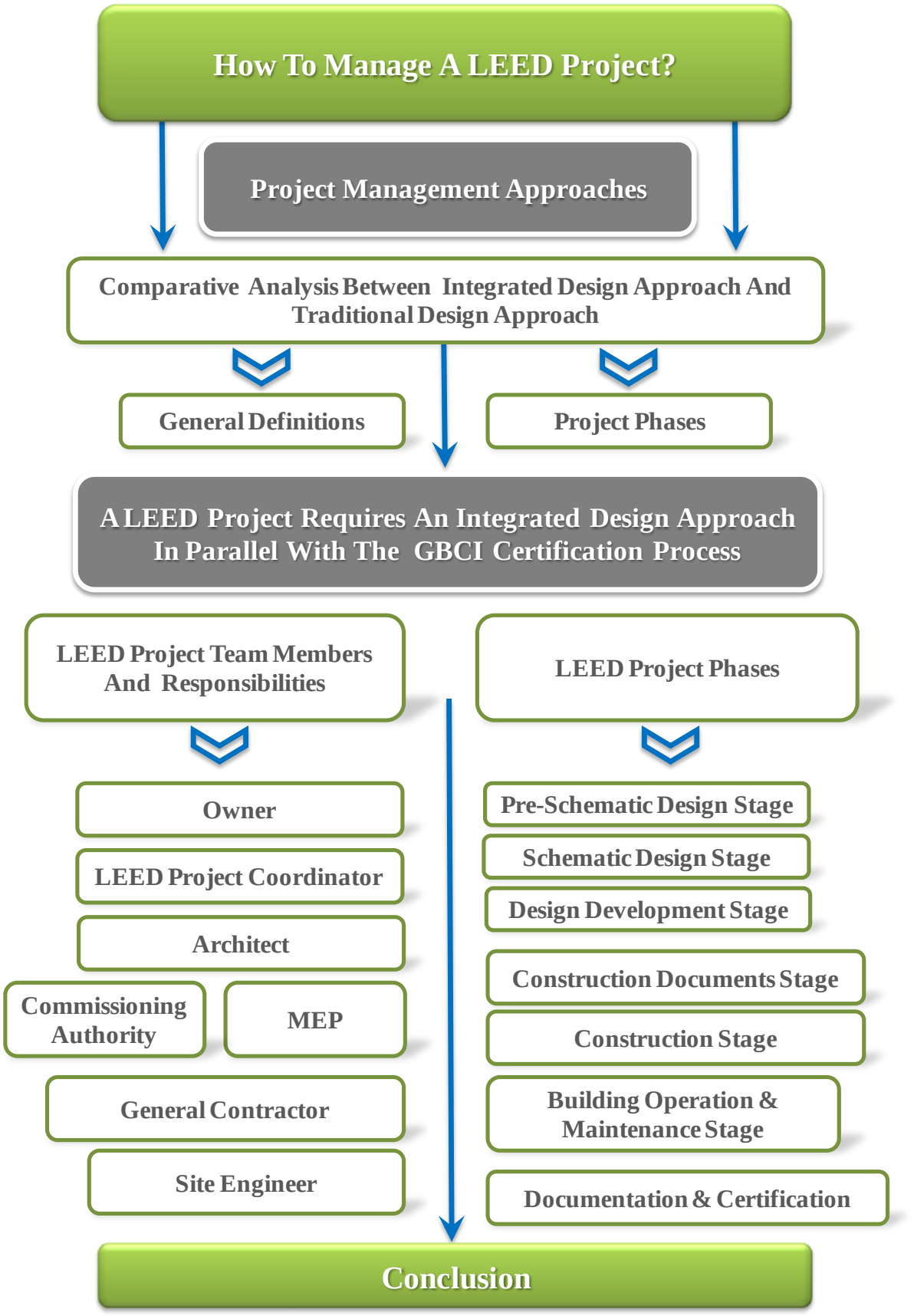
- LEED for Neighborhood Development

Green Home Design and Construction

- LEED for Homes

Chapter Three

Managing a LEED Project


How To Manage A LEED Project?
Project Management Approaches
Comparative Analysis Between Integrated Design Approach And Traditional Design Approach
General Definitions
Project Phases
A LEED Project Requires An Integrated Design Approach In Parallel With The GBCI Certification Process
LEED Project Team Members And Responsibilities
LEED Project Phases
Owner
LEED Project Coordinator
Architect
Commissioning Authority
MEP
General Contractor
Site Engineer
Pre-Schematic Design Stage
Schematic Design Stage
Design Development Stage
Construction Documents Stage
Construction Stage
Building Operation & Maintenance Stage
Documentation & Certification
Conclusion

CHAPTER 3: MANAGING A LEED PROJECT

The Key Ingredient for managing a LEED project is the integrated Design and construction approach. In a traditional project, everyone is concerned about his own discipline; the mechanical engineer focuses on the HVAC needs. The landscape architect is busy doing land surveys and designing the landscape. The electrical engineer gets started identifying the electrical and indoor and outdoor lighting needs for the project. Team members seems not to work according to a strategic plan or identified goals and synergies, everyone is doing his job separately. With a LEED project a totally different approach is required. **LEED projects require establishing an integrated design and a construction Plan from day-one of the project and keeping it updated at least every month according to the needs of the project.**

In a LEED Project the cooperation of all project parties is required in all the stages of the building (Design, construction, operation and maintenance). Owner, Architects, Electromechanical Engineers, and Contractors will have to participate to come up with best practices and construction synergies. In fact, the ultimate success of a LEED project truly depends on managing the LEED project with an integrated Design and Construction Team, Therefore the First step to start a LEED project is to assign a LEED Project Coordinator, or a LEED Consultant.

In this chapter the researcher will discuss the role of the LEED coordinator and the key project team members by going through the stages of a LEED project, and the whole process of certification.

3.1. Traditional Approach versus Integrated Approach

In order to understand why managing a LEED project differs from managing a traditional one there have to be a clear understanding of the Traditional Design Approach and the Integrated Design Approach (IDP).

According to Danny Pearl[1] , A LEED AP and a founding partner of the Canadian architecture firm L'OEUF, *" In conventional design, the architect (or designer) and the client agree on a design concept consisting of a general massing scheme, orientation, fenestration, and the general exterior appearance of the building. Then mechanical, electrical and structural engineers are asked to implement the design and to suggest appropriate systems. The problem with conventional practice is that the design process is too quick and simple, often resulting in high operating costs, poor comfort performance and very few sustainable gestures that fall within the client's restrained budget."*

During a Traditional (or Conventional) approach, design and construction engineers work separately on their scope of proficiency, when new consultants (such as mechanical, structural, electrical or….) are added to the team of the project in the middle of the design or construction process, the new team member shares their relevant background information that changes the project in a late stage, which require more time, effort and money to go back on track or the project team decide to discard these changes , however in both cases the owner is the one who would suffer the consequences .

[1] Pearl, D. "Canadian Architect." 01 June 2004. An Integrated Design Process (IDP) :The crossover between practice and education breeds a new form of architectural representation. ON.17 February 2013 <http://www.canadianarchitect.com/news/an-integrated-design-process-idp/1000156278/>.

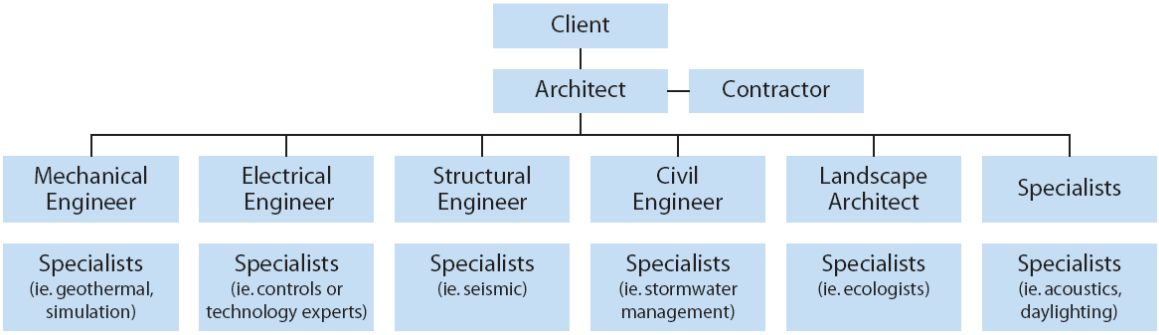


Figure 3-1: Traditional Project Team Organization
Source: Perkins, B., Will Stantec Consulting 2007

The Integrated Design Process differs from this traditional approach by having all team members with various scope of expertise brought together in a design charette to go through a multi brain storming process in early pre-design phase, where the highest potentials and the greatest values are realized from all parties.

"The Integrated Design Process (IDP) is a method for realizing high performance buildings that contribute to sustainable communities. It is a collaborative process that focuses on the design, construction, operation and occupancy of building over its complete life-cycle. The IDP is designed to allow the client and other stakeholders to develop and realize clearly defined and challenging functional, environmental and economic goals and objectives."

Nils Larsson[1]

[1] Larsson, N. "Report on a National Workshop held in Toronto in October 2001." March 2002. The Integrated Design Process. ON.17 February 2013 <http://www.waterfrontoronto.ca/dbdocs/4561b17f1ccf1.pdf>.

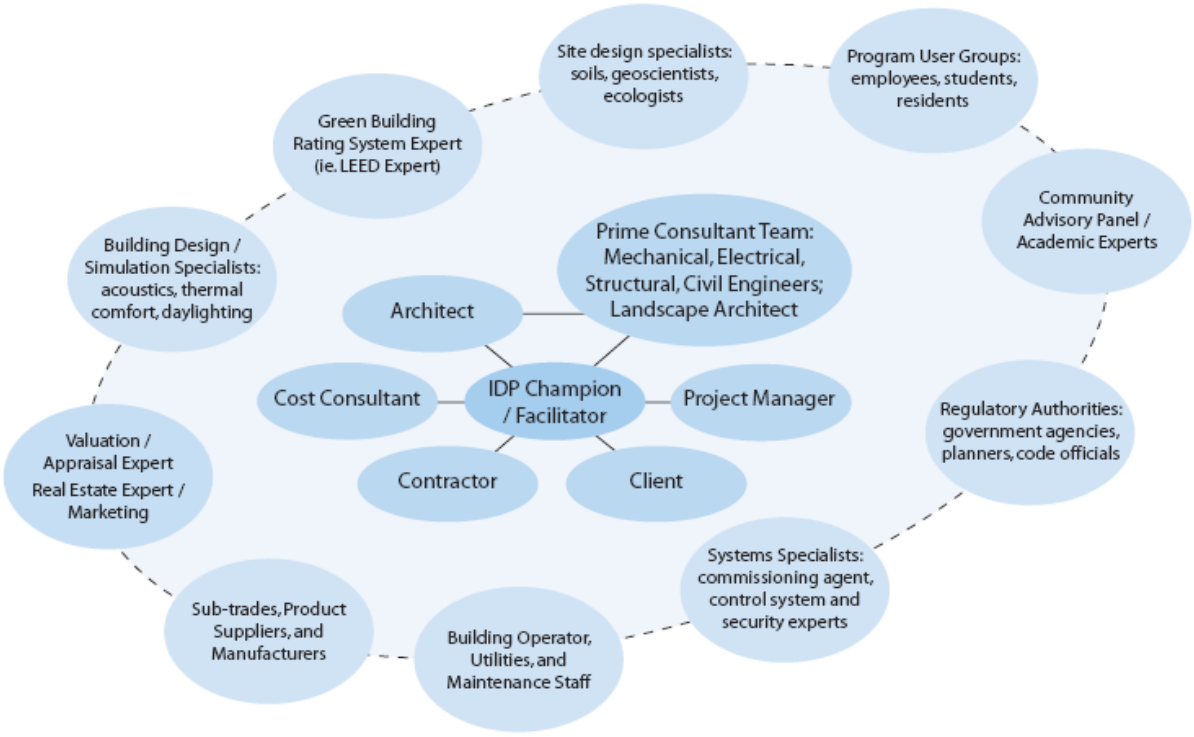


Figure 3-2 : Integrated Project Team Organization
Source: Perkins, B., Will Stantec Consulting 2007

3.1.1. A Comparative Analysis between Traditional Design Approach and Integrated Design Approach (IDP)

In the below section the researcher will go through the main differences between the traditional design approach and the integrated design approach, by going through all the project stages through tables of comparisons.

Table 3-1: Comparing between Traditional Design Approach and Integrated Design Approach in the Pre-Schematic Design stage
Source: Research **By:** Researcher

PRE-SCHEMATIC DESIGN STAGE	
Traditional Approach	**Integrated Approach**
In this phase the owner decisions are dominant, once the owner has selected a piece of property for his project, the site plan is handed over to the architect who works with the owner through: • Specifying the owner project requirements • Gathering information • Setting a preliminary project budget • Working on a detailed program for the project.	In this approach the owner must engage as many team members as possible at this stage, as it is more valuable to have all the consultants share their relevant expertise at the start of the project to have a holistic overview for the project through Selecting an IDP facilitator who is responsible to : • Establish visioning charrette with all project experts to explore the project site, surroundings, climate, etc. to distinguish the optimum design options. • Set, with the cooperation of the project

	team and the owner, the preliminary project goals and budget including IDP activities such as energy modeling. • Establish communication pathways between all the project team members from all disciplines.

Table 3-2: Comparison between Traditional Design Approach and Integrated Design Approach in the Schematic Design stage
Source: Research **By:** Researcher

SCHEMATIC DESIGN STAGE	
Traditional Approach	**Integrated Approach**
This phase includes only the Architect scope of work as it involves the exploration of various design schemes with the owner, the Architect job includes : • Working on conceptual design alternatives according to the criteria, preferences and requirements of the owner and the project needs. • Establishing a preliminary design and layout. • Preparing proper Drawings (plans, sections, elevations and 3d Model) to reflect the idea of conceptual design. • Setting the preliminary specifications outline.	In this phase the project team start to develop the vision aroused from the previous phase through : • Exploring innovative ideas and technologies that may help in achieving the broad vision of the project. • Brainstorming ideas and synergies through various team members' discussions (Design Charrette). • Exploring environmental, economical and social targets. • Performing a preliminary energy and financial analysis. • Coming up with a number of design scenarios that are based on the accumulative knowledge and expertise of the entire project team.

Table 3-3: Comparison between Traditional Design Approach and Integrated Design Approach in the Design Development stage
Source: Research **By:** Researcher

DESIGN DEVELOPMENT STAGE	
Traditional Approach	**Integrated Approach**
In this stage the architect has already designed the building and is now handing over the project drawings to other disciplines engineers such as structural , mechanical ,electrical and so on to incorporate the building systems design into the original architectural design that was designed without their inputs. • These professionals always work separately on their tasks and come up with structural drawings, mechanical drawings and so on.	This phase should come out with integrated design that confirms the project goals and validates the architectural design and whole systems choices through : • Increased communication, collaboration and coordination between all project consultants which is essential in this phase. • Coming up with and settling on a unique project strategy and integrated holistic design. • Smaller focused meetings on specific

• The architectural drawings are then modified and refined according to the needs and modifications of the other team members. • The architect is most likely to coordinate between these various disciplines to make sure that there are no design conflicts. • The goal of this stage is to complete and settle on all design decisions before proceeding with construction documents.	design issues, in addition to the frequent key meetings to insure proper feedback from all disciplines. • Engaging more specialists such as landscape, acoustical, day lighting specialists, and so on. • Taking into consideration the involvement of more disciplines such as contractor, building occupants, and operation and maintenance staff to identify more opportunities and risks. • Performing a more detailed energy simulation to confirm energy performance goals and to optimize the chosen design. • Estimated cost report. • Hiring a qualified third party commissioning agent to start reviewing all design development documents to make sure that they meet owner requirements and project goals. • Refining Schematic Design Drawings through design loops to integrate feedback from different team members and specialists to include as many disciplines as possible. • Final approval from the owner.

Table 3-4: Comparison between Traditional Design Approach and Integrated Design Approach in the Construction Documents stage
Source: Research **By:** Researcher

CONSTRUCTION DOCUMENTS STAGE	
Traditional Approach	**Integrated Approach**
In this stage all the consultants start working to complete a set of construction documents which are the detailed working drawings (Also known as Tender Drawings) of the project with the detailed specifications and General & Special Conditions documents, after that a set of typical steps occur : • Construction documents are sent to local authorities to be reviewed and to acquire the permission to proceed with construction works according to the submitted drawings (Permit review). • Construction documents are issued for bid to a number of contractors.	This stage is one of the most important stages in the building life cycle as all the designed drawings are turned into detailed working drawing to be implemented on real , the integration between all team members should be maintained , this stage requires: • More coordination between all consultants is required, this can be achieved through regular communication between team members and setting up frequent coordination meetings, to insure that there is no any design conflicts. • Including sustainable features and innovative design aspects in

• The contractors are given a period of notification during which they shall revise the whole project and assess the fees and time this project may take. • During this period the candidate contractors may submit (RFIs) Request for information, the main consultant is responsible to reply on all RFIs on time. • All Contractors are evaluated technically then evaluated financially, but technical comes first, no contractor will be accepted financially unless passing the technical evaluation, however a contractor can be chosen according to the lowest price bid (after passing the technical), there is always a compromise, may be the quality of work, or the subcontractors choice and so on. • Once the Construction documents receive the permit, and the contractor is selected, the construction process starts on site.	specifications and detailed drawings and making sure that all the detailed drawings reflects the project goals especially the environmental ones. • Stating all requirements and expectations related to construction activities in General & Special conditions Documents to insure the continuity of the integrated design process such as documentation, keeping accurate records for the construction process and informing subcontractors about the project goals. • Issuing a detailed financial report for the expected project budget. • Developing a Final Commissioning plan through the third part commissioning authority • Submitting all drawings to local authorities to gain project permit. • Issuing construction documents for bidding and having a key meeting with all the prospective contractors to explain the importance of the contractor cooperating in the integrated process by being fully aware and supportive to the project goals (Especially environmental ones) and intent to come up with a successful project. • Choosing the contractor not only according to the lowest bid, but also according to other factors such as previous experiences, quality of work and the willingness to learn and apply new construction methods. • Having a key meeting with the chosen contractor to discuss opportunities for price reduction strategies and giving the contractor a chance to suggest more efficient ways and synergies to reach the same end.

