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Standards for Environmental Performance of High-Rise Buildings in the Egyptian Context

Energy retrofitting strategies for school buildings in hot arid climate

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Abstract

The paper discusses the elements to achieve the efficiency of the environmental performance of projects with a focus on high-rise buildings through comparative and analytical study of international measurement systems for the environmental performance and some of its applications. Based on this study, a quantitative measurement system is developed in order to determine the factors affecting the efficiency of the environmental performance of Egyptian high-rise buildings during the stages of design, construction, and operation. This measure will be applied to some examples of high-rise buildings in Egypt. The paper concludes a number of findings and a set of recommendations addressed to the State, the construction industry, and the local communities on the efficiency of the environmental performance.

Keywords: Environmental Performance; Sustainability; High-Rise Buildings; Leadership in Energy & Environmental Design (LEED); Building Research Establishment Environmental Assessment Method (BREEAM).

1. International Systems to Achieve Environmental Performance Efficiency

The following points constitute the most important basic principles to achieve efficient environmental performance:

a. Increasing the operational efficiency of energy in buildings during their lifespan [1].
b. Promoting the use of clean and renewable energy.
c. Encouraging the use of collective transport means that operate by clean energy.
d. Increasing the efficient use of water and other resources [2].
e. Reducing the factors that contribute to the greenhouse effect.
f. Enhancing the efficiency and quality of the indoor environment of buildings.
g. Ensuring environmental compatibility between the project and the surrounding environment.
h. Reducing carbon dioxide (CO_2) emissions.
i. Reducing the maintenance and operation costs during the lifespan of a building.

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2. International Systems to Achieve Environmental Performance Efficiency

Many rating systems have been developed to measure the efficiency of the environmental performance of buildings worldwide. This paper will focus on the LEED system which is based on American environmental performance efficiency standards and BREEAM system which is based on the British environmental performance efficiency standards:-

2.1 LEED System:

LEED is a rating system that relies on a set of specific requirements and criteria in the form of a checklist made in accordance with the standards of design, implementation, and operation of green buildings. It functions as a helping factor in the processes of design, implementation, operation, and registration for green buildings. It equally helps to measure the level of efficiency of these buildings and identify positive and negative elements in performance. The final outcome of this system is represented by a number from 0 to 110 determining the level to which the green building standards are met [3].

The LEED system aims to:

a. Define the concept of "green building" by formulating clear and uniform standards.
b. Raise environmental awareness with regard to the significance of having efficient green buildings as far as the State, the property owner, and the departments operating the building are concerned.
c. Identify areas in the building industry that influence the efficiency of environmental performance.
d. Ensure the principle of competitiveness between the registered buildings to allow for competition between different work elements with the view of increasing the level of efficiency of the buildings performance since there will be publicity entailed for the building owner and the team work [4].

2.1.1 System versions:

Several versions of the LEED system have been issued to suit the uses of various projects as shown in Table 1 and Figure 1, namely:

a. LEED NC – (New Construction)
b. LEED EB – (Existing Building)
c. LEED CI – (Commercial Interiors)
d. LEED CS – (Core& Shell projects)
e. LEED For Schools
f. LEED for Retail
g. LEED for Homes (H)
h. LEED for Neighbourhood Development (ND)

Table 1: Shows the points of LEED system lists [3].

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Category	LEED 2.2	LEED 3.0
Sustainable Sites	14	26
Water Efficiency	5	10
Energy & Atmosphere	17	35
Materials & Resources	13	14
Indoor Environ Quality	15	15
Innovation & Design	5	6 (bonus)
TOTAL	69	106
Regional Priority	N/A	4
Total incl. bonus points	N/A	110

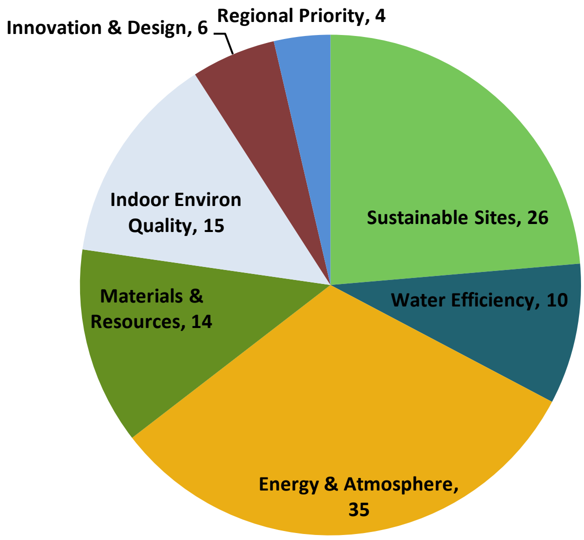

Figure 2: The LEED point distribution across different credit categories. Source: [5]

