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Applicability and Implementation of U.S. Green Building Council Rating System (LEED) in Egypt (A Longitudinal study for Egyptian LEED Certified Buildings)

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Abstract

According to the USGBC projects' directory, there are only Six LEED Certified projects and 17 registered projects in Egypt. This implies the limited number of LEED projects in Egypt. That's why most of the empirical studies conducted about LEED Rating System were performed on other markets than the Egyptian one; Accordingly This paper is the result of a longitudinal study that was performed on Three Egyptian LEED Certified projects as a part of a master thesis research that was submitted to Cairo University in 2013 by the first author where the second and the third author were the main supervisors. The objective of this study was to investigate the implementation of the LEED Rating system credits in Egypt through a comparative analysis of Three Egyptian LEED Certified projects.

The results of this study included a classification for the most achieved and targeted credits within the Egyptian market. This study may also contribute to a better understanding of the concept of implementing LEED green building rating system in Egypt and may suggest some recommendations for future studies.

Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange

*Keywords:*LEED Rating System, Egyptian Construction Market, Building Sustainability, Applicability & implementation.

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1. Introduction

The green growth in construction market and the need to be green have resulted in so many buildings claiming sustainability. This rising trend required the necessity to define greenness in order to minimize green-washing (McKay, 2007). That is why the emergence of green building rating systems was crucial, as they inform people how environmentally a building is through their certification (Kubba, 2010). "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" (Emirates Green Building Council, 2012). Rating systems were developed to measure sustainability aspects within a building so it can be easily compared with other buildings (McKay, 2007). Hence, they can provide an effective framework to assess the building sustainability and environmental performance throughout building design, construction and operation (Ali, 2009).

One of the green building rating systems that have been recently used in Egypt is the LEED (Leadership in energy and environmental Design) Rating system. However, although LEED have achieved a huge success it has received so many critics. According to (Gifford, 2008) LEED has contributed to the recognition of the buildings sustainability within the mass public. However in (Abo Neama, 2012) the author pointed out that LEED doesn't really achieve sustainability as it is only based on "collecting some points and achieving some Prerequisites" and he criticized that the only concern of some consultants is to collect points regardless these points really achieve sustainability or not. In addition, another study criticized the whole concept of credits weighing in which the author implied that the weights of the credits are not reflecting its environmental benefits; that is why the author suggests a modified scoring system for LEED Credits (Humbert, 2007).

In (Lstiburek, 2008) the author severely criticized green building rating systems, especially LEED, the author implied that current green buildings rely on deception rather than science, and he questioned the fact that architects and engineers can only design good building just to be rewarded with points, while designing a good building should be the base case. Furthermore (Gifford, 2008) criticized the fact that LEED is business driven rather than being Environmentally driven, and he attributed that to the fact that two of the cofounders of USGBC were originally business oriented as David Gottfried was a real estate developer, and Rick Fedrizzi was a marketing executive for an air conditioning company.

Therefore, this study aims to explore and analyze the use and the implementation of the LEED rating system on Egyptian grounds, in order to point out the opportunities and the drawbacks of using the LEED rating system on local buildings.

2. Methodology

The research went through two phases, in phase one, two main approaches were followed in parallel; the first one is a Three years (2010-2012) exploratory approach in which three Egyptian LEED projects were monitored onsite (Construction Works) and offsite (Documentation Works). The researcher was able to collect and document longitudinal data through the time frame of each building; starting from the design stage passing by construction and operation until the building received the LEED Certification; the researcher was part of the three projects' teams which facilitated information access.

The second main approach is an online desk research approach that addressed the essentials of managing a LEED project, the main roles of the project team towards achieving the LEED credits, and international case studies showing LEED credits implementation. In Phase two, the researcher used a comparative analytical approach to compare between the credits implemented in the three projects.