Table 3-5: Comparison between Traditional Design Approach and Integrated Design Approach in the Construction stage
Source: Research **By:** Researcher

CONSTRUCTION STAGE	
Traditional Approach	**Integrated Approach**
In this phase a whole new team take over the project , from consultant side ,civil engineer who takes the construction documents and start reviewing and exploring the project, and at the same time the contractor side who start developing the tender drawings to shop drawings and start constructing the project under the supervision of the main consultant, construction stage involves a lot of activities such as : • Construction administration and managing subcontractors. • Contacting suppliers and materials purchasing. • Updating time schedule. • Achieving milestones on time. • Variation orders according to instant changes required by owner, which in this case cost a lot of time and money, because these changes weren't included in the project from the start. • Document control which include documenting all materials, drawings and works submitted by contractor to consultant. • Frequent site visits by consultant and site inspections. • After substantial completion of most of the construction works, the main consultant and the owner visit the site for a preliminary handover from the contractor. • The consultant and the owner issue a snag list for the contractor to finalize any problem that is found on site during preliminary inspection. • After all the items in snag list are fixed and finalized the building is inspected one last time by the consultant.	The project should be transferred smoothly from the design team to the construction team , to insure that the construction team would maintain the integrative process and the project final goals , this can happen through several steps : • Conducting an information session at the start of the project in which the design team explains the project goals, objectives, synergies between systems, innovative strategies and technologies to the construction team (Contractor and consultant). • Addressing special requirements such as minimizing construction wastes, conserving resources, and maintaining indoor air quality during construction. • Conducting frequent meetings that bring together the design team along with the construction team to review the project progress and solve any issues or obstacles that may arise on site. • Making sure that the shop drawings, submittals, and materials supplied are matching those specified in the design stage and fulfilling project goals and requirements. • Frequent site visits from the design team to make site inspections and make sure all construction activities are conducted according to the project objectives. • Maintaining accurate record and documentations through submittals, as-built drawings, photos, systems manuals and so on. • Updating project schedule on frequent basis. • Conducting partial and final commissioning for the building, and a commissioning report should be prepared by the commissioning authority, this report should contain any items that need

	attention or fixation from the contractor side. • Confirming that all building goals are met such as energy performance.

Table 3-6: Comparison between Traditional Design Approach and Integrated Design Approach in the Operation and Maintenance stage
Source: Research **By:** Researcher

OPERATION AND MAINTENANCE STAGE	
Traditional Approach	**Integrated Approach**
This phase requires the least intervention of the project team through the below : • The contractor shall provide the as built drawings and manuals to the consultant and after approval, a copy is sent to the owner and building operator. • The owner shall get the certificate of occupancy and start occupying the building. • The contractor shall submit guarantees for all the machines installed in the project. • The building operator starts managing and maintaining building systems.	In this phase the design team must make sure that the building knowledge and responsibility is well transferred to the building owners, occupants, and operating staff through : • The contractor shall deliver all building manuals, warranties and as built documents and drawings to the owner and the operator of the building after being approved by the consultant. • The contractor shall conduct an educating session, in the presence of the main consultant, to the building operator to make sure that all systems will be operated correctly. • The commissioning authority shall hand over the final commissioning report to the owner. • Educating occupants about the building features and how their behavior can affect the building performance, this can be achieved through: brochures, case study presentation, building tours, signage, posters, etc. • Developing methods to insure ongoing monitoring for system performance.

3.1.2. Why A LEED Project Should Be Managed Through An Integrated Approach?

Because A LEED project must be designed holistically to achieve credits synergies and to optimize systems' building performance, a LEED project needs early goal definition, early involvement from all key participants, organization, and intensified communication between all the project team members, all of this can be achieved through an integrated design process, however, in a LEED Project the integrated design process should work in parallel with the GBCI Certification process, and that what will be discussed later in this chapter.

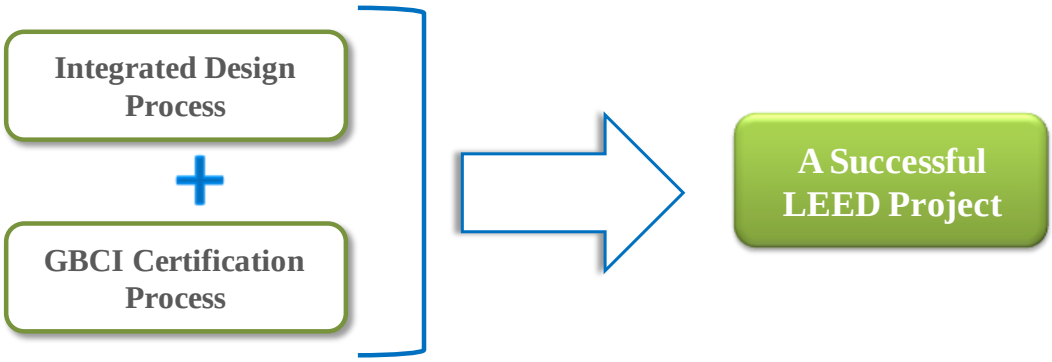


Figure 3-3: LEED Project Process
Source: Research **By** Researcher

3.2. LEED Project Team Responsibilities

In a LEED Project, communication between team members within an integrated design and construction process is the key for the success of the project, an integrative effort is required from all the project team, in a LEED Project all members are important, the painter sub contractor is as important as the architect, everyone is contributing in the success of the LEED project.

Not only the commitment of the owner is required in the project, but also the motivation of the rest of the project team is required, in a LEED project, so many paper works and tracking are required that so many thing may slip here or there, here come the role of a LEED coordinator who should make sure that all the project documentation on the right track through all the project team, in the below section , so in order to have a good understanding for the LEED project process we need first to identify the key team members and their roles in the project which will be discussed below , however a more detailed description for each member tasks according to LEED credits will be discussed in the following chapter .

3.2.1. Owner Role

In a LEED project the owner or client shall specify a dedicated person to be always in contact with the project team, as the owner have an important role in taking some critical decisions along the project design and construction process:

- The owner should choose the appropriate project team preferably with a LEED projects background.
- The owner shall specify the project goals, the targeted Level of certification and the project time frame, with the help of the LEED coordinator.
- The owner shall assist the project team in taking some important decisions, such as project site selection, project HVAC system, water treatment and plumbing systems according to systems, strategies feasibility and consultants' recommendations.
- The owner shall evaluate the feasibility and the cost of all project design and construction alternatives, and shall also specify the preferred payback period.
- The owner shall specify an operating policy, and may develop educational incentives.

3.2.2. LEED Project Coordinator Role

The LEED Coordinator (or consultant) is not likely to have experience in all the details of the project which encompass various aspects including Civil, MEP works and Design strategies; however the LEED Coordinator is expected to have:

- An excellent back ground about sustainability (preferably a LEED Accredited Professional).
- The ability to identify appropriate green building strategies and performance goals.
- The ability to interface and work with all levels of staff including Designers, Contractors, subcontractors , suppliers and even waste managing companies to fulfill all LEED requirements.

When mentioning the LEED consultant or the LEED Coordinator, people get confused about the exact job and responsibilities of a LEED coordinator, however to get a clear understanding of a LEED coordinator responsibilities we can classify this job into two main Categories:

- ***LEED Coordinator*** : is a dedicated person from the main consultant side , have a good back ground about LEED and sustainability, responsible for all LEED aspects within the project through all project stages starting with pre schematic design and ending with documentation and certification process , the LEED coordinator shall be involved in all project details with all of the project team , since the LEED coordinator job is not yet common in Egypt , and no real experience in that field, the main consultant probably would hire an external LEED Consultant.
- ***LEED Consultant*** : is a third party that is responsible to manage the whole LEED process and documentation , the LEED consultant is more experienced in the field of LEED certification , probably a LEED AP , the LEED coordinator shall always refer back to the LEED consultant.

3.2.3. Architect Role

The main role of the architect is to design the building and the project layout according to LEED targeted credits and to coordinate with other team members, to have a holistic design:

- The Architect shall take into consideration the climate of the project area and should coordinate with electromechanical team to choose the building orientation and building envelope materials in a way that decrease HVAC loads and optimize energy consumption.
- The architect shall incorporate any LEED design requirements in the project drawings such as showers, lockers, recycling area, car parks, designated smoking area …… and so on.
- The architect shall include all green materials in the specifications, such as Low VOC[1] paints and adhesives, high SRI[2] roofing and hardscape materials, regional, recycled materials……and so on.

[1] Volatile Organic Compounds (VOCs) are carbon compounds that participate in atmospheric photochemical reactions (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonates, and ammonium carbonate). The compounds vaporize at normal room temperatures.

[2] The Solar Reflectance Index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise, it is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100

- The architect shall coordinate with the plumbing engineer regarding all water fixtures in the project.

3.2.4. MEP (Mechanical, Electrical and Plumbing) Team Role

This Team is the most important team in any LEED project, as this team is associated to almost all energy savings, water savings and indoor air quality aspects that should be taken into consideration in the design of any LEED project, the cooperation of this team with the LEED project coordinator is essential.

- The Mechanical engineer shall identify appropriate conditioning and ventilation systems in accordance to ASHRAE codes and local codes.
- The mechanical engineer shall coordinate with the architect to take into consideration the site climatic conditions, building orientation and suitable building envelope materials.
- The electrical engineer is mainly responsible for the lighting system inside and outside the building, he shall provide the most efficient lighting design , and specify all lighting related fixtures, that shall contribute in LEED credits
- The electromechanical engineers shall work together with an energy simulation expert to provide an HVAC and lighting systems that optimize energy efficiency for whole building systems
- The Plumbing engineer shall design plumbing systems for building, storm water management systems and landscape irrigation, he may suggest a water treatment strategy for the building, and he shall also select all water fixtures and coordinate with the LEED coordinator in order to reach the targeted water savings percentage.
- The MEP team is responsible, with the help of LEED coordinator, to find innovative cost efficient systems' strategies that will make the building operate more efficiently.
- The MEP team shall make sure that the building is designed to fulfill at least the minimal indoor air quality required by ASHRAE to ensure occupants comfort.
- The MEP team shall discuss with the owner all possible systems' strategies and shall explain the benefits of each system and the associated expected initial and running costs.
- The MEP team shall work with the commissioning authority to make sure that all the commissioning activities are implemented.

3.2.5. Commissioning Authority Role

The commissioning authority is responsible to make sure that all building systems Mechanical, electrical, Lighting, water systems and BMS are all installed and commissioned according to the owner's project requirements, however according to LEED requirements the commissioning authority shall be involved in the project since the schematic design stage.

- The commissioning authority shall work with the owner and the LEED coordinator, to prepare the owner project requirements.
- The commissioning authority shall work with the contractor to verify and test all installed systems.
- The commissioning authority should make sure that the contractor has submitted all building systems' manuals to the owner and the building operator.
- The commissioning authority should make sure that training and educational sessions have been conducted by the contractor to the building operator.

- The commissioning authority shall submit a commissioning report to the owner to address any complications or issues that need to be resolved before handing over the project to the owner.

3.2.6. General Contractor Role

For a contractor, one of the toughest jobs is to keep a proper documentation through construction process including collection of submittals, paper works, photos during construction to document construction credits phase, maintaining the LEED Requirements along with the ordinary construction works, preparing the proper documents and uploading it on LEED online, here comes the role of a LEED coordinator (Consultant side) who must insure the presence of a dedicated person from the contractor side to follow up with LEED procedures .

3.2.6.1. LEED Administrator

A LEED Administrator from the contractor side is an assigned person from the contractor team and responsible for the follow up of all LEED documentation and requirements on site, however he always feedback to the main consultant LEED Coordinator, the LEED administrative shall have frequent contact and with the below parties.

3.2.6.2. Subcontractors

LEED administrator shall follow up all subcontractors and make sure they are working according to the LEED project requirements on site.

3.2.6.3. Suppliers

LEED administrator is responsible to get all data sheets, and required letters from suppliers, he also should make sure that all the supplied materials for the project are applicable to LEED Requirements, however all project materials shall be approved from the LEED Coordinator (Main Consultant) if there is a conflict, or the LEED coordinator is not able to specify whether the material is compliant or not, then he should refer back to the LEED consultant.

3.2.6.4. Waste managing companies

The LEED administrator is responsible for managing and separating construction wastes on site, and to search for companies that would take the wastes and recycle it.

3.2.7. Site/Civil Engineer Role

The site engineer is the responsible engineer from the consultant side on site; he must make sure, with the support of the LEED coordinator, that the contractor is following all the LEED requirements on site:

- The Site engineer shall not approve materials submittal unless he makes sure that it is recommended by LEED coordinator.
- The Site engineer shall make sure that the contractor and subcontractor are following all LEED requirements and practices on site, on daily basis.

- The site engineer shall recommend substitute materials or strategies on site that may be much applicable according to site conditions and circumstances.
- The site engineer shall coordinate with the landscape engineer and plumbing engineer regarding any landscape issues.

3.2.8. Other Disciplines (Specialties)

- ***Facility Manager (Building systems operator):*** the facility manager shall work with the project team to be handed over all the project systems, and understand how to operate these systems, the facility manager team shall implement any LEED requirements that is required post occupancy, such as green cleaning policy , or building system maintenance .
- ***Landscape Engineer:*** the landscape engineer shall work with the plumbing engineer and the LEED coordinator to create and implement a landscape design and irrigation system that achieve the required water savings, and landscape space as per LEED, through selecting native plants, evaluating the option of having a vegetated roof, and working with plumbing engineer on the option of using treated wastewater.
- ***Interior Designer:*** the interior designer shall work with the architect on selecting interior materials for flooring, carpets, paints and ceiling, in a way that enhance indoor air quality for occupants, he also is responsible for selecting the furniture and taking into consideration all LEED requirements, he shall work with the MEP team and the energy simulation expert on the interior lighting design.
- ***Energy Simulation expert:*** The energy simulation expert is an essential member in the LEED project , however he can be a part of the MEP team or an independent consultant , in both cases he has a very important role in calculating how much energy will be saved according to building design, orientation, building envelope materials, HVAC and plumbing systems, so this means that an energy simulation expert shall work with almost all project team so he can get accurate results, and recommend for the best scenario to optimize energy consumption.

3.3. LEED Project Process Stages:

After identifying the key participants in a LEED project, in the below section the researcher will go through the stages of a LEED project, however later in the next chapter LEED credits implementation (who and when) will be discussed.

3.3.1. Pre-Schematic Design Stage (PSD)

This stage is mainly about data gathering and identifying project goals and site conditions through the owner, the project team and the expected project occupants, these data can be defined through:

3.3.1.1. Owner Decisions Data:

This part mainly represents the owner decisions towards the project, such as whether the owner will go for a traditional project or a LEED project in the first place; however, once there is an assigned LEED coordinator, it is his job to get all the required data from the owner, this data can be summarized in the form of some questions

- What is the desired Level of certification? certified, silver, gold, or platinum
- How much the owner is willing to pay? And what is the preferred pay pack period?
- What are the social, economical and environmental aspects that should be taken into consideration? (Triple bottom line goals)
- What is the expected or requested energy and water savings?
- Are there specific indoor environmental quality aspects that should be taken into consideration, such as acoustical or temperature requirements for special spaces?

3.3.1.2. Site Conditions and project preliminary data

If the owner hasn't chosen a site yet, then it is expected from the LEED coordinator to assess the site alternatives and recommend the best site that will contribute in achieving some of the LEED related credits, however if the site is already chosen by the owner the LEED coordinator must gather some data regarding the project site :

- Site area and contouring.
- Site development conditions, is it a Greenfield[1], a farmland, or Brownfield[2]….etc.
- Green space and number of car parks required by Local zoning requirements.
- Building occupancy expected number.
- Project Legal boundaries.

3.3.1.3. Data Gathering conclusion

After having all the required data the LEED coordinator shall make a preliminary LEED assessment where he have a preliminary vision for the project possible LEED strategies and possible credits, the LEED coordinator is then required to:

- Start presenting LEED, LEED general goals and responsibilities to the project team through a LEED workshop (Charrette) where the project team gets to know more about sustainability, LEED credits and LEED online.
- The LEED coordinator shall decide on the rating system which is more appropriate for the project.
- The LEED Coordinator shall present a preliminary scorecard for the project including all possible credits.
- Register the LEED project on LEED online where the Registration is a flat fee paid up front at the time of registration. Registration rates are based on the date of registration. The rates up till 4/march/2013 are: $900 for USGBC Silver, Gold and Platinum Members, and $1200 for Organizational or Non-Members.

3.3.2. Schematic Design Stage (SD):

This is the best stage from an economical point of view to identify the LEED project goals and start discussing possible scenarios and synergies, in this stage:

- The LEED Coordinator shall hold up a LEED charrette with all the project parties including owner, architect, MEP consultants, contractors, landscape architect, commissioning agents, etc to start discussing and exploring different points of views,

[1] Greenfields are sites not previously developed or graded that could support open space, habitat, or agriculture.

[2] A Brownfield is real property whose use may be complicated by the presence or possible presence of a hazardous substance, pollutant, or contaminant.

innovative ideas and come up with an integrative design plan to achieve the maximum number of credits with the least cost impact.

- Team members start working on alternatives for their scope of LEED credits , Electromechanical team start working on energy credits by performing the required calculations and energy modeling, plumbing and landscape team start working on water saving calculations and strategies ,architect and civil team start identifying possible materials strategy for the project (recycled, regional, high SRI and low VOCs materials).
- Another meeting is held to discuss the results of the work of each team and start brain storming about credit synergies and cost impacts, the project team shall present to the owner each possible credit with its associated costs and different methods of implementation. During this meeting the team may agree that some credits are no longer feasible or applicable for the project, in this case the project team should start looking for other more feasible credits opportunities to make sure the project achieve the pursued level of certification. At the end of this meeting the team should have a clear vision and understanding for the exact pursued LEED credits, and their impacts on the design drawings.
- The LEED Coordinator shall update the LEED Scorecard to incorporate attempted credits with the agreement of all project parties.
- The LEED Coordinator should start assigning LEED credits to project team on LEED online, so they would have a clear idea on what exactly kind of documentation will be needed to document design stage credits.
- The LEED Coordinator shall engage a commissioning authority to start identifying commissioning goals and activities according to the owner requirements.