2.1.2 LEED Certification Process:

The LEED certification process consists of these four stages:

a. **Project Registration Stage:** At this stage, the project is to be registered on the website of the Green Building Council www.usgbc.org, which gives the opportunity for the registration team commissioned by the owner to use helping tools to assist in the registration of the project such as the LEED Application Guide programme [7]. The pre-registration fees are deposited before this stage and after having chosen the type of system for registration.

b. **Technical Support Stage:** The project is granted three weeks of technical assistance by the Board to train and assist the project registration team and responding

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to all queries with regard to any of the items prior to approving any of them (Credit Interpretation Request – CIR).

c. **The Re-engineering and Design Evaluation Stage (Optional):** Subsequent to the design phase of the project, designs are sent for review to ensure that designs match the system of choice. This stage entails additional costs and is mostly used for LEED NC.

d. **Building Certification Stage:** All project documents are to be submitted at the site LEEDONLINE, with a revision of notes in order to reach the highest ratings available and this phase is conducted through several steps. The levels of certification under LEED system are shown in Table 2 [5].

The following table shows the LEED rating system that offers four certification levels for new projects under construction; Certified, Silver, Gold and Platinum. The LEED rating system (LEED2.2) correspond to the number of credits accrued in six green design categories (Sustainable sites-water efficiency-Energy and Atmosphere-Material and Resources –Indoor environmental quality and Innovation in design). If the project scores (26-32) of the assessment points out of 69, then, this project is Certified. In case the project scores (32-38) of the assessment point then this project achieves Silver certificate. This is also applied for projects scoring (39-51) Gold certificate and (51-69) Platinum certificate.

The other rating system (LEED 3.0) depends on seven green design categories (Sustainable sites-water efficiency-Energy and Atmosphere-Material and Resources – Indoor environmental quality –Innovation in design and Regional Priority). If the project scores (40-49) then the project is Certified; (50-59) Silver certificate; (60-79) Gold certificate; and (80 and more) achieves Platinum certificate.

Table 2 shows levels of certification under LEED system [5].

Certification Level	LEED 2.2	LEED 3.0
Certified	26-32	40-49
Silver	33-38	50-59
Gold	39-51	60-79
Platinum	51-69	80+

2.2 BREEAM System

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BREEAM is a rating system that is based on a combination of specific points in the form of checklist consisting of main sections, each with a certain percentage set in accordance with the standards of design, implementation, and operation of green buildings. The system equally functions as a helping factor in the processes of design, implementation, operation, and registration of green buildings and serves to measure the level of efficiency and identify strengths and weaknesses of performance. The final outcome of this system is represented by a number from 0 to 100 that specifies how far the building meets the standards for green buildings [1].

This system aims to:

- Reduce carbon dioxide emissions;
- Increase the operational energy efficiency in the buildings during their life span;
- Encourage the use of clean and renewable energy means;
- Reduce the effects of buildings on the surrounding environment – both domestic and global;
- Provide adequate internal environment;
- Encourage the use of means of mass transport with clean energy;
- Increase the efficiency of water use and resources;
- Reduce the factors affecting global warming;
- Increase the efficiency and quality of the internal environment of buildings;
- Increase the environmental compatibility between the project and the surrounding environment, and
- Reduce maintenance and operating costs during the life span of a building[6].

This system consists of several sections that contain a set of points constituting in its entirety an assessment of the impacts of the project on the environment:

- Management: general policies and procedural steps.
- Health & Wellbeing: internal and external impacts of buildings.
- Energy: operational energy and the concern about CO2 emissions.
- Transport: transport sites, means of transport and emissions of CO2 resulting thereof.
- Water: assembling wasted water as well as leakage and abuse issues.
- Materials: measurement of the efficiency of materials utilization and recycling plants.
- Land Use: green areas, infrastructure and distribution issues.
- Environment and Ecology: the environmental value of sites.
- Pollution: the air and water pollution, except issues related to carbon dioxide [1].

Environmental measures have been developed for each of the previous sections to determine the total score as illustrated in Figure 3[6].