3. Case Studies Analysis & Discussion

The researcher compared and analyzed the LEED credits and prerequisites of three certified Egyptian LEED projects. Two projects were applying for LEED New Construction v2009 and targeting the silver level. The first project was a logistic warehouse with a small two floors administrative building and a small labor building. The second project provided documents storage and management services warehouse space and it had a three floors administrative building. The third project was a call center; it was applying for LEED for Commercial Interior v2009

and targeting the Gold level. The building consisted of a ground floor and three typical floors, as well as the basement that incorporated all building electromechanical systems. This paper contains the final analytical results after a preliminary comparative analysis that was performed in the original thesis. Credits/Prerequisites are categorized according to the below:

- Easily Achieved Credits (EA): These credits/Prerequisites were targeted/achieved in two or more projects and did not face any problem during the project.
- Project Circumstances Dependent Credits (PC): These credits/Prerequisites depend on the project circumstances, such as project location, number of occupants and owner requirements.
- Rarely Achieved Credits (RA): These are the credits that the project team did not target, or were rejected in the three projects.
- High Initial Cost Credits (HC): These credits need high initial cost in any project and their achievement depends on the project team decisions.

3.1. Sustainable Sites Category Credits Analysis

This category addresses project site, location & surroundings' environmental aspects. The credits applicability analysis (fig 1a) reflects that, as 40% of the credits fall under the project circumstances category, while 47% of the sustainable sites credits were easily achievable. (Table 1) discusses credits applicability in this category in details.

Table 1: LEED Credits implementation analysis in Egypt: Sustainable Sites Credits

Credit Name	Points	Prerequisite/Credit Analysis	Applicability in Egypt
Construction Activity Pollution Prevention	P	Achieved in the two NC projects. This credit was not applicable on the CI project; 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.	EA
Site selection	1	Achieved as none of the projects land met any of the prohibited criteria stated in LEED reference guide such as being a farmland or wetland.	EA
Development Density and Community Connectivity	5	Achieved in one project only. The other two projects were located in an industrial area that lies away from any basic services, or residential areas. This credits 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.	PC
Brownfield Redevelopment	1	The Projects were not applicable to that credit as they all were constructed on Greenfields. This credit depends mainly on the project location. If it is a contaminated site that needs remediation, it will probably cost much money. For that, reason owners prefer a Greenfield site.	PC
Alternative Transportation - Public Transportation Access	6	Only one project was able to fulfill this credit. Two projects were denied, due to safety reasons concerning pedestrian access. This credit depends mainly on the existence of public transportation around the project site.	PC

Alternative Transportation-Bicycle Storage & Changing Rooms	1	Achieved in two projects but was not targeted in the third one. 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.	PC
Alternative Transportation - Low-Emitting and Fuel-Efficient Vehicles	3	Achieved in the two NC projects, but this credit was not applicable on the CI project. This credit can be achieved through option one, by specifying 5% of parking slots to efficient 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.	EA
Alternative Transportation - Parking Capacity /Availability	2	Achieved in the three projects. The first option in this credit only requires that the project team does not 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 LEED reference guide presents several options to achieve it.	EA
Site Development - Protect or Restore Habitat	1	The Greenfield option was fulfilled in the two NC project and was not applicable for the CI Project. 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 reference guide.	EA
Site Development - Maximize Open Space	1	Achieved in the two NC projects, but this credit was not applicable on the CI project. This credit is achievable through several options provided in the reference guide. However, it depends on the owner requirements and the project needs regarding landscape and open space.	PC
Storm water Quantity	1	Not Targeted in any project, as storm water occurs occasionally in Egypt. In addition, it cost too much.	RA
& Quality Control	1		RA
Heat Island Effect, Non-Roof	1	Achieved in two projects, where the parking number was small and the owners wanted to cover all provided car parks. Samples of the selected materials for car park cover were tested in the (HBRC) Housing and Building Research Center for the Solar Reflective Index.	EA
Heat Island Effect, Roof	1	Achieved in the Three projects, through option one, by installing a high SRI roof material after being 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.	EA
Light Pollution Reduction	1	Achieved in one project only due to security issues in the other two projects, which needed exterior lighting above the rates specified by the LEED. Therefore, the applicability of this credit depended on the project nature and needs.	PC

Fig. 1: credits applicability analysis (a) Sustainable Sites (b) water Efficiency

3.2. Water Efficiency Category Credits Analysis

This category addresses water consumption inside and outside the building; furthermore, it highlights water treatment and reuse. However, according to (Fig. 1b) 75% of the credits considered costly due to the high initial cost of water treatment systems and water fixtures required to achieve the required flow rates.