3.3.3. Design Development Stage (DD):

In this stage the LEED coordinator must make sure that all the LEED prerequisites are fulfilled and that all the attempted credits are being represented through detailed drawings, this can be achieved through several steps:

- The schematic design is refined, developed and coordinated between all the team members so that all the sustainable goals and LEED credits are demonstrated through Design drawings and documents.
- The LEED scorecard is confirmed through obvious goals and targeted credits.
- The commissioning goals and requirements are reviewed.
- The LEED Coordinator must make sure that all the project parties have access to LEEDonline, and are able to fulfill the documentation requirements.
- The LEED coordinator in cooperation with the design team start preparing LEED documentation required for the Design credits submission and start uploading them on LEEDonline.
- It is recommended that the LEED coordinator submit the LEED Design phase documentation to the GBCI to be reviewed and have feedback from the GBCI review team, to confirm that the project is on the right track , however in some projects a lot of modifications are made through the construction phase according to the owner requirements, ***in this case it is better to wait until the construction is finalized and submit the Construction and Design Documents to GBCI in one stage to be revised so there wouldn't be any conflicts between design and construction drawings and documents.***

3.3.4. Construction Documents Stage (CD)

In this stage the LEED coordinator must insure that the project drawings and documents are detailed and handed over to the contractors in a format that reflects LEED project goals and sustainable construction activities, this stage can be identified through two sub- phases:

3.3.4.1. Before Bidding

- General and special site conditions should include detailed description for all the required sustainable construction activities, such as construction waste management, dust control, Indoor air quality during construction, and educating labors about sustainable activity practices on site.
- The LEED project coordinator with the help of the project team must make sure that the project specifications reflect the targeted LEED credits , through choosing recycled or regional materials ,paints and adhesives with Low voc, high SRI roofing materials…and so on , also specifying specific suppliers who have available data sheets and materials specs.
- The LEED project coordinator must make sure that the commissioning requirements are finalized and included in the construction documents.
- A detailed financial report with the expected project costs should be submitted to the owner.
- If the LEED Coordinator have already submitted the design documents on LEEDonline by the end of the previous stage, then at the middle of this phase the GBCI would have issued a preliminary report which have comments and may be extra documentation and requirements, in this case the LEED coordinator should coordinate with the project team to make sure that any required modification or documentation are incorporated in the construction drawings and documents.

3.3.4.2. After Selecting the Contractor

The LEED coordinator must make sure that the contractor has a clear understanding to LEED requirements and sustainable construction practice through:

- Having a LEED charrette with the contractor, and may be the sub contractors too, to explain more about LEED credits and project sustainable goals.
- Asking the contractor submit a plan on how he will be managing the project along with sub contractors to comply with construction LEED requirements.
- Specifying a fixed day for weekly LEED meetings and inspections on site with contractor.

3.3.5. Building Construction Stage (BC):

In this phase the LEED coordinator is responsible to follow up with the contractor to make sure that all the LEED requirements are fulfilled on site, however in this stage as discussed previously it is more preferable to assign a particular engineer from the contractor side to follow up all LEED requirements on site on daily basis, this assigned engineer will also be responsible for all documentation to be submitted to the LEED coordinator to be reviewed before submitting to GBCI, this can be insured through :

- A weekly held up meeting between the contractor and the LEED coordinator to discuss any updates or issues on site.

- Follow up from the consultant and the LEED coordinator to make sure that all the construction activities on site are implemented in a sustainable way that meets the LEED requirements.
- The contractor shall submit a weekly LEED report documenting all LEED requirements and updates on site through photos and appropriate documentation.
- A weekly or monthly materials log, according to the progress of the project , to document all the quantities and specs of all the materials that were supplied to the project and to insure that they are following the targeted LEED requirements.
- The LEED coordinator must make sure that the contractor has access to LEEDonline.
- Prior to the end of the construction stage the LEED project manager must make sure that the contractor has finalized all required documentation and uploaded them on LEEDonline , the LEED coordinator should review these documents and inform the contractor if there is anything missing or need modification.
- After all the building systems are installed and tested, the commissioning authority is required to complete all commissioning-related activities, if the commissioning authority finds out that there are some systems that are not installed or not working properly, then the contractor is required to fix it immediately.
- The LEED project coordinator is required to review the design credits documents in addition to the construction credits documents to make sure that there is no conflicts, and if there is any major changes that were conducted in the construction stage then the LEED project coordinator is required to update on LEEDonline.
- At the end of this stage the LEED project coordinator is required to submit all project documents Construction credits and Design credits (if they were not submitted previously) to GBCI to be reviewed.

3.3.6. Building Operation and Maintenance Stage (BOM):

Prior to the building occupancy the LEED coordinator must make sure that:

- The contractor prepares a training manual or conducts a training session for the building operator.
- A total clean up and flush out (if targeted) is conducted for all the building systems and spaces.
- The commissioning authority prepares a final commissioning summary report verifying the proper installation and operation of the building systems.
- The contractor submits all operating manuals and warranties of the building systems and machines to the building operator.

3.3.7. Documentation and Certification Stages

After submitting all documents to GBCI through LEEDonline:

- The GBCI review team will respond with a Preliminary Review Report which contains the anticipated and pending credits that may need more documents or clarifications from the project team side.
- The project team then will have to submit the proper documents to insure sufficient clarification for the GBCI review team.
- GBCI then will response with the Final Review Report which have a list of achieved and denied credits.

- If the project team is not satisfied with the report result , the project team can apply for Appeals, which Cost 500 $ for each credit and 800 $ for a complex credit to be reviewed again with extra submitted documents
- An Appeal may be accepted or denied, after that the project is certified according to the number of achieved points.
- In addition the GBCI has issued The Project Credit Interpretation Ruling (Project CIR) process recently which is designed to allow Project Teams to obtain technical guidance on how LEED requirements including Minimum Program Requirements (MPR), Prerequisites, and Credits pertain to their projects. A Project CIR may be submitted at any time after project registration, Project Teams must submit the formal inquiry and the Project CIR with their LEED application in order to ensure a complete review.(fig3-4)

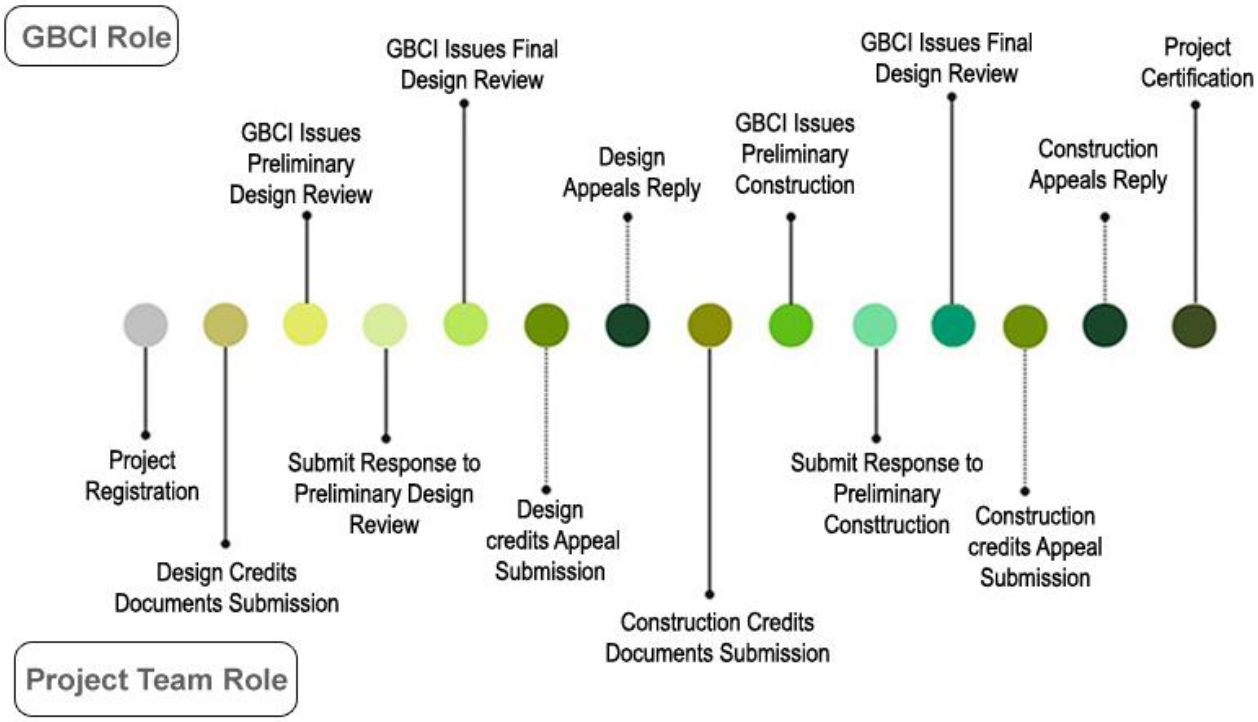


Figure 3-4: LEED Project Documentation Process
Source: various

3.4. Conclusion

- In this chapter the researcher discussed the key differences between the Traditional Design approach and the Integrated Design Approach through passing through all the project phases, the differences are summed up in the below table :

Table 3-7: The key Difference between the Traditional Design approach and the Integrated design Approach
Source: Research **By:** Researcher

Traditional Design Approach	Integrated Design Approach
Linear and sequential design process.	Holistic thinking and design from the start.
Each team member is working separately.	Collaborative approach
Separated building systems (HVAC, Lighting, …)	System integration and synergies (Whole building systems)
More time and energy are invested throughout various project stages.	More time and energy invested in the beginning.
Fewer people are involved in critical decisions.	Most of the team members are engaged in almost all decisions.
Consider initial cost.	Consider life-cycle costs.
Limited optimization for design solutions.	Maximum optimization is allowed through various design synergies.

- LEED project team members cooperation is essential for the success of the project, The LEED project key team members responsibilities were discussed in details in this chapter, however the team organization members can be summarized in figure (3-5).

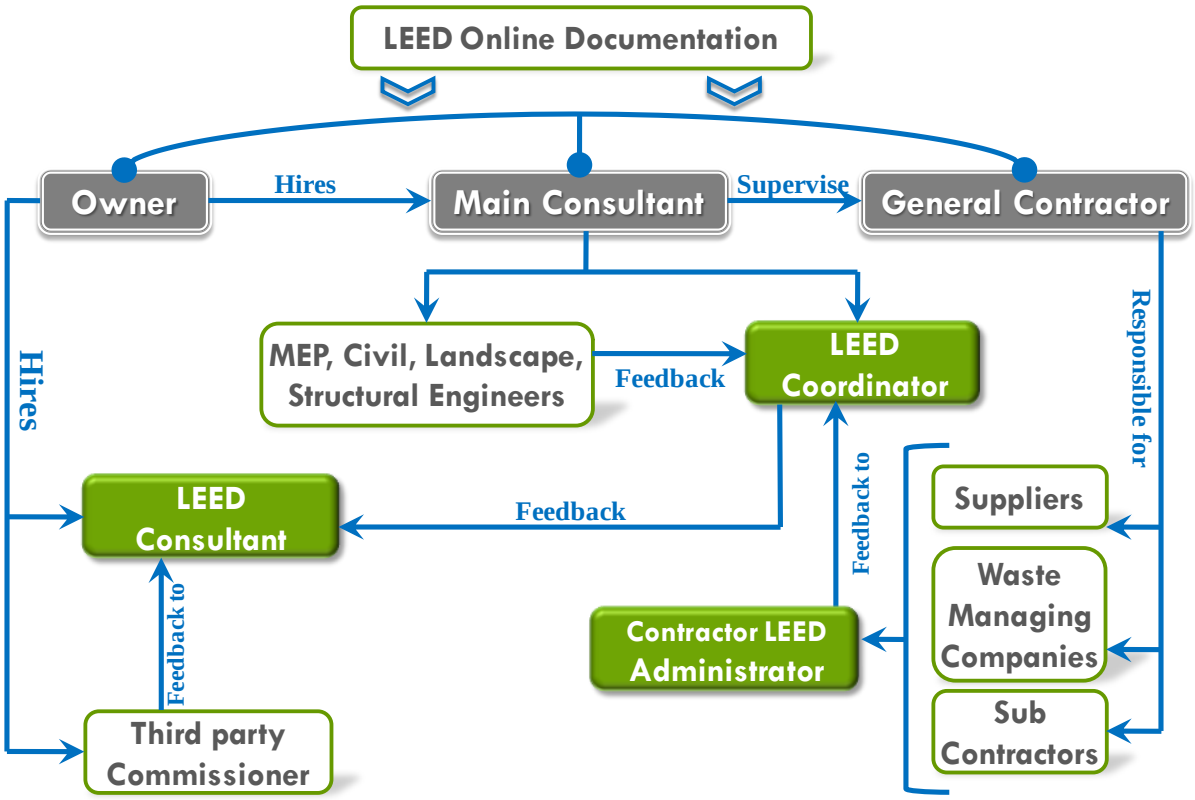


Figure 3-5: LEED Project team members
Source: Various **By:** Researcher

- The Integrated process in addition to the LEED certification process was explained in the previous chapter, the integrated LEED project management process can be summarized in figure (3-6).

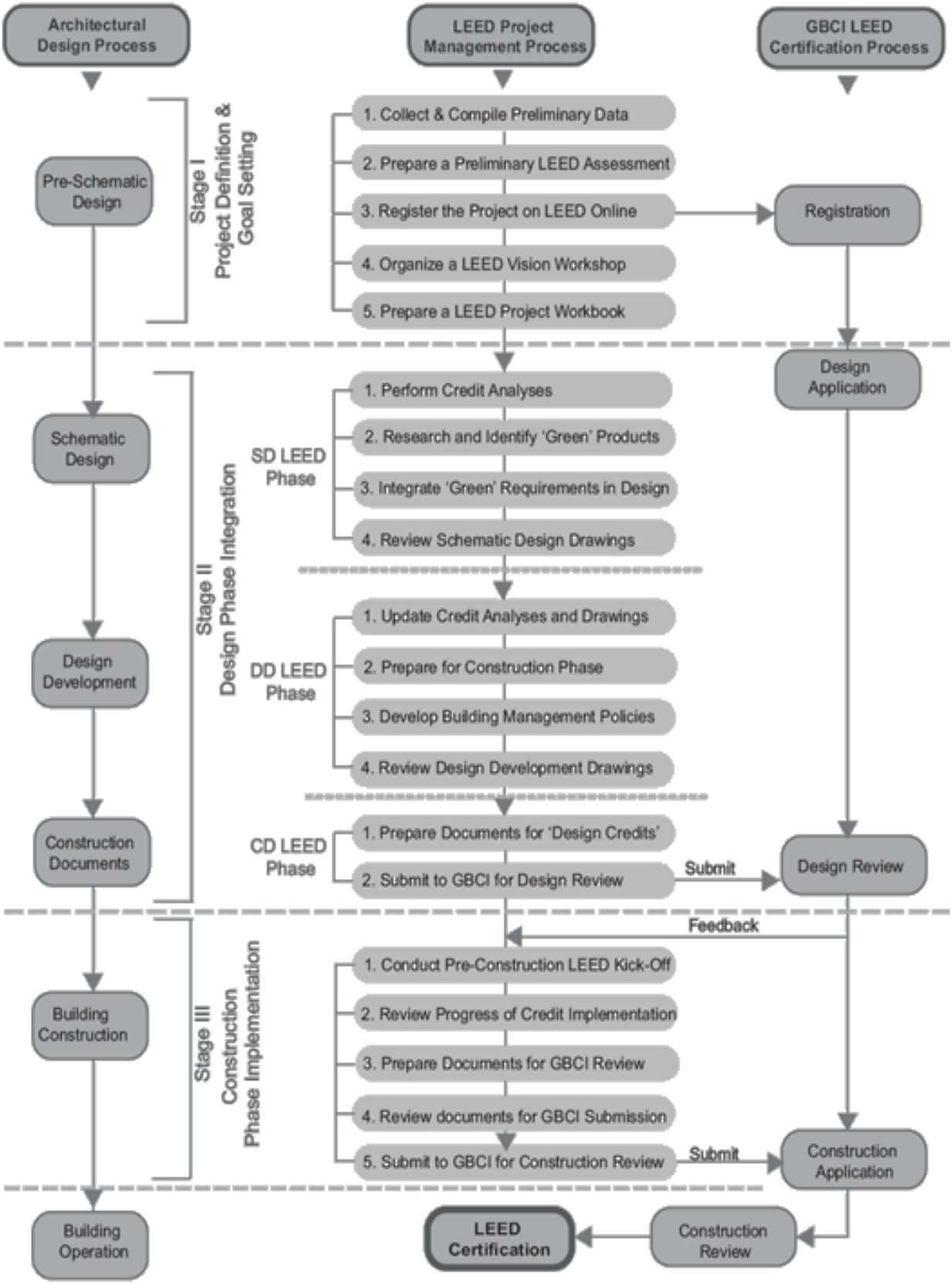
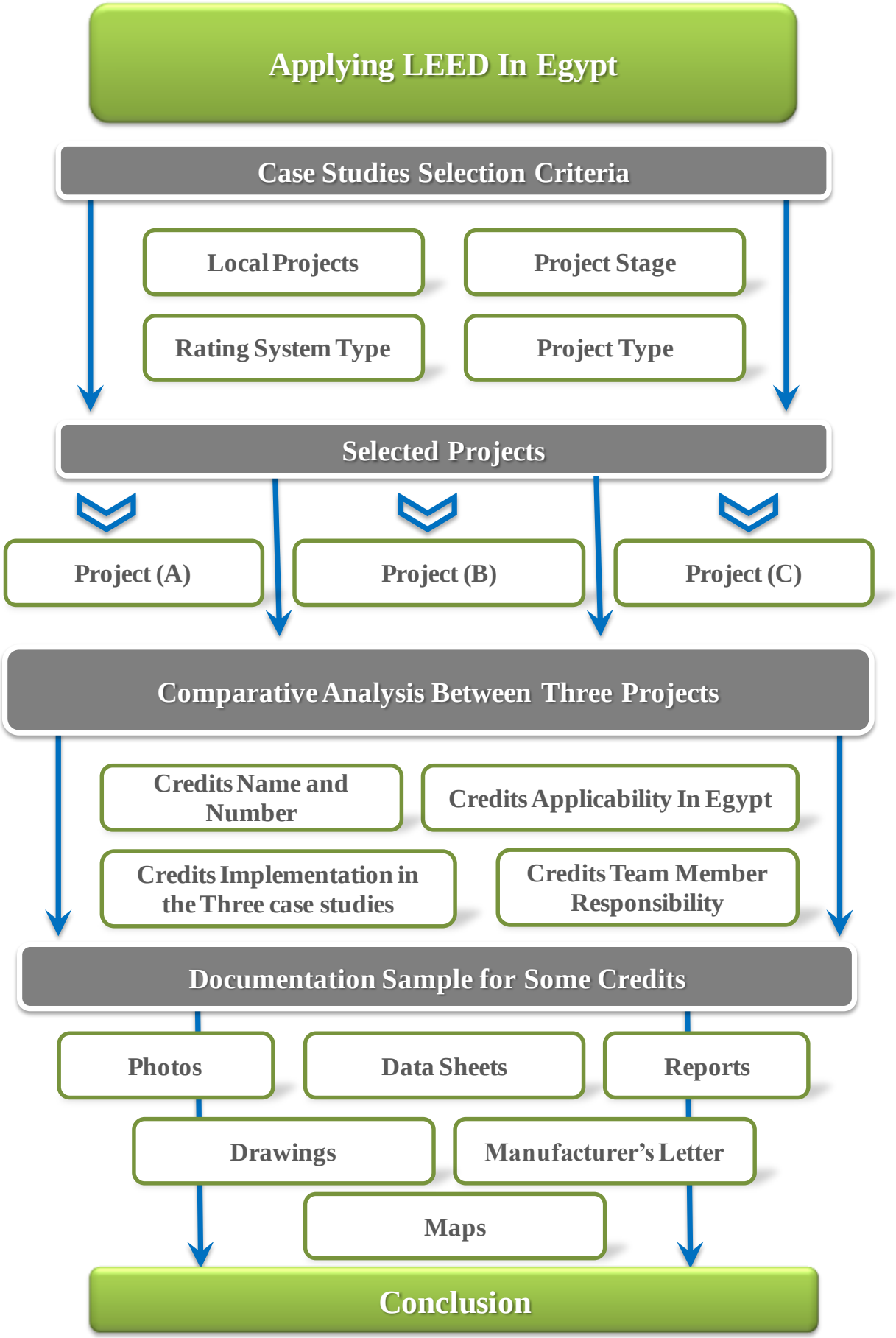