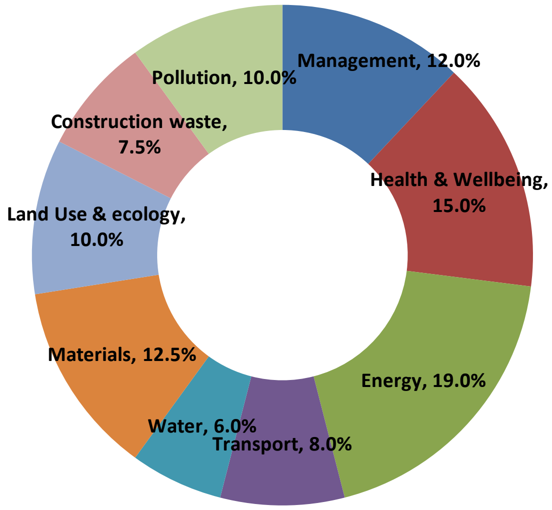

Figure 2outlines the environmental weightings for the nine BREEAM sections for the type of building projects that BREEAM Buildings can be used to assess. Source [6]

2.2.1 System versions:

Several versions of the BREEAM system have been issued to suit the different uses and sizes of projects, namely:

- Eco Homes
- BREEAM For Offices
- NEAT
- BREEAM Schools
- BREEAM Retail
- Industrial BREEAM
- BREEAM RESPOKE

Each system is concerned with a set of comprehensive standards that classify a building according to its usage.

2.2.2 BREEAM Certification Process:

The BREEAM certification process consists of four main stages:

a. Preparation for Project Registration Stage:

- An approving body is chosen by the owner to supervise the preparation for registration phase.
- The auditor is to collect information about the project.

b. Registration Phase:

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- The auditor will submit a request to the approving entity to classify the project according to the type of building and its use.

c. Evaluation Stage:

- The project is to be evaluated according to a set of selected criteria by the relevant approving body.
- Registering officially will be carried out per the submission of official request by the evaluator to the approving body.

d. Results Phase:

- The final output will be an evaluation of the project in its final form and which will be divided into: the manual of eco-efficiency, and the final grade accorded to the project, whether Acceptable or Good or Excellent [7] as presented in Figure 4.
- Post Construction Review: in case of new buildings.

BREEAM rating and scoring requirements	
Pass	30
Good	45
Very Good	55
Excellent	70
Outstanding	85

Figure 3:shows the BREEAM rating benchmarks. Source [7]

3. Analytical Study of Some International Models based on the Standards Used to Raise the Environmental Performance Efficiency

3.1 Palestra Building –London – UK, as shown in Figure 5,an example where LEED rating system is applied.

- Owner: London Climate Change Agency, London Development Agency
- Architectural Designer: Aslop Architects
- Construction Designers: BuroHappold
- Location: South to London Downtown –England
- Use: Administrative
- Total offices Area: 27871 m^2
- Shape: Rectangular cuboid topped by another rectangular cuboid projecting outward from the lower part [8].

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Figure 4: Palestra Building, London. Source[8]

3.1.1 The system used to assess the efficiency of the performance of a building:

The assessment was conducted in accordance with BREEAM rating system and the building qualified for a Very Good estimate (VG) and scored 57 points from 90. It was equally assessed according to LEED v2.2 and got Certified scoring 29 out of 69, as the building has scored earlier additional points according to BREEAM as a result of being 500 m away from central public transportation station. The variance in assessment is attributed to the comprehensive nature of the BREEAM system that has detailed criteria. BREEAM has also been designed to fit the British elements, climate and standards for energy, materials and resources, and the relative weight of the lists of the BREEAM system is also different from the LEED system [9].

Architectural analysis:

The project could be described as "cuboids", and viewers of this building will instantly realize the smoothness and seamlessness of its surface, as a result of how the facades are designed and covered with glass which lent it its smooth outlook. A double system is used in the generation of energy from renewable sources through the use of sophisticated air generating units (micro wind turbines) for converting wind energy into electricity using meanwhile solar panels to convert solar energy into electricity which in turn provides about 4% of the total electrical consumption of the building [8]

.**Description of the results of the building evaluation according to LEED measure:**

- Sustainable Sites (10/14)
- Water Efficiency (3/5)
- Energy & Atmosphere (2/17)

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- Materials & Resources (5/13)
- Indoor Environmental Quality (9/15)
- Innovation & Design (0/5)

3.1.2 Technical analysis according to LEED rating system

It was found that the Palestra building contains 44.3% of glass (glazed facades) with glass used less than 50% specified as the maximum in the ASHRA Standard 90.1-2004. Shading of facades coefficients were as follows: the maximum for the North facade is 36% whereas for all other facades25%. The coefficient of the void and open (the ratio of the openings to the total area of facade) for all the facades of floors (ground-8th) and the Northern facade of the levels (9th-12th) – projecting part — has matched the standard, while the south, east and west elevations of levels (9-12) did not correspond to the standard with a value of 0.34 > 0.25.