Table 2: LEED Credits implementation analysis in Egypt: Water Efficiency Credits

Credit Name	Points	Prerequisite/Credit Analysis	Applicability in Egypt
Water Use Reduction	P 4	Achieved in the three projects by 26%, 38% and 41% reduction rates through installing highly efficient water fixtures. However, some owners may find the initial cost a little bit higher.	HC HC
Water Efficient Landscaping	4	Achieved in two projects and wasn't targeted in the third. However, the difficulty of this credit lies in finding the appropriate landscape engineer who understands the LEED requirements to achieve a sustainable landscape and perform irrigation calculations as per LEED standards.	EA
Innovative Waste Water Technologies	2	Achieved only in one project, as the developer of the entire office park had a wastewater treatment facility that served all the office buildings including the project building. The facility treated domestic wastewater to be used for landscape irrigation. This credit cost so much and needs special and complicated measures for onsite water treatment.	HC

3.3. Energy & Atmosphere Category Credits Analysis

This category can be considered as one of the very hard to achieve category among the LEED rating system in Egypt. As 67% of total credits have high initial cost, while 22% of the credits are rarely achieved. This can be attributed to the fact that renewable energy systems requires maintenance and very high initial cost in Egypt. In addition to that, efficient HVAC and Ventilation Systems also require high initial cost.

Table 3: LEED Credits implementation analysis in Egypt: Energy & Atmosphere Credits

Credit Name	Points	Prerequisite/Credit Analysis	Applicability in Egypt
Fundamental Commissioning of the Building Energy Systems	P	Achieved in the three projects. However, The difficulty of this prerequisite/ credit lies in finding a proper Commissioner who is familiar with the LEED requirements and has high documentation skills. In addition, 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 Commissioning Authority.	HC
Enhanced Commissioning	2		HC
Minimum Energy Performance	P	Achieved in the three projects with 28.2%, 30.6% and 23.6% reduction rates, Through installing BMS and using Energy Star Rated Equipment, improved thermal envelope, high efficiency glazing, reduced interior lighting power density and efficient HVAC Systems. 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 background about simulation, but not Experts.	HC
Optimize Energy Performance	19		HC
Fundamental/ Enhanced Refrigerant Management	P	Achieved in the three projects, through using chilled water system and exported split units with R407 as a cooling refrigerant. This prerequisite / credit requires high initial cost.	HC
	2		HC
On-Site Renewable Energy	7	Not Targeted in any project .This Credit is very hard to target. This is due to the fact that till now in Egypt renewable energy systems 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 trend.	RA
Measurement and Verification	3	Achieved in the Three Projects. This credit target the running cost and monitoring of the building systems, and how it complies with the design and 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.	EA
Green Power	2	Not Targeted in any project .This credit is very difficult to achieve, as it requires buying electricity from certified renewable resources in the form of certificates.	RA

Fig. 2: credits applicability analysis (a) Energy & Atmosphere (b) Materials & Resources

3.4. Materials & Resources Category Credits Analysis

In this category, the percentage of rarely achieved credits is very high (56%), that is due to the tendency of contractors and owners to use new materials, and to buy low priced local materials, which mostly lacks the sustainable specs and datasheets that LEED requires.