Figure 3-6: LEED Project Management Process Overview
Source: Yellamraju, V., 2010

CHAPTER FOUR

IMPLEMENTATION OF LEED IN EGYPT (CASE STUDIES)


Applying LEED In Egypt
Case Studies Selection Criteria
Local Projects
Project Stage
Rating System Type
Project Type
Selected Projects
Project (A)
Project (B)
Project (C)
Comparative Analysis Between Three Projects
Credits Name and Number
Credits Applicability In Egypt
Credits Implementation in the Three case studies
Credits Team Member Responsibility
Documentation Sample for Some Credits
Photos
Data Sheets
Reports
Drawings
Manufacturer's Letter
Maps
Conclusion

CHAPTER 4 : IMPLEMENTATION OF LEED IN EGYPT (CASE STUDIES)

During the previous chapter, the researcher went through the stages of a project that is targeting the LEED certification, however in order to have a detailed demonstration of applying LEED rating system, especially in Egypt, the researcher will present three case studies in which all credits applicability will be presented from the researcher point of view according to the achieved credits.

4.1. Case Study Selection

The researcher will go through three different case studies, discuss the implemented options for each credit in the three projects, and highlight the difficulties that faced the project team and prevented them from achieving some credits, the three case studies were selected according to the below criteria (**Fig4-1**):

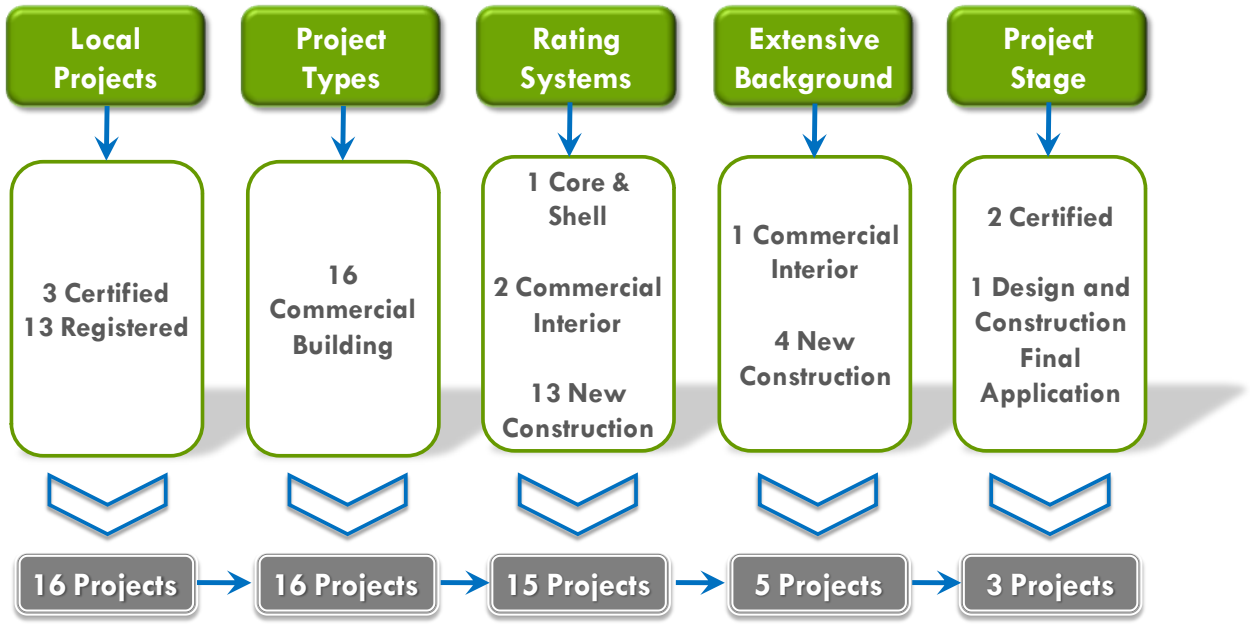


Figure 4-1: Decision Tree
Source: Researcher

4.1.1. Local Projects

Since the main objective of this research is to discuss implementing LEED rating system in Egypt, the researcher had to choose local projects, as mentioned before Egypt has only two certified projects and 14 registered projects, therefore the selected projects must me from these 16 projects.

4.1.2. Project Type

Till now all registered and certified projects in Egypt are categorized as commercial buildings, so the researcher field of study and implementation was limited to this category.

4.1.3. Rating System

The registered LEED projects in Egypt fall into only three rating systems, we have two commercial interior projects, one core and shell project and the rest of the projects are new construction; so In this research the researcher will discuss the most sufficient approach to apply LEED rating system in Egypt by going through the LEED credits of mainly two rating systems which are LEED for new construction and LEED for commercial interior which are the two most famous categories of LEED in Egypt.

4.1.4. Available Resources and Extensive Back Ground

As a LEED projects coordinator, the researcher had extensive back ground and access to projects data for some of the local projects; therefore the projects' selection was minimized to five projects.

4.1.5. Projects Stage

The researcher chose the projects that are more progressed than others, so that there would be more accuracy and verification of the targeted and achieved credits for each project.

4.2. An Overview on the Selected Projects

In order to have a full understanding of the upcoming analytical comparison, an introduction about the three case studies was necessary; the case studies were provided for research by MA Consultants, who is the projects main consultant, However the project names will be anonymous due to privacy issues, the case studies below are arranged according to the stage of the project, although not all the projects have been awarded the LEED Certification yet, but they have achieved most of the credits, and only a few more steps are left for certification.

4.2.1. Project (A)

Project A is a warehouse with total built up gross area of 32,030 m^2, it is located in 6th of October city industrial zone, and the project mainly consists of the following:

- A main warehouse building that is divided into 3 main zones due to the racking system and separated by two escape tunnels. Temperature controlled areas with flexibly for future extension. The warehouse contains "Dock Levelers system" that serves trucks and regular loading docks serving vans at the same time.
- Main administration two floors building in the middle zone, supported by two separate administrations in each zone.
- Labors and drivers building contain a cafeteria & praying room.

Table 4-1: Project (A) Infocard

LEED Rating System	New Construction and Major Renovations V2009
Level of Targeted Certification	Silver
Project Stage	Awarded the certification
Layout Area	90,678.8 m2
Building Footprint	31,347.4 m2
Main Consultant	MA Consultants
LEED Consultant	EMS
Main Contractor	Gama for construction
Context	Industrial setting
Project type	Commercial- Industrial
Project Usage	Logistics Warehouse
Climatic region	Arid (Desert) climate
Climate	Hot Temperature

4.2.2. Project (B)

Project (B) is a warehouse with total built up gross area of 16,963m^2, it is located in 6th of October city industrial zone, and the project mainly consists of the following:

- The project is divided into two zones, first zone is administrative, second zone is ware house.
- The administrative building is at the main entrance, this building is concrete structure and it contains three floors and roof.
- The warehouse is divided into four sections, three main zones due to separated racking system, the fourth zone contains transit in and out area, auditing rooms, scanning rooms, security and services areas.

Table 4-2: Project (B) Infocard

LEED Rating System	New Construction and Major Renovations V2009
Level of Targeted Certification	Silver
Project Stage	Design and Construction Final Application
Layout Area	22,987.5 m2
Building Footprint	14,870.7
Main Consultant	MA Consultants
LEED Consultant	EMS

Main Contractor	Design and Construction for construction
Context	Industrial setting
Project type	Commercial- Industrial
Project Usage	Document Storage & Management services
Climatic region	Arid (Desert) climate
Climate	Hot Temperature

4.2.3. Project (C)

Project (C) is a call center that is located in Pyramids heights office park (Cairo-Alex desert road).it is designed to accommodate at least 1400 agents, with highest standards, and to have all appropriate facilities within the office spaces of the building to operate on 24 hours base for 365 days of the year with no possible failure., the project mainly consists of the following:

- A ground floor and three typical floors, as well as the basement with total built up gross area 12500 square meters.
- The call center basic office spaces are to accommodate the ground and the typical floors. Whereas the basement is to be accommodated by the machine and data rooms, the meeting rooms, the main office spaces, as well as the main cafeteria and the building facilities.

Table 4-3: Project (C) Infocard

LEED Rating System	Commercial Interior V2009
Level of Targeted Certification	Gold
Project Stage	Design and Construction Final Application
Layout Area	NA
Building Footprint	2500
Project Manager	Conssult
Main Consultant	MA Consultants
LEED Consultant	EMS
Main Contractor	Nextep
Context	Office Park
Project type	Commercial- offices
Project Usage	Call Center
Climatic region	Arid (Desert) climate
Climate	Hot Temperature

4.3. Comparative Analysis between the Three Case Studies

The upcoming table will analyze each credit/prerequisite achievement in the three selected project. It is essential to highlight that in this table the researcher will not discuss or demonstrate LEED credits/prerequisites which are demonstrated in details in the official USGBC reference guides. However in order to understand the structure of the table, a brief is introduced below:

- The first two columns indicate the number of each credit or prerequisite in NC-2009 rating system and CI-2009 rating system respectively, where the first two characters represents the credit category (ex: SS refer to Sustainable Sites), the third character refer to whether it is a credit or a prerequisite (ex: c or p) which is followed by the number of credit or prerequisite, in some credits there might be an additional (P) after the credit number, it refers to Path, as some credits have several paths to be achieved through.
- The third column indicates the name of each credit or prerequisite in both rating systems.
- The fourth column indicates the stage in which the credit shall be submitted to USGBC for review (Design phase submission or Construction phase submission).
- The fifth column (which is divided into 11 small columns) indicates the team members responsible for each credit or prerequisite during project, there is a Lead team member who is responsible for implementing this credit and supporting team members who help and support the Lead team member in achieving this credits.
- The sixth column is divided into three (indicating the three selected projects) in which the researcher explains the achievements and implementation of each credit/prerequisite for the three projects.
- The seventh column indicates the conclusion of applying the credit/prerequisite in Egypt; it is worth mentioning that this column represents the researcher's point of view.

Table 4-4: Case Studies Analytical Comparison (By Researcher**)**

Sustainable Sites Credits																
# NC	**# CI**	**Credit Name**	**Stage**	**Responsibility[1]: Lead(L)/ Support (S)**											**Case Studies**			**Applicability in Egypt**
				O	**BM**	**LC**	**A**	**ID**	**LA**	**MEP**	**SE**	**CA**	**C**	**GC**	**Project (A)**	**Project (B)**	**Project (C)**	
SSp1	**NA**	**Construction Activity Pollution Prevention**	**C**			**S**							**L**	**L**	• An Erosion and sedimentation control plan was implemented through dust control. • All Materials, stock piles and trucks were covered on site. • Gravel spread on main entrance and main truck routes.		• Not Applicable in this rating system.	• This Prerequisite can be easily achieved; however the difficulty of this prerequisite lies in keeping up and maintaining these measures on site, in addition to the frequent inspections and documentation through photos.
SSc1	**SSc1 Option1**	**Site selection**	**D**	**S**		**L**									• The site doesn't meet any of the prohibited criteria stated in the LEED reference guide.		• The project was not located in a certified building.	• This credit can be achieved by choosing an appropriate site that doesn't meet any of the prohibited criteria stated in LEED reference guide such as being a farmland.
SSc2	**SSc2**	**Development Density and Community Connectivity**	**D**	**S**		**L**	**S**						**S**		• The projects were not applicable for that credit because they are located in an industrial area which is away from any basic services, or residential areas.		• The project site is located within 804 meter of ten basic services (Bank, market, school, park, 2 restaurants, hardware store, masjed, expected clinics building and a pharmacy) and a residential district.	• This credit depends mainly on the project location; and its proximity to existing services however the difficulty of this credit lies in documenting the existence of these services and the existing of a pedestrian access for these services.
SSc3	**SSc1P1**	**Brownfield Redevelopment**	**D**	**S**		**L**							**S**		• The Projects were not applicable to that credit as they all were constructed on Greenfields.			• This credit depends mainly on the project location; and if it is a contaminated site that needs remediation, it will probably cost much money, that's why owners prefer a Greenfield site.
SSc4.1	**SSc3.1**	**Alternative Transportation - Public Transportation Access**	**D**	**S**	**L**	**L**	**S**								• The Project is served by 5 private shuttles. • Shuttle buses provide direct access to transit facilities within a 5-10 minute drive.	• This Credit was Denied	• The project is located within two bus stops of three minibus lines.	• This credit depends mainly on the existence of public transportation around the project site, however if no public transportation exists near to the project the owner can provide frequent shuttle buses to the nearest bus stops.
SSc4.2	**SSc3.2**	**Alternative Transportation - Bicycle Storage and Changing Rooms**	**D**	**S**		**L**	**S**						**S**		• 6 bicycle racks were provided • 1 shower facility and lockers.	• 6 bicycle racks were provided • 1 shower facility and lockers.	• The project didn't target this credit as it would have needed a large number of bicycle racks.	• This credit mainly depends on the number of occupants and the willingness of the owner to initiate a sustainable transportation policy, however it doesn't cost much and it is easy to achieve in projects with limited occupants number.

[1] **O** (Owner), BM (Building Manager), **LC** (LEED Coordinator), **A** (Architect), **ID** (Interior Designer), **MEP** (Mechanical, Electrical, Plumbing), **SE** (Simulation Expert), **CA** (Commissioning Authority), **C** (Civil), **GC** (General Contractor)

# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
SSc4.3	NA	Alternative Transportation - Low-Emitting and Fuel-Efficient Vehicles	D	S		L	S						S		• Special parking spots (near the entrance) were provided for Low Emitting & Fuel Efficient cars.		• Not Applicable in this rating system	• This credit can be achieved through option one, by specifying 5% of parking slots to LE &FE Cars near the main entrance, however other options are costly or hard to achieve, it mainly depends on what the owner is willing to offer to initiate a sustainable transportation plan.
SSc4.4	SSc3.3	Alternative Transportation - Parking Capacity /Availability	D	S		L	S						S		• The number of parking spaces provided to the base building does not exceed the minimum number required by local zoning regulations. • Preferred parking for car/vanpools was provided for 9.54% of the total parking capacity: **2 parking spots**	• The number of parking spaces provided to the base building does not exceed the minimum number required by local zoning regulations. • Preferred parking for car/vanpools was provided for 5.56% of the total parking capacity: **1 parking spot**	• The number of parking spaces provided to the base building does not exceed the minimum number required by local zoning regulations. • Preferred parking for car/vanpools is provided for 5.14% of the base building FTE occupants: **24 parking spot**	• The first option in this credit only need that the project team doesn't exceed the number of parking specified by local authorities, however, the difficulty lies in specifying a preferred parking for carpooling and making the owner and occupant commit to that. • This credit is very flexible as the reference guide presents several options to achieve it.
SSc5.1	NA	Site Development - Protect or Restore Habitat	C			S	S						L	L	• The site was a Greenfield. • The construction site disturbance was limited according to the credit requirements. • All documents and photos were provided.	• The project wasn't applicable for that credit as the project site was so small, that the contractor needed the surrounding lands to be used as a part of the construction site.	• Not applicable for that rating system.	• The Greenfield option in this credit depends on the construction site size and planning through all the construction stages, however the difficulty of this credit depends on the commitment of contractor to come up with a construction plan that will comply with the disturbance limits specified in the LEED.
SSc5.2	NA	Site Development - Maximize Open Space	D			L	S		L				S		• The project has provided 27% more open space than required by local zoning regulations.	• The project has provided 34.16% more open space than required by local zoning regulations.	• Not applicable for that rating system.	• This credit is achievable through several options provided in the reference guide, however it depends on the owner requirements, and the projects needs.
SSc6.1 SSc6.2	SSc1P2 SSc1P3	Stormwater Design- Quantity & Quality Control	D			S	S		S	S			L		• These credits were not targeted in the three projects.			• These credits are rarely targeted as storm water occurs occasionally in Egypt, in addition, it cost too much.
SSc7.1	SSc1P4	Heat Island Effect, Non-Roof	D			L	L		S				S		• 100% of the car parking is located under cover with an SRI of 33.		• The project Team didn't target that credit because there was a big number of parking slots and it would have cost so much.	• This credit is very easy to achieve, however in two of the case studies, option 2 was targeted which only needed that the project team send three samples of the selected materials for car parking cover to be tested in the (HBRC) Housing and Building Research Center for the SRI.

[1] **O** (Owner), BM (Building Manager), **LC** (LEED Coordinator), **A** (Architect), **ID** (Interior Designer), **MEP** (Mechanical, Electrical, Plumbing), **SE** (Simulation Expert), **CA** (Commissioning Authority), **C** (Civil), **GC** (General Contractor)

# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
SSc7.2	SSc1P5	Heat Island Effect, Roof	D	S		L	L						S		• A roof with 79 Solar Reflectance Index covered the building: **Roof steel sheet** (corrugated steel sheet +insulation +air gab + corrugated steel sheet)	• A roof with 85 Solar Reflectance Index covered the building: **Sandwich panel** (Corrugated steel sheet + insulation + flat steel sheet)	• A roof with 89 Solar Reflectance Index covered the building: **Tiles** (white terrazzo tiles with tiny brown spots)	• This credit is applicable through option one, by installing a high SRI roof material after getting tested at the HBRC, however option two and three may not be applicable as green roofing is not yet common in Egypt, and so it would lack quality and durability.
SSc8	SSc1P6	Light Pollution Reduction	D	S		S	S	S	S	L	S				• The project exterior lighting was not complying with credit requirements.	• The credit was not targeted.	• All nonemergency interior luminaries with a direct line of sight to any openings in the building envelope have had their input power reduced by at least 50% between 11pm and 5am via automatic devices.	• The applicability of this credit depends on the project nature and needs.
Water Efficiency Credits																		
WEp1 WEc3	WEp1 WEc1 SSc1P10	Water Use Reduction	D	S		S	S		S	L					• The project reduced potable water use by 26% from a calculated baseline.	• The project reduced potable water use by 36% from a calculated baseline.	• The project reduced potable water use by 46% from a calculated baseline.	• This credit is very easy to achieve, by installing the appropriate water fixtures, however some owners may find the initial cost a little bit high.
WEc1	SSc1P7 SSc1P8	Water Efficient Landscaping	D			S	S		L	S					• PHOENIX DACTYLIFERA Palms were installed which don't need permanent irrigation.	• PHOENIX DACTYLIFERA Palms were installed which don't need permanent irrigation. • A special soil type was installed has a water-holding capacity of 300%.	• These paths were not targeted by the project team.	• This credit is very easy to be achieved; however the difficulty lies in performing the calculations and finding the appropriate landscape engineer who understands the LEED requirements for Landscape irrigation.
WEc2	SSc1P9	Innovative Waste Water Technologies	D	S		S	S		L	L					• The Project wasn't qualified for this credit.		• The as the developer of the entire office park had a waste water treatment facility that serves all office buildings including Project (C) building, the facility treats domestic waste water to be used for landscape irrigation.	• This credit cost so much and needs special and complicated measures for onsite water treatment.

[1] **O** (Owner), BM (Building Manager), **LC** (LEED Coordinator), **A** (Architect), **ID** (Interior Designer), **MEP** (Mechanical, Electrical, Plumbing), **SE** (Simulation Expert), **CA** (Commissioning Authority), **C** (Civil), **GC** (General Contractor)

Energy And Atmosphere Credits																	
# NC	**# CI**	**Credit Name**	**Stage**	**Responsibility[1]: Lead(L)/ Support (S)**											**Case Studies**			**Applicability in Egypt**
				O	**BM**	**LC**	**A**	**ID**	**LA**	**MEP**	**SE**	**CA**	**C**	**GC**	**Project (A)**	**Project (B)**	**Project (C)**	
EAp1 EAc3	**EAp1 EAc2**	**Fundamental Commissioning of the Building Energy Systems** **Enhanced Commissioning**	**C**	**S**	**S**	**S**	**S**			**S**		**L**		**S**	• The Project team used a multinational Commissioning Authority (CA) to commission and test the required energy systems in building. • The owner and the CA prepared the OPR (Owner Project Requirements) documents • The Project team prepared the BOD (Basis of Design) with the help of CA • The project Team didn't target enhanced commissioning credit because it cost so much.			• The difficulty of this prerequisite/ credit lies in finding a proper Commissioner who is familiar with the LEED requirements and has high documentation skills; also this credit may have high cost according to the type of commissioning (Fundamental or enhanced) as the enhanced commissioning requires more involvement and tasks from the CA.
EAp2 EAc1	**EAp2 EAc1**	**Minimum Energy Performance** **Optimize Energy Performance**	**D**	**S**		**S**	**S**			**L**	**L**				• Energy cost savings by 28.2 % were achieved mainly through connecting all ventilation fans to BMS and improved building envelope.	• The project is targeting energy cost savings by 29.84%, through improved thermal envelope, high efficiency glazing, reduced interior lighting power density; high efficiency split system heat pumps and connecting all ventilation fans to BMS.	• The project is targeting a 31.43% reduction in connected lighting power density from that allowed by ASHRAE 90.1-2007 • ENERGY STAR-rated equipment and appliances equal to 100%, determined by rated power, have been installed on the project.	• This Prerequisite / Credit requires a simulation expert which is a rare specialization in Egypt, as building energy simulation is not yet a common field in Egypt, However sometimes mechanical engineers or Architects have a good back ground about simulation, but not Experts.
EAp3 EAc4	**EAp3**	**Fundamental/ Enhanced Refrigerant Management**	**D**	**S**		**S**	**S**			**L**					• No CFCs, HCFCs based refrigerants or Halons in the HVAC or the fire suppression systems • R407 was used as Cooling Refrigerant. • Exported split units.		• R407 was used as Cooling Refrigerant. • Exported split units. • Chilled water system.	• This prerequisite / credit requires high initial cost, as in order to use split units that can be operated by a non CFC based refrigerant, it has to be exported from outside , as it is not available locally.
EAc2	**NA**	**On-Site Renewable Energy**	**D**	**S**		**S**	**S**			**L**	**S**				• The project didn't apply for that credit because it cost too much		• Not Applicable in this rating system.	• This Credit is very hard to target, as till now in Egypt renewable energies have a very high initial cost, in addition to the difficulty of maintenance, however in the future this credit may be targeted as renewable energy is the new trends.
EAc5	**EAc3**	**Measurement and Verification**	**C**	**S**	**L**	**S**	**S**			**L**	**S**				• The project team has developed and implemented a Measurement and Verification Plan.		• Sub metering equipment is installed to measure and record energy uses within the tenant space. • The project team has developed and implemented a M&V plan.	• This credit target the running cost and monitoring of the building systems, and how it complies with the design energy savings predictions, it can be achieved although the cost of monitoring or sub-metering systems may vary a lot according to the size of building systems.
EAc6	**EAc4**	**Green Power**	**C**	**S**		**S**	**S**			**L**	**S**				• The project didn't apply for that credit.			• This credit is very difficult to be achieved as it requires buying electricity from certified renewable resources which is very rare in Egypt.

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Materials And Resources Credit																	
# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
MRp1	MRp1	Storage and collection of Recyclables	D	S	S	S	L								• The project team designated an external area for waste separation and storage of materials for recycling, including cardboard, paper, plastic, glass, and metals.		• The project team designated an internal area in each floor for waste separation and storage of materials for recycling, including cardboard, paper, plastic, glass, and metals.	• This credit is very achievable, however it needs monitoring from the building manager as he is supposed to contact the recycling companies on regular basis to make sure that wastes are being handled in a sustainable manner.
MRc1.1 MRc1.2	NA MRc1.2	Building Reuse Maintain Existing Walls, Floors& Roof Building Reuse, Maintain 50% of Interior	C	S		S	L	S					S	L	• The project wasn't applicable for that credit as it was a new construction not a renovated building		• Not applicable for that rating system.	• This Credit was not achieved before in a project in Egypt as most of the projects applying for LEED are newly constructed.
NA	MRc1.1	Tenant Space-Long-Term Commitment	D	L	L	S									• Not applicable for that rating system.		• The project occupant has leased the building for at least 10 years and has provided the signed lease agreement.	• This credit depends on the project type and circumstances.
MRc2	MRc2	Construction Waste Management	C	S		L	S						S	L	• The project has diverted 70% of the on-site generated construction waste from landfill	• The project has diverted 56.64% of the on-site generated construction waste from landfill.	• The project has diverted 95.66% of the on-site generated construction waste from landfill.	• This credit is easily achievable, however the diverted waste rate depends on the contractor capability in reducing and reusing wastes on site and the continuity of waste separation on site along with the progress of the project.
MRc3	MRc3.1 MRc3.2	Materials Reuse	C	S		L	S	S					S	L	• This credit was not attempted by the project team.			• This credit is more appropriate for projects that are being renovated, however its implementation is not easy as most project owners tends to use new materials.
MRc4	MRc4	Recycled Content	C	S		L	S	S					S	L	• This credit was not attempted by the project team.		• The project is targeting 25.63% recycled content.	• This credit is not easy to be achieved, as most local materials don't have recycled content, or don't have the proper data sheets to proof the recycled content percentage.
MRc5	MRc5	Regional Materials	C	S		L	S	S					S	L	• 41.60% of the total building materials have been manufactured and extracted locally (within 500 miles,804 KM, of the project)	• 74.95% of the total building materials have been manufactured and extracted locally (within 500 miles,804 KM, of the project)	• 14.61% of the total building materials have been extracted and 32.27% of the total building materials manufactured locally (within 500 miles).	• This credit is very achievable, as a lot of the construction materials are manufactured regionally with local raw materials.

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# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
MRc6	**MRc6**	**Rapidly Renewable Materials**	**C**	**S**		**L**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team.			• This credit is very hard to be achieved because these materials are almost rare in the local construction market, and it cost too much if purchased from outside.
MRc7	**MRc7**	**Certified Wood**	**C**	**S**		**L**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team.			• This credit is very hard to be achieved because certified wood is not yet recognized in the local construction market, and it cost too much if purchased from outside.
Indoor Environmental Quality Credits																		
IEQp1	**IEQp1**	**Minimum Indoor Air Quality**	**D**	**S**		**S**	**S**			**L**	**S**				• The project is mechanically ventilated and mechanically conditioned. • ventilation rates for all occupied spaces meets the minimum established in ASHRAE Standard 62.1-2007			• This prerequisite is very easy to be achieved, as mechanical engineers in Egypt works according to ASHRAE standards; however mechanical engineer may find some difficulty in documenting this credit through performing some additional calculations and filling the required online form.
IEQp2	**IEQp2**	**Environmental Tobacco Smoke (ETS) Control**	**D**	**S**	**S**	**S**	**L**			**S**					• Smoking is prohibited inside the building and within 25 feet (7.62 m) of all entries, outdoor air intakes, and operable windows. • Outside designated area for smoking.			• This prerequisite is very easy to be achieved, however implementing it later on depends mainly on the building manager to make sure that no one smokes except in the designated area.
IEQc1	**IEQc1**	**Outdoor Air Delivery Monitoring**	**D**	**S**	**S**	**S**	**S**			**L**					• The credit was denied as not enough CO2 sensors were installed due to its high cost.	• This credit was not attempted by the project team as it costs too much due to the high price of CO2 sensors.		• This credit is very had to be achieved because of the high cost of co2 measurement devices which are required to be installed in densely occupied area.
IEQc2	**IEQc2**	**Increased Ventilation**	**D**	**S**		**S**	**S**			**L**	**S**				• The project has increased breathing zone outdoor air ventilation rates to all occupied spaces by 30% above the minimum rates required by ASHRAE 62.1-2007.	• This credit was not attempted by the project team as occupied area was huge and it would have cost so much to increase the ventilation rate by 30%.		• This credit depends on the project nature and occupancy rate; however it may cost extra money if the occupancy rate is very high.
IEQc3.1	**IEQc3.1**	**Construction IAQ Management Plan- During Construction**	**C**	**S**		**S**				**S**				**L**	• HVAC protection on site: all ducts and equipment openings were sealed after installation, HVAC systems were not used during construction • Source control: keeping containers of wet products closed as possible, sealing containers of waste materials that can release odor or dust. • Pathway interruption: finished spaces were isolated from areas of work, • Housekeeping: regular cleaning to remove contaminants, suppressing and minimizing dust, keeping all coils, air filters, fans and duct work clean. • Absorptive materials were protected from moisture damage.			• This credit is easy to be achieved; however it needs a lot of effort from the contractor side and regular follow up from LEED coordinator to make sure that all the required procedures are implemented onsite.

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# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
IEQc3.2	**IEQc3.2**	**Construction IAQ Management Plan- Before Occupancy**	**C**	**S**		**S**				**S**				**L**	• This credit was not attempted by the project team. Because the owner partially occupied the building before the construction was finished, so it was impossible to flush out the place, and the IAQ test cost too much.		• A flush out plan was implemented before occupancy.	• This credits is not easy to be achieved as it needs early finish for the construction works so the flush out can be achieved, it depends on the commitment of the contractor with the time schedule, and the flexibility of the owner to not occupy the building before the flush out is completed.
IEQc4.1	**IEQc4.1**	**Low-Emitting Materials- Adhesives and Sealants**	**C**	**S**		**S**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team as all adhesives and sealants were locally manufactured above limits in addition there were no available cut sheets or documented information regarding the VOC limit.		• The project team purchased all adhesives and sealants from national manufacturers, where all cut sheets were available, and the used products complied with the required voc limits.	• This credit is very hard to be achieved, unless all products are purchased from international suppliers. • This credit requires regular follow up and documentation for all the supplied materials and their Specs.
IEQc4.2	**IEQc4.2**	**Low-Emitting Materials- Paints and Coatings**	**C**	**S**		**S**	**S**	**S**					**S**	**L**	• The project team used Low VOC paints and coatings and was able to document all the used paints with their Voc limits and Spec.			• This credit can be achieved through specific paint types, which are limited through specific local manufacturers in Egypt.
IEQc4.3	**IEQc4.3**	**Low-Emitting Materials- Flooring Systems**	**C**	**S**		**S**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team as none of the flooring materials used in the project, complied with the required criteria.		• All flooring materials were purchased from national manufacturers. • All Carpets were Green Label plus certified. • Laminated HDF complied with California department of health services standard. • Terrazzo tiles and marble qualifies without testing.	• This credit is very hard to be achieved with local materials, as local manufacturers and suppliers are not familiar with materials certifications, such as FloorScore and Green Label Plus. • So this credit can cost a lot of money according to the types of materials purchased.
IEQc4.4	**IEQc4.4**	**Low-Emitting Materials- Composite Wood and Agrifiber Products**	**C**	**S**		**S**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team as most of the used wood and agrifiber products were locally manufactured.			• This credit is very hard to be achieved, as most local wood manufacturers use urea formaldehyde, and purchasing these items from international suppliers would cost so much.
NA	**IEQc4.5**	**Low-Emitting Materials- Systems Furniture and Seating**	**C**	**S**		**S**	**S**	**S**					**S**	**L**	• Not applicable for that rating system.	• Not applicable for that rating system.	• This credit was not attempted by the project team	• This credit is very hard to be achieved because local furniture manufacturers are not familiar with the Greenguard IAQ Certificate, neither do they perform the testing protocol required in option two for that credit. • Purchasing all furniture from international supplier would cost too much.

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# NC	# CI	Credit Name	Stage	Responsibility[1]: Lead(L)/ Support (S)											Case Studies			Applicability in Egypt
				O	BM	LC	A	ID	LA	MEP	SE	CA	C	GC	Project (A)	Project (B)	Project (C)	
IEQc5	**IEQc5**	**Indoor Chemical and Pollutant Source Control**	**D**	**S**		**S**	**S**	**S**					**S**	**L**	• This credit was not attempted by the project team.		• Permanent 10 ft (3.1m) Floor mats were installed in all main entrances. • Exhaust systems and door closers in toilets and janitor rooms. • MERV 13 filters were installed.	• This Credit is very easy to be achieved however some clients may find it unsuitable to install a 3.1 meter floor mat at the main entrances.
IEQc6.1	**IEQc6.1**	**Controllability of Systems-Lighting**	**D**	**S**		**S**	**S**	**S**		**L**	**S**				• This credit was denied	• This credit was not attempted by the project team.	• This credit was denied.	• This credit requires task lighting for each individual office or work station which was technically impossible to be achieved in the three projects, it depends on the project nature and owner requirements.
IEQc6.2	**IEQc6.2**	**Controllability of Systems-Thermal Comfort**	**D**	**S**		**S**	**S**	**S**		**L**	**S**				• This credit was denied.	• This credit was denied.	• This credit was denied.	• The projects teams couldn't reach to a strategy that grants access for 50% of the occupants to thermostat control or operable windows, it depends on the project nature and owner requirements.
IEQc7.1	**IEQc7.1**	**Thermal Comfort-Design**	**D**	**S**		**S**	**S**	**S**		**L**	**S**				• The HVAC Design for mechanically conditioned and ventilated spaces complies with ASHRAE Standard 55-2004.			• This Credit is very easy to be achieved, as mechanical engineers in Egypt works according to ASHRAE standards; however mechanical engineer may find some difficulty in documenting this credit through performing some additional calculations and filling the required online form.
IEQc7.2	**IEQc7.2**	**Thermal Comfort-Verification**	**D**			**S**	**S**	**S**		**L**	**S**				• A sample questionnaire and a narrative which identifies the comfort criteria, strategy for ensuring performance to the comfort criteria, description of the permanent monitoring system implemented, and process for corrective action have been prepared by the project team.			• This credit is very easy to be achieved, as it requires surveying building occupants regarding comfort conditions.
IEQc8.1	**IEQc8.1**	**Daylight and Views-Daylight**	**D**	**S**		**S**	**L**	**S**			**S**				• The project wasn't applicable for that credit.			• This credit depends on the project type, conditions, architectural design and owner requirements.
IEQc8.2	**IEQc8.2**	**Daylight and Views-Views for Seated Spaces**	**D**	**S**		**S**	**L**	**S**			**S**				• The project wasn't applicable for that credit.	• The project wasn't applicable for that credit.	• 91.14 % of all regularly occupied seated spaces have access to outdoor views.	• This credit depends on the project type, conditions, architectural design and owner requirements.