Table 4: LEED Credits implementation analysis in Egypt: Materials & Resources Credits

Credit Name	Points	Prerequisite/Credit Analysis	Applicability in Egypt
Storage and collection of Recyclables	P	Achieved in the Three projects. Designated areas for waste separation and storage of materials for recycling, including cardboard, paper, plastic, glass, and metals were provided. 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 handled in a sustainable manner.	EA
Building Reuse Walls, Floors& Roof	3	Not Targeted in any project, as all projects were newly constructed. This Credit was not achieved before in a project in Egypt as most of the projects applying for LEED are newly constructed.	RA
50% interior	1		RA
Construction Waste Management	2	Achieved in the three projects with 70%, 71.51% and 95.66 % diverted construction waste away from landfill. The diverted waste rate depends mainly on the contractor's capability of reducing and reusing wastes on site and the continuity of waste separation on site along with the progress of the project.	EA
Materials Reuse	2	Not targeted in any project. 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.	RA
Recycled Content	2	Achieved in one project with 23.17% 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. Therefore targeting this credit depends on team decision and the selected materials.	PC
Regional Materials	2	Achieved in the three projects with 41.60%, 74.95% and 14.41 % locally extracted and manufactured materials as a lot of the construction materials were manufactured regionally with local raw materials.	EA
Rapidly Renewable Materials	1	Not targeted in any project. 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.	RA
Certified Wood	1	Not targeted in any project. 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.	RA

3.5. Indoor Environmental Category Credits Analysis

This Credit Category Contains the largest number of credits (17 credits & prerequisites). This allows more variations and options to achieve points in this category. When it comes to applicability in Egypt, the four categories almost have the same percent as per (fig 3).

Table 5: LEED Credits implementation analysis in Egypt: Indoor Environmental Quality Credits

Credit Name	Points	Prerequisite/Credit Analysis	Applicability in Egypt
Minimum Indoor Air Quality	P	Achieved in the three projects, where the ventilation rates for all occupied spaces met the minimum established in ASHRAE Standard 62.1-2007 as mechanical engineers in Egypt already works according to ASHRAE standards; however mechanical engineers may find some difficulty in documenting this credit through performing some additional calculations and filling the required online form.	EA
Environmental Tobacco Smoke (ETS) Control	P	Achieved in the three projects, as Smoking was 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, however implementing it during project lifetime depends mainly on the building manager to make sure that no one smokes except in the designated area.	EA
Outdoor Air Delivery Monitoring	1	Achieved only in one project. 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.	HC
Increased Ventilation	1	Achieved in two projects only by increasing the breathing zone outdoor air ventilation rates to all occupied spaces by 30% above the minimum rates required by ASHRAE 62.1-2007, this credit depends on the project nature and occupancy rate. However, it may cost extra money if the occupancy rate is very high.	PC
Construction IAQ Management Plan- During Construction	1	Achieved in the three projects, Through HVAC Protection, source control, pathway interruption, and regular housekeeping. 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.	EA
Construction IAQ Management Plan- Before Occupancy	1	Achieved only in one project. 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. The other option is very costly, as it requires specific air particles measurements.	PC
Low-Emitting Materials- Adhesives and Sealants	1	Achieved in two projects, this credit is very hard to be achieved, unless all products are purchased from international manufacturers, because most local manufacturers do not provide the required datasheets. This credit requires regular follow up and documentation for all the supplied materials and their Specs.	HC
Low-Emitting Materials- Paints and Coatings	1	Achieved in the Three Projects through specific paint types with low VOC, which are limited through specific local manufacturers in Egypt.	HC