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4.4. Documentation Examples for Some Credits

In order to have a full understanding of the LEED rating system, and get familiar with the documentation process which was explained earlier in the previous chapter, a sample of the submitted documents to USGBC on LEEDOnline shall be presented for some credits in this section. The documentation samples are randomly selected from the three projects.

Documentation are submitted in several formats, some credits/prerequisites need a written, signed and stamped plan such as ESC plan, Construction waste management plan IAQ management plan, commissioning plan, M&V pl**a**n, and transportation plan, other supporting documentation are needed such as photos, or tracking sheets, submittals forms and so on.

Therefore in the below section the documentation samples are categorized according to the credits/prerequisites categories, the credits number refer to the number of credit/prerequisite in the LEED NC-2009 in order to avoid any conflicts. However some Documentation will be in the Appendix as they represent products data sheets.

4.4.1. Sustainable Sites Credits Documentation Sample

Figure 4-2 : Sample of photos presented in the ESC Plan which is submitted as a part of the documentation for SSp1

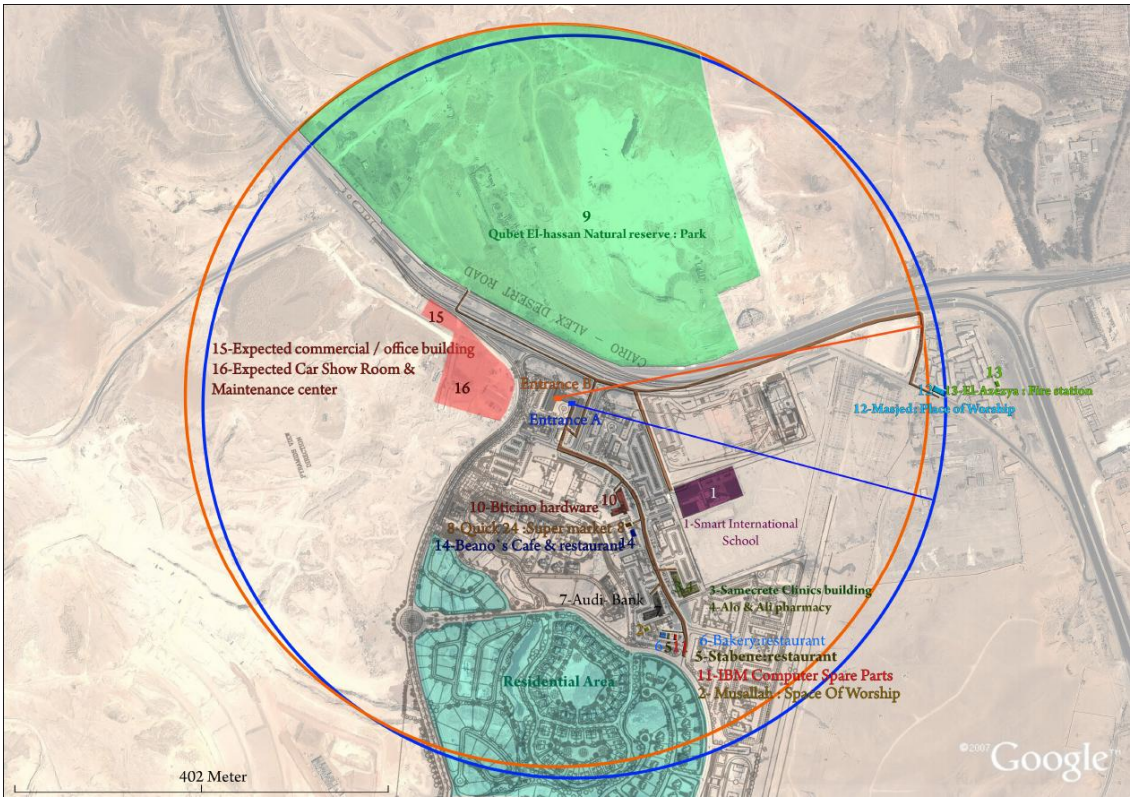


Figure 4-3: Sample map for community connectivity showing basic services and residential developments around the project for SSc2

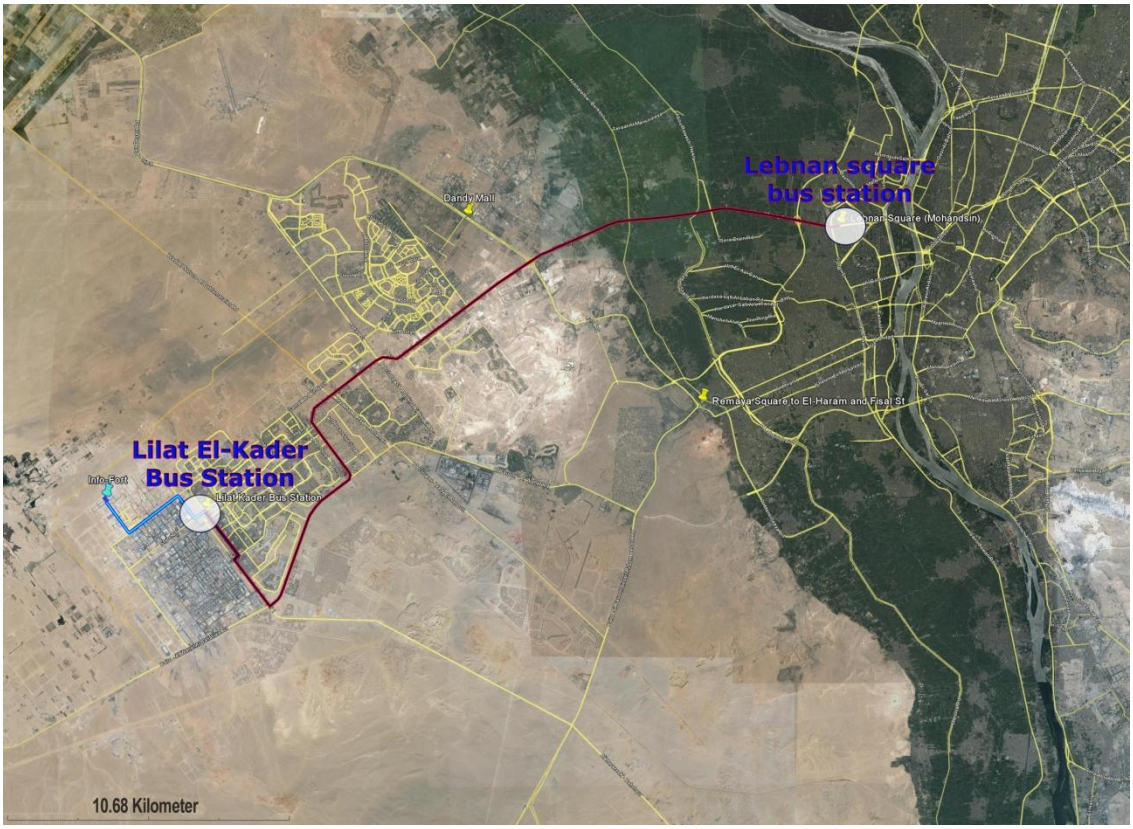


Figure 4-4: Sample map showing the closest public bus station and one of the bus lines that passes through it as part of SSc4.1 documentation

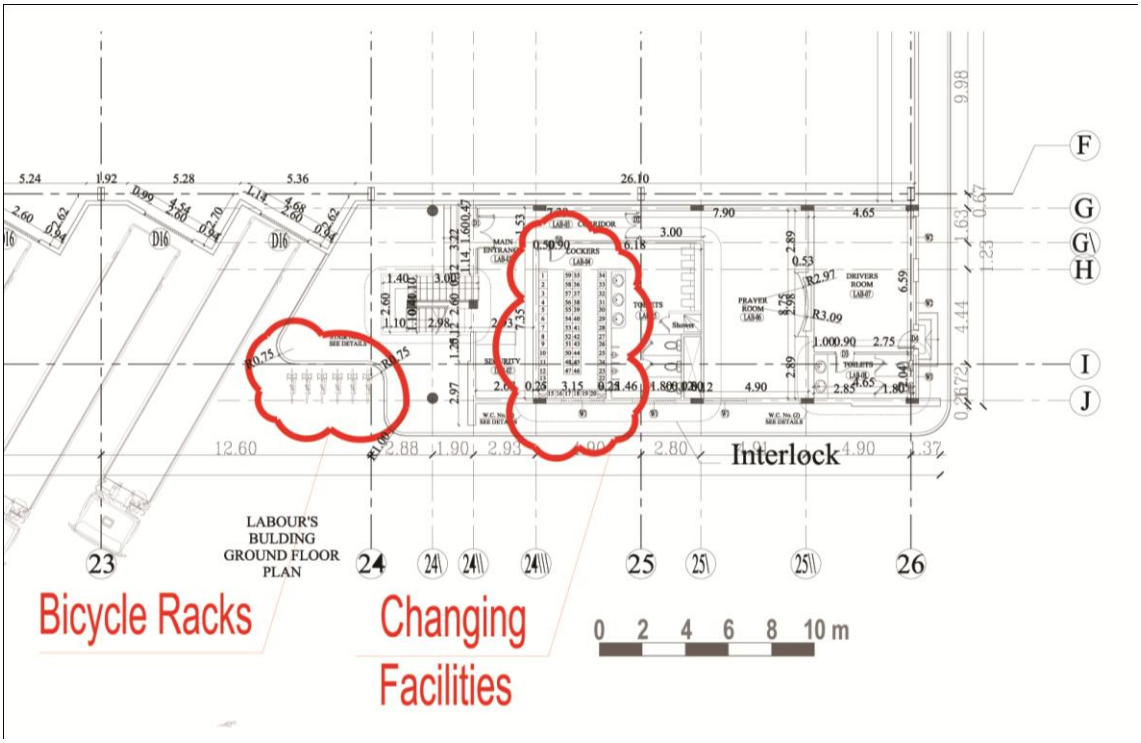


Figure 4-5: Sample documentation for SSc4.2 the plan above showing the bicycle racks and lockers location, then the credit is documented with photos

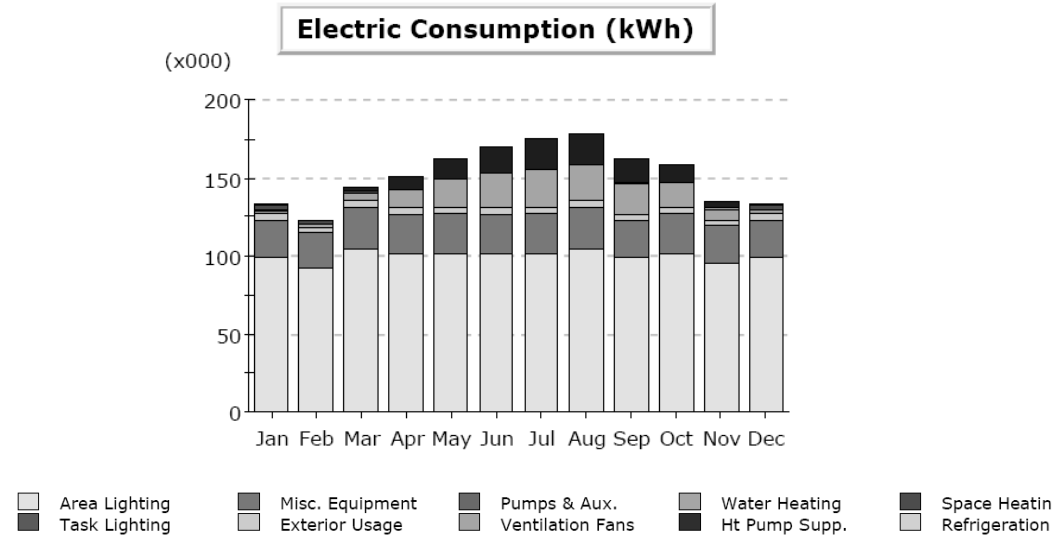
Figure 4-6: Photos documenting SSc4.3 Alternative Transportation Low-Emitting and Fuel-Efficient Vehicles

4.4.2. Water Efficiency Credits Documentation Sample

Fixtures	Manufacturer	Model	Gal/Flush	Flow GPM
Water Closet	Duravit	Dellarco	1.6/0.8	_
Kitchen Sink	Franki samy	GRN -721-150	_	1.6
Lavatory Faucet	Ideal Standard	A3820	_	1.6
Aerators : 0.80 GPM	Miro	PCA 4	_	0.8
Shower Mixer	Ideal Standard	A3832	_	2.4
URINAL	Duravit	Echo	0.3	_

Figure 4-7: Sample of water fixture schedule submitted to document WEp1

4.4.3. Energy and Atmosphere Credits Documentation Sample



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.6	1.0	2.6	7.2	12.1	16.6	19.1	19.1	15.1	11.2	4.2	1.1	109.9
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.8	1.8	1.0	0.1	0.0	-	-	-	-	0.0	0.2	1.8	7.6
HP Supp.	0.0	-	-	-	-	-	-	-	-	-	-	-	0.0
Hot Water	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	4.5
Vent. Fans	1.7	2.1	4.7	11.6	17.9	22.0	23.5	23.1	19.5	15.8	7.1	2.3	151.4
Pumps & Aux.	0.1	0.1	0.0	-	-	-	-	-	-	-	0.0	0.1	0.3
Ext. Usage	4.0	3.6	4.0	3.9	4.0	3.9	4.0	4.0	3.9	4.0	3.9	4.0	47.5
Misc. Equip.	25.1	23.0	26.0	25.2	25.5	25.2	25.5	26.0	24.7	25.5	24.2	25.1	301.2
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	98.3	91.5	105.1	101.7	101.7	101.7	101.7	105.1	98.3	101.7	94.9	98.3	1,199.9
Total	133.1	123.5	143.9	150.1	161.7	169.8	174.2	177.7	161.9	158.6	134.9	133.1	1,822.4

Figure 4-8: A capture from the simulation report submitted as a part of EAp2 documentation

4.4.4. Materials and Resources Credits Documentation sample

Figure 4-9: Photos Documenting MRp1

Material	Quantity	Recyclable/Reusable	Destination/ End User	Recycling Method
Cement based waste (m^3)	31.7628tons		Landfill	
Block	31.514 tons	Reusable	On Site	Reused Directly at site
Steel	14.92 tons	Recyclable	Youth Spirit	
Plastic	4.94 tons	Recyclable	Youth Spirit	
Paper	1 tons	Recyclable	Youth Spirit	
Wood	9.56 tons	Recyclable	Youth Spirit	
Cement based Waste(m3)	3.662064 tons	Reusable	On Site	Reused Directly at site.