Low-Emitting Materials-Flooring Systems	1	Achieved only in one project. This credit is very hard to be achieved with local materials, as local manufacturers and suppliers are not familiar with materials certifications, such as Floor Score and Green Label Plus. So this credit can cost a lot of money due to the types of materials purchased which are usually exported.	HC
Low-Emitting Materials-Composite Wood and Agrifiber	1	Not targeted in any project. This credit is very hard to be achieved, as most local wood manufacturers use urea formaldehyde, and purchasing these items from international manufacturers would cost so much.	RA
Indoor Chemical and Pollutant Source Control	1	Not achieved in any project, although it 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 due to high cost.	RA
Controllability of Systems-Lighting	1	Not achieved in any project, 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.	RA
Controllability of Systems-Thermal Comfort	1	Achieved only in one project. The credit requires a strategy that grants access for 50% of the occupants to thermostat control or operable windows, it depends on the project nature, occupancy rate and owner requirements.	PC
Thermal Comfort-Design	1	Achieved in the Three Projects, as mechanical engineers in Egypt works according to ASHRAE standards by default; however, mechanical engineers may find some difficulty in documenting this credit through performing some additional calculations and filling the required online form.	EA
Thermal Comfort-Verification	1	Achieved in the Three Projects, as it requires surveying building occupants regarding comfort conditions after occupancy.	EA
Daylight and Views-Daylight	1	Not achieved in any project, this credit depends on the project type, conditions, architectural design and owner requirements.	RA
Daylight and Views-Views for Seated Spaces	1	Achieved only in one project, as 91.14 % of all regularly occupied seated spaces had access to outdoor views. This credit depends on the project type, conditions, architectural design and owner requirements.	PC

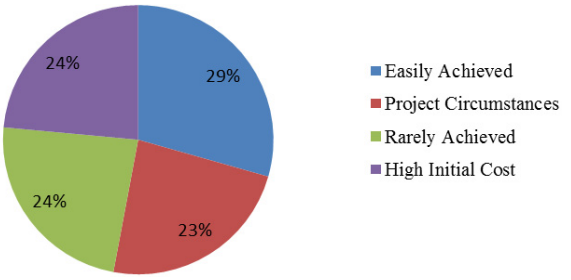

Fig. 3: Credits applicability analysis Indoor Environmental Quality

4. Conclusions and Recommendations

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.

Many efforts were exerted in order to develop the LEED Rating system, to fit into other contexts and to address other defects. Since it is already one of the most used rating systems around the world. The Jordan green building council has published a detailed report about the localization of LEED rating system and respecting the region diversity by taking Jordan as a case study. In this report, each credit is analyzed and evaluated through: credit practice, ease of implementation, cost and feasibility. The report then suggested recommendations to enhance the credit implementation locally(Jordan GBC). Furthermore, a lot of individual studies were performed to address the same issue; for instance a study was performed to come up with a model for developing a green building rating system in Saudi Arabia(Alyami, 2012), the authors suggested a model that include (a) using combined criteria from some well-known rating systems including LEED (b) considering regional contextual aspects (c) Professional cooperation between government, academia and industry; to establish a valid local rating system. Similarly, another study (Ali, 2009) was performed in Jordan to develop an assessment tool for residential buildings in Jordan. The author reviewed existing rating systems from a critical point of view, studied the local context of Jordan (social, environmental & cultural aspects), and then the author referred to different stakeholders to participate in identifying the aspects that should be integrated in a local assessment system. Not to mention, local efforts in Egypt such as one of the latest studies (El-Din, 2012) in which the author performed an extensive comparative analysis study for the most famous Green Building Rating systems across the world including LEED Rating system. In addition, the author developed a new rating system for Egypt based on critical analysis for international rating systems and local Egyptian climate and context.

Most of the recommendations draw attention to the importance of adapting the needs and regional considerations including climate, social, cultural, environmental and economic aspects in any emerging local rating system. Moreover, developing local codes and standards should be based on scientific research, technical knowledge, and stakeholders participation. Similarly an assessment for building performance local situation shall be performed to specify local sustainability strategies and major aims (Attia, 2013)(Ali, 2009)

5. Research Limitation

The Limitation of this study was the constrains lied upon selecting the case studies. As the author was only able to select three case studies that have accessible data and direct contact with the project team. This resulted in the fact that the same consultancy office and the same LEED Consultant supervised the three case studies. That may jeopardize the research results because of having the same approach or strategies when implementing the LEED Credits.

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