Project waste analysis worksheet

Waste separation on site

Reusing of hollow blocks waste on site

Selling wastes to recycling companies

Weighing separated wastes

Figure 4-10: Sample of photos and documents presented in the CWM Plan which is submitted as a part of the documentation MRc2

4.4.5. Indoor Environmental Quality Documentation Sample

Figure 4-11: Photos documenting IEQp2: Smoke Prohibiting

Figure 4-12: Sample of photos presented in the IAQ Plan during construction which is submitted as a part of the documentation for IEQc3.1

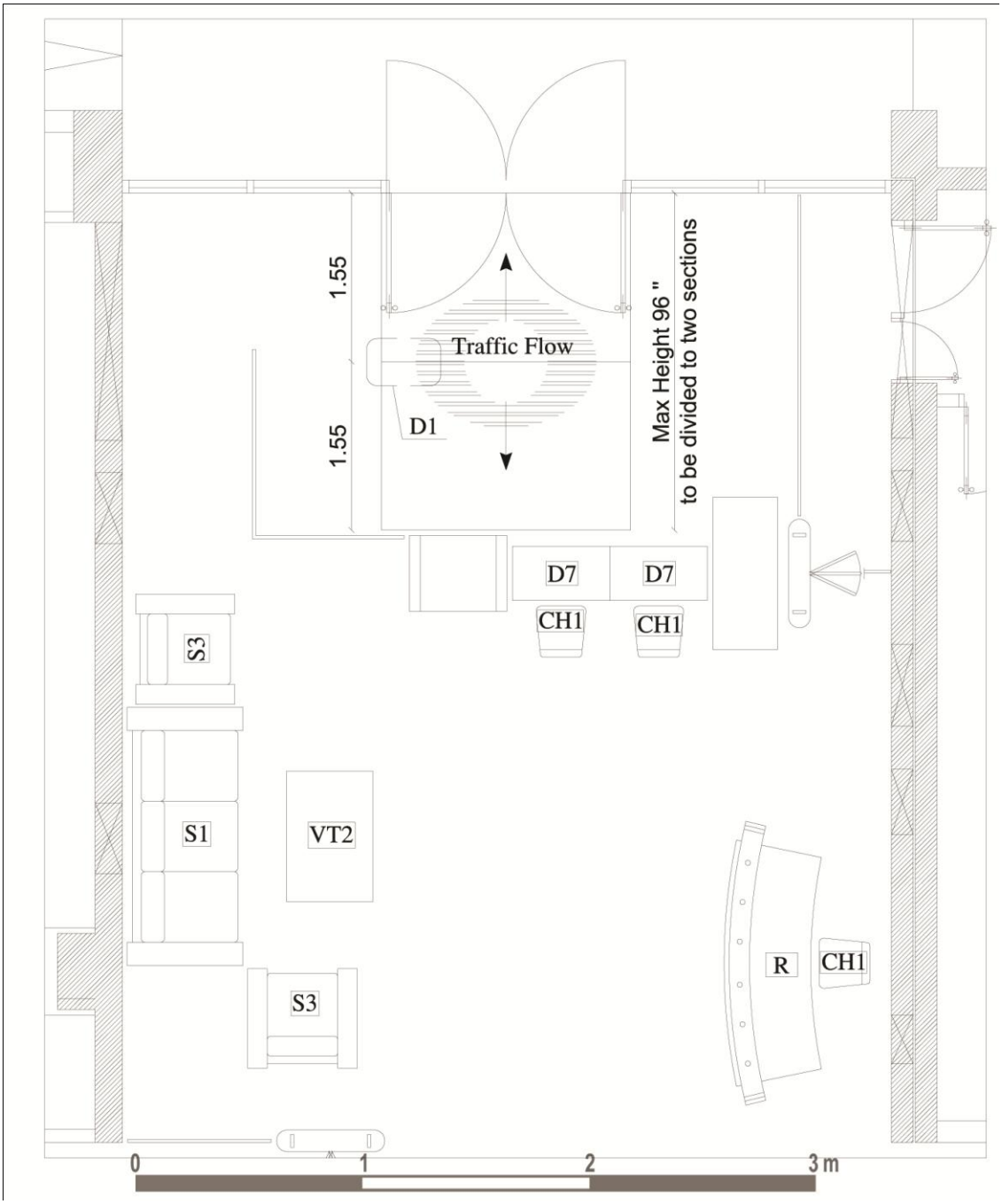


Figure 4-13: Entrance lobby Plan after applying the floor mat as a part of IEQc5 Requirements

4.5. Conclusion

This chapter figured out the applicability and implementation of all credits of the LEED rating system NC-2009 and CI -2009 in Egypt, so in order to sum up the previous chapter the researcher has categorized the credits into four categories:

- ***Easily Achieved Credits:*** These are the credits/Prerequisites that were targeted/achieved in two or more projects and didn't face any problem during the project.
- ***Project Circumstances Dependent Credits:*** These are the credits/Prerequisites that depends on the project circumstances, such as project location, number of occupants and owner requirements.
- ***Rarely Achieved Credits:*** These are the credits that weren't targeted or were rejected in the three projects.
- ***High Initial Cost Credits:*** These are the credits that certainly need high initial cost in any project and its achievement depends on the project team decisions.

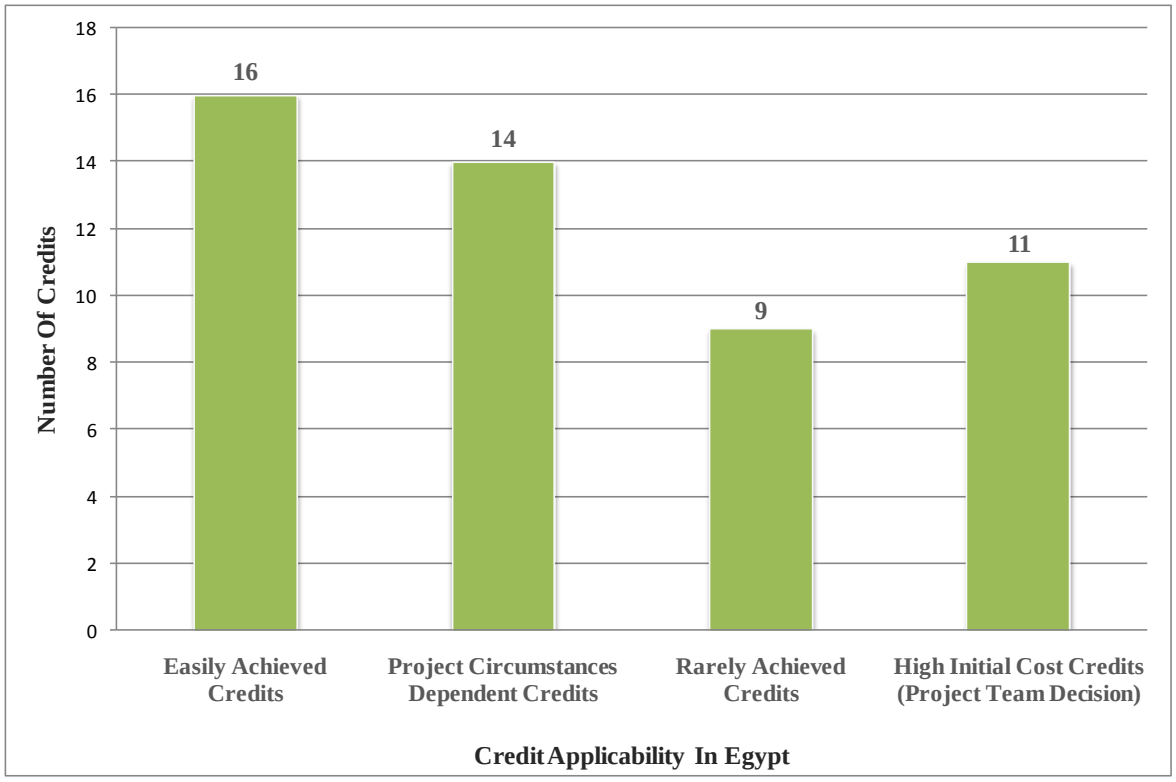
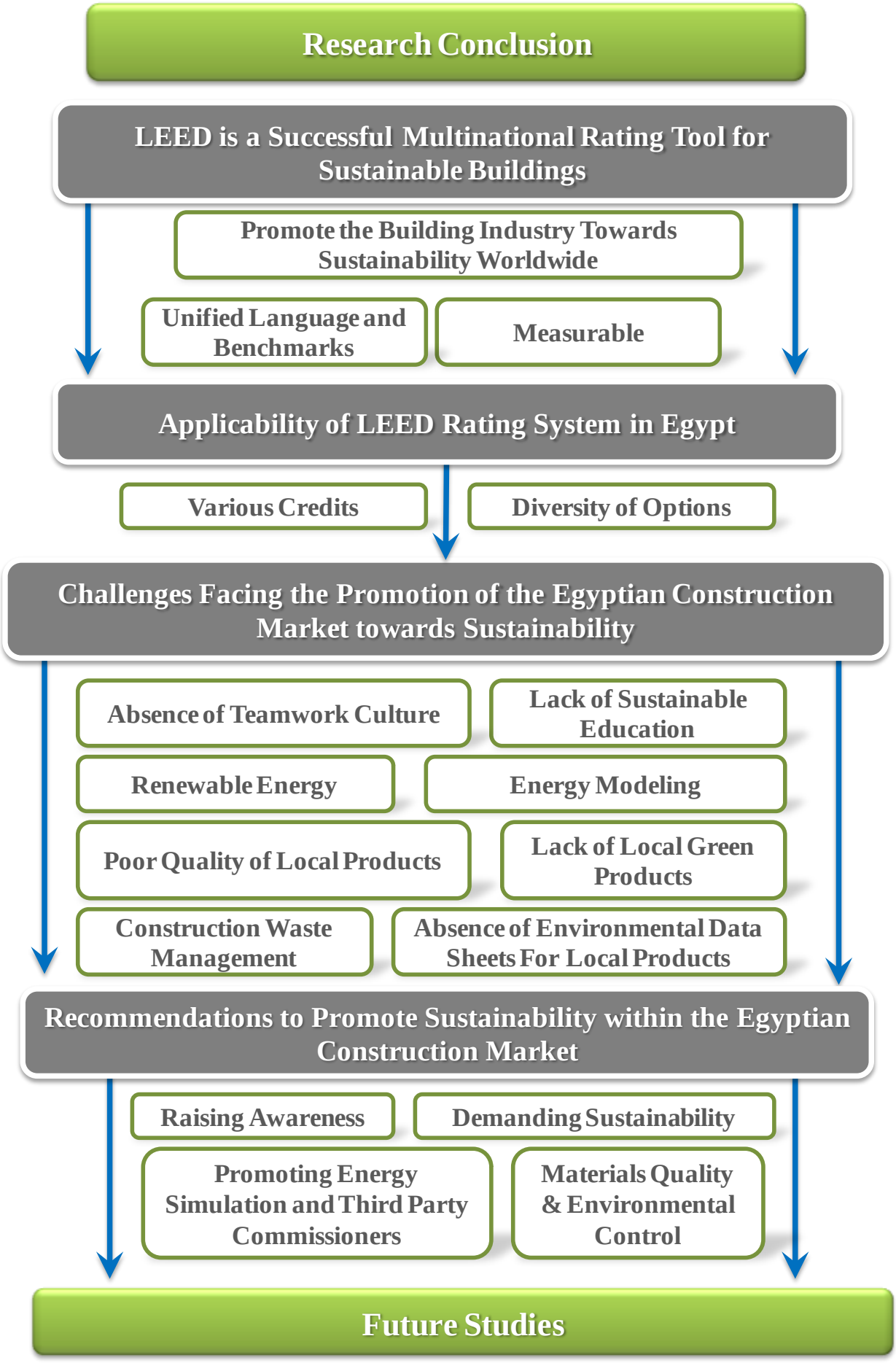


Figure 4-14: LEED Credits Applicability in Egypt
Source: Researcher

Chapter Five

Conclusion, Recommendations & Future Studies


Research Conclusion
LEED is a Successful Multinational Rating Tool for Sustainable Buildings
Promote the Building Industry Towards Sustainability Worldwide
Unified Language and Benchmarks
Measurable
Applicability of LEED Rating System in Egypt
Various Credits
Diversity of Options
Challenges Facing the Promotion of the Egyptian Construction Market towards Sustainability
Absence of Teamwork Culture
Lack of Sustainable Education
Renewable Energy
Energy Modeling
Poor Quality of Local Products
Lack of Local Green Products
Construction Waste Management
Absence of Environmental Data Sheets For Local Products
Recommendations to Promote Sustainability within the Egyptian Construction Market
Raising Awareness
Demanding Sustainability
Promoting Energy Simulation and Third Party Commissioners
Materials Quality & Environmental Control
Future Studies

CHAPTER 5: CONCLUSION, RECOMMENDATIONS & FUTURE STUDIES

LEED is not a design Tool; it is a rating system that enhances the sustainability of buildings through measuring how much of the building harmful impacts on the environment were minimized during the whole building life cycle.

The success of LEED rating system internationally goes back to several reasons that can be summarized as follows:

- It is an effective and tangible tool that measures the sustainability of a building.
- It created a multinational language and benchmarks for the sustainable construction industry.
- It drives all market related suppliers and contractors to promote themselves and their products towards sustainability.

5.1. Applicability of LEED in Egypt

This research main purpose was to investigate the use and implementation of the international LEED rating system on Egyptian projects by analyzing three Egyptian LEED certified or registered Projects. Based on the analysis in this research and based on personal experience and professional background the researcher has found out that when it comes to Egyptian projects, the implementation of the requirements of the LEED rating system is not a problem as there is always several options to earn the targeted number of points within the desirable budget, through the various number of credits, and the diversity of implementation of credits through several available options.

5.1.1. Why LEED Can Be A Successful Tool For Rating Sustainable Buildings In Egypt?

LEED Rating system can be a very successful tool not only as a rating system for sustainable buildings but also as an efficient way to enhance the sustainability of buildings in Egypt, this can be attributed to the below:

- ***Recognized***: LEED rating system is well recognized internationally which encourage investors to go for it.
- ***Systematic Tool***: LEED is a systematic process that ensures that a building performs in accordance with its design.
- ***Tested***: LEED rating system is tested worldwide and has proved its effectiveness and success all over the world.
- ***Organized***: LEED Rating system is a very well organized tool, with all its types and reference guides that contains all details and options of applying LEED Credits.
- ***Clear***: LEED Rating system is clear enough to be understood and implemented worldwide in addition to all the supporting tools, previously mentioned in this research, which can guide anyone working with this rating system.
- ***Third party concept***: LEED rating system integrity through third party managers and commissioners made it successful and trustworthy.

5.2. Challenges Facing the Promotion of the Egyptian Construction Market towards Sustainability

Applying LEED rating system on several projects locally have raised some important challenges that are related to the emergence of a sustainable construction market in Egypt subsequently the emergence and application of a green buildings rating systems in Egypt. Therefore, based on the previously discussed case studies, the researcher has concluded that the transformation of the construction market in Egypt to a sustainable one requires overcoming a lot of challenges, these challenges are stated below with some suggested solutions:

5.2.1. Teamwork Culture

As discussed before, the integrated design approach is the key stone of carrying out a sustainable high performance building. This means that project team members' collaboration is essential to come up with a successful sustainable project. However, in Egypt the teamwork culture is missing, as most of projects are executed through the traditional design approach, explained earlier in this research, in which each team member work separately and integration between consultants and contractors doesn't exist this can be practically translated in the below points:

- Absence of Communication and coordination between project teams (Owner, Architect, MEP, Civil, Contractor…)
- Using software programs as drafting tools instead of using it as a coordination tool
- Omitting project documentation and lack of documentation tools

5.2.1.1. Suggested Solutions:

- A sustainability Charrette should be conducted between project teams at least twice per month according to the project needs and timeline, to discuss any updates or issues in the project.
- Assigning a dedicated team or person (according to the project scale) to be responsible for coordination and documentation.
- Using coordination and documentation tools and software

5.2.2. Construction Products and Construction Waste Management

Egypt is facing a huge problem regarding waste managing, whether for domestic wastes or construction wastes, managing wastes in public buildings depends on facility managers, and owner internal policy regarding wastes, although a lot of waste recycling facilities have evolved in the past few years, but they are only specialized in taking separated domestic wastes, so contractors may find it a little bit difficult to find a waste recycling facility for construction wastes, unless they are properly separated on site.

The term Green or sustainable material doesn't exist in the Egyptian construction market especially within contractors and suppliers, most of the local manufacturers don't give the proper attention to how much green are the materials they manufacture, Also most of local materials don't have environmental data sheets or information, for example local manufactured steel have recycled content, but the manufacturer wouldn't put that peace of information in a formal data sheet, other important green features are extremely important to be recognized in data sheets This can be practically translated as below:

- Absence of Construction Waste Management Concept.
- Lack of Data Sheets and Products Information.
- Poor Quality of Locally Manufactured Products.

5.2.2.1. Suggested Solutions:

Clients and consultants are the main market drivers by raising their requirements and demanding sustainability in their projects through:

- Urging contractors to sort wastes on site and connecting them with the proper waste recycling companies.
- Urging suppliers and manufacturers to test their products and to comply with the minimal environmental requirements: HBRC is a suggested testing authority.

5.2.3. Energy systems

Energy modeling simulation of a project is an essential component of its sustainability. Energy modeling allows detailed comparative analysis of potential building systems and strategies to optimize energy performance.

Modeling enables the team to make integrated design decisions based on a full understanding of cost and how systems will interact. However we have two main problems when it comes to energy modeling the first one is its high cost, the second one is that there are a very few number of energy modeling experts in Egypt.

With Energy Modeling at the beginning of the project, comes the building systems commissioning at the end of the project to ensure that all systems work in accordance to the design, however it may cost the client, but still its importance cannot be neglected.

Although the prices of oil and gas are growing rapidly, but still the initial cost of Integrating renewable energy within buildings is way too high whether for ordinary users or general facility owners, that makes initial cost one of the main obstacles facing the Egyptian construction market, all of this can be practically translated as below:

- Energy Modeling Simulation High Cost.
- Omitting building systems testing & commissioning in some projects.
- Extremely High Cost of Renewable Energy.

5.2.3.1. Suggested Solutions:

It is the Consultant role to encourage the owner to use Energy modeling tools and to integrate renewable energy within their buildings through:

- Explaining how Energy simulation can provide the most cost effective design to meet the owner environmental goals.
- Explaining the operational cost savings over the life of the building.
- Explaining the Environmental benefits of renewable energy and assessing the payback period.
- Testing and commissioning of all building systems to make sure they are built according to the minimal environmental requirements.

5.3. General Recommendations

After going through the three case studies in person and analyzing them, the researcher has found out that some major steps are essential in order to promote the Egyptian construction market towards sustainability, and accordingly this will help in the emergence and implementation of a sustainable rating system, these steps are discussed below:

5.3.1. Sustainable Awareness and Education

Raising sustainable awareness and education is very important, whether in schools and colleges or within the key players of the construction market (Owners, consultants, contractors, manufacturers…) through public lectures, courses, building models case studies and so on. Promoting for the feasibility and economical, social and environmental benefits of green projects to owners and landlords is an important step to start upgrading the construction market.

5.3.2. Increasing the Demand for Sustainability

Clients, landowners, house holders and property owners are the main market drivers, by raising their requirements and demanding sustainability in their projects, consultants, contractors and manufacturers will be eager to enhance their knowledge and to practice sustainability in their works.

In addition, the governmental intervention is very important through upgrading local mandatory codes and enforcing sustainability practices at least in public buildings.

5.3.3. Sustainable Materials Quality Control

In order to have qualified sustainable materials and to avoid green washing, an official qualified independent third party authority for quality and environmental control of locally manufactured construction materials is required, this third party shall be responsible for materials green labeling, and verifying environmental data sheets of local materials. The data sheets shall include environmental data such as the recycled content, the source of the material, the SRI value, and the VOC content.

5.3.4. Energy Simulation and Commissioning

Promoting the use of energy modeling programs is very important to achieve energy efficiency in built environment.

The same applies for building systems commissioning, an independent qualified authority shall be responsible for authenticating and certification of qualified third party commissioners who would make sure that energy building systems are built according to environmental preferences.

5.4. Future Studies

Challenges facing the sustainable transformation of the construction market in Egypt are not limited to those concluded in this research, this research have only highlighted the challenges that emerged through applying LEED rating system, since sustainability have

several other approaches therefore other challenges that face the sustainable construction market in Egypt shall emerge when studying and analyzing them. These challenges in addition to the challenges mentioned in this research are a good research material for more detailed analyzing and coming up with a detailed plan for upgrading the Egyptian construction market into a sustainable one, However two specific idioms seems to be more promising as a field of research from the researcher point of view

5.4.1. Promoting Sustainable Construction Materials

Promoting sustainable construction materials in the Egyptian market requires a lot of research and frame works the researcher have highlighted some important steps that can be a good start in promoting sustainable construction materials:

- Performing a material survey to sort out existing Egyptian construction materials and materials' suppliers.
- Establishing a material database with existing specs and a list of the required environmental tests for each material.
- Suggesting a proposed model for a unified data sheet form for all construction materials.
- The Government intervention is necessary to assign a third party testing authority, and to modify the national policy regarding construction materials Environmental specs.

5.4.2. Promoting Building Energy Modeling Use

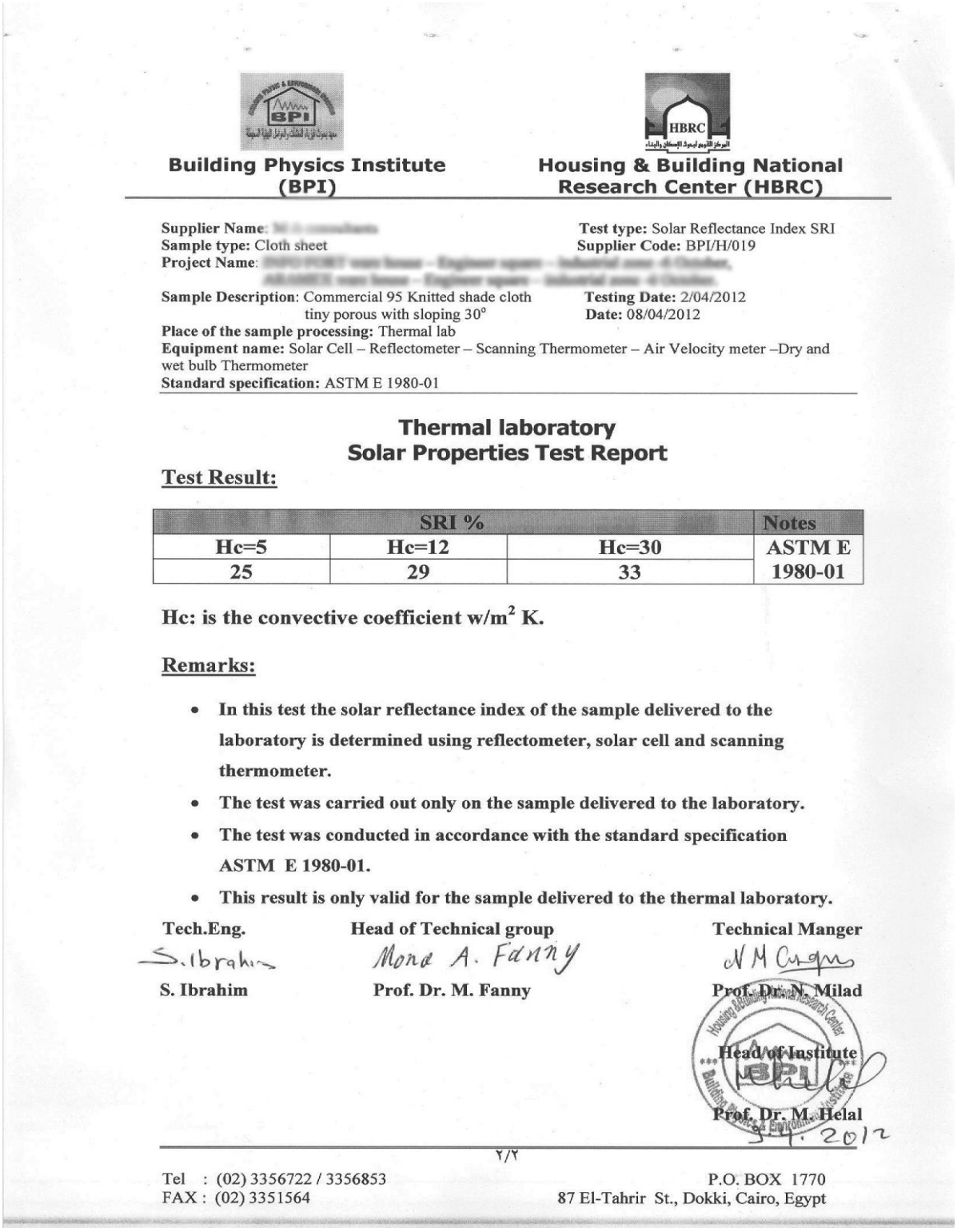
Building Energy Modeling is still considered as a new field and business in Egypt, However in order to make energy modeling effective in Egypt, the researcher have highlighted some steps that may encourage this field below:

- *Governmental role:* Changing energy national policies and enforcement of applying local building energy codes.
- *Non Governmental Organizations role*: Spreading awareness and education through colleges and workshops.
- *Consultants' role*: urging clients to use energy modeling simulation tools through explaining the cost benefits over the life cycle of the building.

APPENDIX

SAMPLE DOCUMENTATION

APPENDIX



Building Physics Institute (BPI) — **Housing & Building National Research Center (HBRC)**

Supplier Name: [redacted] **Test type:** Solar Reflectance Index SRI
Sample type: Cloth sheet **Supplier Code:** BPI/H/019
Project Name: [redacted]
Sample Description: Commercial 95 Knitted shade cloth tiny porous with sloping 30° **Testing Date:** 2/04/2012 **Date:** 08/04/2012
Place of the sample processing: Thermal lab
Equipment name: Solar Cell – Reflectometer – Scanning Thermometer – Air Velocity meter –Dry and wet bulb Thermometer
Standard specification: ASTM E 1980-01

Thermal laboratory
Solar Properties Test Report

Test Result:

SRI %			Notes
Hc=5	Hc=12	Hc=30	ASTM E
25	29	33	1980-01

Hc: is the convective coefficient w/m^2 K.

Remarks:

- **In this test the solar reflectance index of the sample delivered to the laboratory is determined using reflectometer, solar cell and scanning thermometer.**
- **The test was carried out only on the sample delivered to the laboratory.**
- **The test was conducted in accordance with the standard specification ASTM E 1980-01.**
- **This result is only valid for the sample delivered to the thermal laboratory.**

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S. Ibrahim	Mona A. Fanny	N M Cuqm
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Figure A- 1: Part of the HBRC testing report for the SRI value of the car park covering material (SSc7.2)

Teknion

Environmental Data Sheet

www.teknion.com

12-Mar-13

Product: *Zone*

LEED Credit MR 5- Regional Materials

Manufactured in Toronto

LEED Credit MR 4 Recycled Content

Material	Product		Recycled Content						Ability to Recycle
			Total Recycled		Pre Consumer		Post Consumer		
	lbs	%	lbs	%	lbs	%	lbs	%	
Aluminum	0.0	0.0%	0.0	0.0%	0.0	60.0%	0.00	10.0%	Yes
ABS	0.0	0.0%	0.0	0.0%	0.0	65.0%	0.00	35.0%	Yes
Cardboard	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Fabric	0.0	0.0%	0.0	0.0%	0.0	100.0%	0.00	0.0%	Yes
Hardboard	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Lumber	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Nylon	0.0	0.0%	0.0	0.0%	0.0	45.0%	0.00	12.0%	Yes
Plastic	2.3	16.1%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Plywood	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Polypropylene	3.2	22.2%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Polyurethane	0.5	3.7%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Polyurethane Foam	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Rubber	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Steel	8.4	58.0%	3.1	21.3%	1.4	17.0%	1.66	19.8%	Yes
Zinc	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	Yes
Other	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.00	0.0%	N/A
Total (Product)	**14.4**	**100.0%**	**3.1**	**21.3%**	**1.4**	**9.9%**	**1.7**	**11.5%**	**100.0%**

LEED Credit EQ 4.5 - Low emitting Materials

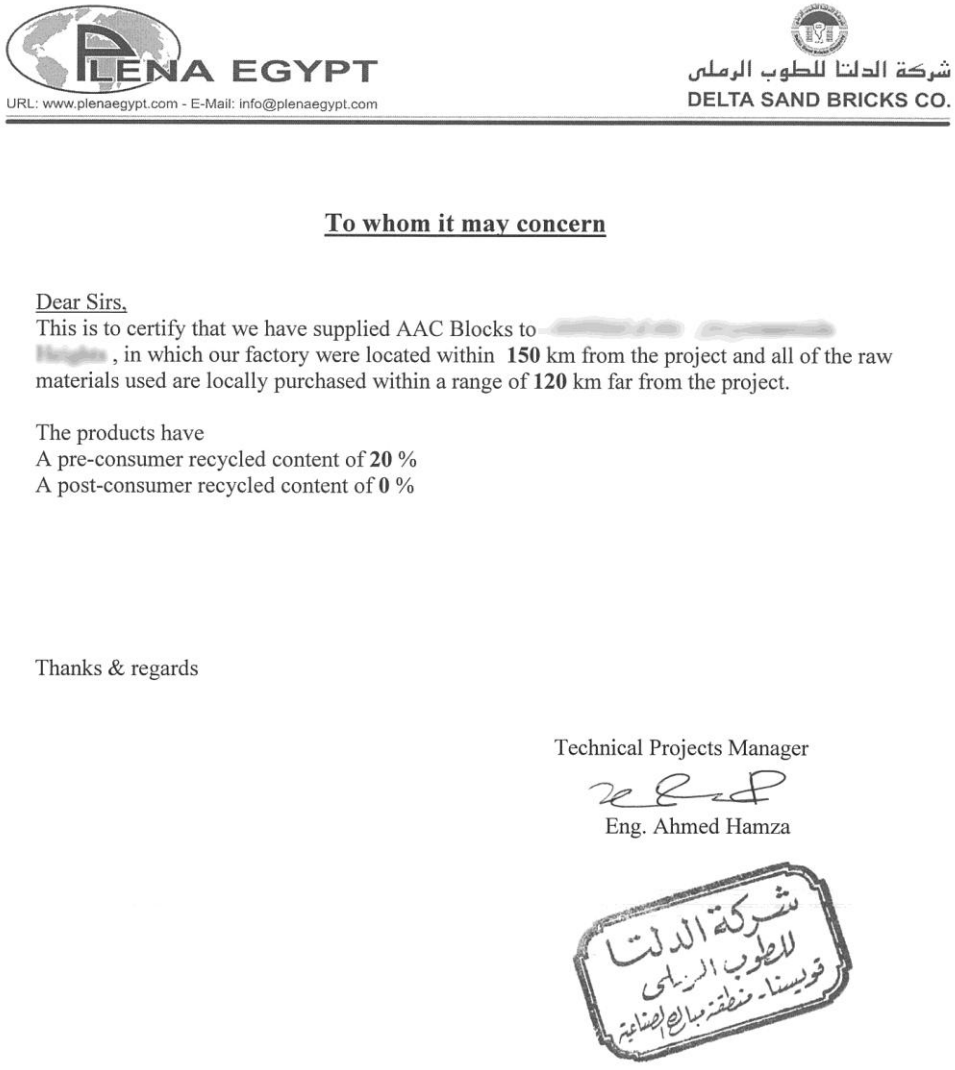
For Emissions Certification go to www.greenguard.org, look for Teknion in the Manufacturers/Brands section

Steel recycled content information is taken from Steel Recycling Institute published documentation at http://www.recycle-steel.org/

Doug Hietkamp

Doug Hietkamp Director of Sustainable Development Programs

Figure A- 2: A data sheet showing the recycled content of one of the items used in one of the projects, it represents a part of the documents needed for MRc4



PLENA EGYPT
URL: www.plenaegypt.com - E-Mail: info@plenaegypt.com

شركة الدلتا للطوب الرملى
DELTA SAND BRICKS CO.

To whom it may concern

Dear Sirs,
This is to certify that we have supplied AAC Blocks to [redacted] , in which our factory were located within **150** km from the project and all of the raw materials used are locally purchased within a range of **120** km far from the project.

The products have
A pre-consumer recycled content of **20** %
A post-consumer recycled content of **0** %

Thanks & regards

Technical Projects Manager
Eng. Ahmed Hamza

شركة الدلتا للطوب الرملى قويسنا- منطقة مبارك الصناعية

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Figure A. 1: A manufacturer letter proving the locality of the supplied materials MRc5

JOTUN
No. 1 in Paints

FENOMASTIC EMULSION MATT

PRODUCT DESCRIPTION:

Fenomastic Emulsion Matt is a high quality acrylic copolymer based emulsion paint with low VOC, which ensures good indoor air quality. It has high washability, hiding power, incan antibactarial and colour retention properties. Fenomastic Emulsion Matt also has good flow and gives a smooth , durable flat finish.

RECOMMENDED USE:

For interior use on most surfaces i.e. plaster, stucco filler gypsum board , concrete, asbestos cement sheeting , rendered block-work.

TECHNICAL INFORMATION:

Colors : White + Tinted on Jotun multicolor machine.
Solids (% by volume) : 35 ± 5
Specific Gravity : 1.25 – 1.48 gm/cm^3
Viscosity : 90 – 110 K.U.

VOC - 0 gms/lit (theoretical) when measured as per ISO EU.

Dry film thickness per coat (microns)	Theoretical spreading rate (m^2/Itr.)
35 - 43	8 - 10

APPLICATION DATA:

Application Methods : Airless Spray, brush, roller or conventional spray
Mixing ratio : Single pack
Thinner/Cleaner : Water

Guiding data airless spray

Pressure at nozzle : min. 150 kp/cm^2 - 2100 psi
Nozzle tip : 0.021 –0.027 inch
Spray angle : 65° - 80°

SURFACE PREPARATION:

The surface must be sound, clean, dry, free from dust, oil, grease and laitance etc.All traces of release agents must be removed. On chalky and dusty surfaces, all loose material must be removed by stiff bristle brushing.

CONDITIONS DURING APPLICATION:

The temperature of the substrate should be min. 10°C and min. 3°C above the dew point of the air, temperature and relative humidity measured in the vicinity of the substrate.

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Figure A- 3: One of the paints data sheets showing the VOC limit within the documents of IEQc4.2

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الملخص

تصميم المباني وتشييدها وتشغيلها لها تأثيرات كبيرة على البيئة والاقتصاد والمجتمع والتي تمثل الركائز الثلاث الأساسية التي تشكل الاستدامة. هناك الكثير من الموارد يتم استخدامها أثناء دورة حياة أي مبنى مثل الأراضي والطاقة والمياه والمواد الخام. و المباني تولد الكثير من النفايات والكثير من الانبعاثات الضارة التي تؤثر على الأنسان والأرض والمياه والغلاف الجوي. أصحاب الأملاك، والمصممين، والمقاولين لديهم دائما عبء التغلب على الكثير من التحديات من أجل تلبية احتياجات شاغلي المبنى ومتطلبات المالك مع الحفاظ على آثارها السلبية على البيئة والاقتصاد والمجتمع إلى الحد الأدنى.

تطبيقات البناء الأخضر يمكن أن قلل بشكل كبير من الآثار السلبية علي البيئة من خلال المباني ذات الكفاءة في الأداء و ذات التصميم و التنفيذ المتميز الموفر للطاقة و الموارد ، وبالتالي مع ظهور الاتجاه الأخضر في البناء والنمو الملحوظ للاستدامة في سوق البناء، ظهرت الكثير من أنظمة تصنيف المباني المستدامة ، بما في ذلك نظام تقييم المباني في الريادة في الطاقة والتصميم البيئي (LEED).

نظام الريادة في تصميمات الطاقة والبيئة أو اختصارا ليد) بالإنجليزية Leadership in : Energy and Environmental Designأو (LEED هو نظام معترف به دوليا بأنه مقياس تصميم وا ٍنشاء وتشغيل مبانٍ مراعية للبيئة وعالية الأداء.حيث يقيّم نظام التصنيف ويقيس أثر أي منشأة وأداءها، والتي تأخذ بعين الاعتبار عدة نقاط منها اختيار الموقع وتوفير الطاقة والكفاءة المائية وانبعاثات غاز ثاني أوكسيد الكاربون وتحسين البيئة الداخلية للتصميم، وغيرها. حيث يتم تصنيف المباني التي تنال هذه الشهادة إلى ٣ مراتب حسب تطبيقها للمعايير المطلوبة، وهي: المرتبة البلاتينية، الذهبية والفضية.

والغرض من هذا البحث هو المساهمة في التوصل إلى فهم أفضل لمفهوم وتنفيذ نظام تصنيف LEED للمباني الخضراء ودورها لتحقيق الاستدامة في تشييد المباني في مصر.

وبما أن معظم الدراسات العملية التي قدمت على LEED يتم تنفيذها على أسواق أخرى غير السوق المصري و ذلك يرجع الي أن نظام (LEED) يعتبر جديد إلى حد ما في مصرو لذلك في هذا البحث سوف يتم مناقشة المبادئ الرئيسية لإدارة مشروع LEED، من خلال المرور

بالخطوات العملية برمتها للحصول على شهادة LEED للمشاريع بدءا من التصميم، مرورا بالبناء و التوثيق و أنتهاء بصيانة المبني و تشغيله.

ثم سيناقش البحث تطبيق معايير ال LEED في مصر، من خلال تحليل و مناقشة ثلاثة مشاريع LEED مسجلة و حاصلة علي الشهادة في مصر والتي تمثل دراسات الحالة المثالية لهذا البحث، في نهاية هذه الدراسة البحثية سوف نجد النتائج المستخلصة من هذا البحث و التوصيات المناسبة التي يمكن أن تساعد، من وجهة نظر الباحث، في تطوير سوق البناء المصرية، وجعلها أكثر استدامة.

إمكانيات تطبيق نظام الجمعية الأمريكية للمباني الخضراء علي المباني في مصر دراسة حالة: مباني حاصلة و مسجلة للحصول علي شهادة الريادة في الطاقة و التصميم البيئي (LEED)

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