The Palestra lighting consumption has been calculated in accordance with ASHRAE 90 and the "space by space method" which is a method for summing as there were only 4 spaces from 6 spaces all over the building according to classification by activity that are in accordance with ASHRAE 90 and this includes the spaces in: the bathrooms, the reception, the electricity generator room at the top of the building, and the internal corridors. As for the spaces that were not found complying: the offices (15.75 W/m^2>11.83 W/m^2) and the car parking below the ground level (3.5W/m^2>2.15W/m^2).

On the other hand, and according to the "Built-up Area Analysis Method", we find that the coefficient of distributing the total building lighting power is 14.75 W/m^2 which is greater than the 10.7 W/m^2 mentioned in ASHRAE 90 standard, which means that the Palestra building doesn't conform to ASHRAE 90 in terms of requirements for the coefficient of total lighting power distribution. The building has a surface to generate renewable energy (chiller plant). A central boiler was fitted in the basement and an additional main mechanical space is located on the ground floor to serve the reception area. It was also found that the percentage of 10.56% (3450.11 m^2) of the total building area was used for electro mechanical rooms as a result of applying these systems. The design team aimed to achieve a value of 6-11% for such spaces of the gross area, thus the coefficient of efficiency usage of the area is good [9].

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3.2 The Scottish Parliament Building- Edinburgh- UK –an example of BREEAM system as illustrated in Figure 6[10].

- Owner: Scottish Parliament
- Architect: RMJM Scotland
- Construction Designer: Arup
- Location: Downtown Edinburgh-Scotland
- Use: Administrative
- Total area of site: 16000m^2 [10].


Figure 5: Scottish Parliament, Edinburgh, Granite panels represent drawn-back curtains, symbolising open government. Source [10]

3.2.1 The system used in evaluating the efficiency of the building's performance

The assessment was conducted in accordance with BREEAM and the building qualified for Excellent upon scoring 77 points out of 100 [10] for having scored additional points in BREEAM being 500m away from a central public transportation station and having developed a brown field site (a site that was environmentally harmed from previous uses or a site that was reused) [11].

Architectural Analysis

The project could be described as an "Urban Cluster" as it is shown in Figure 5. Casting a look at the building will make you sense its smoothness and how its elements are well-blended. In spite of the fact that the building comprises a cluster of other buildings an on-looker can't help feeling its impressive and imposing height thanks to a variety of facades and details and few openings which lends it its formidable presence. Equally, the concrete walls in the Assembly Building which comprises the central debating chamber with a total of five towers linked to it. The

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press tower is located on the east side of the chamber, whereas the other 4 towers are located on the west side of the chamber. These towers are 3-4 storeys high and comprise committee rooms and office space, with catering facilities at ground floor level. The two storey Canon gate Tower is located just to the north of the main building. The total net area of the building is 18,000 m^2 comprising the debating rooms, the committees rooms, offices, and the office net area is almost 4,500 m^2 for every floor.

3.2.2 Description of the results of the building evaluation according to BREEAM measure:

- Management (9/10)
- Health & wellbeing (11/16)
- Energy (10/17)
- Transport (13/13)
- Water (5/6)
- Materials & Waste (7/11)
- Land Use & Ecology (10/15)
- Pollution (7/10)

3.2.3 Technical Analysis according to BREEAM rating system:

The walls are designed to achieve a U coefficient of 0.245W/m^2, and are constructed of in-situ concrete of 300mm thickness, in addition to 12mm of plaster, 2 mm of thermal insulation, and 30 mm of cladding. The external cladding on the walls includes 40mm of granite (Figure 6) and 150mm of precast concrete panels (Figure 7), and some small areas have stainless steel cladding (Figure 8). Floors are generally constructed using the tilt-slab technique. The roof was designed to achieve a coefficient of energy used in manufacturing of 0.245 W/m^2. Typical roof build up comprises steel rafters of 46mm thickness, 180mm glass foam insulation (or 30mm pyroc and 150mm glass foam), and the rooftop is covered with stainless steel panels[11].

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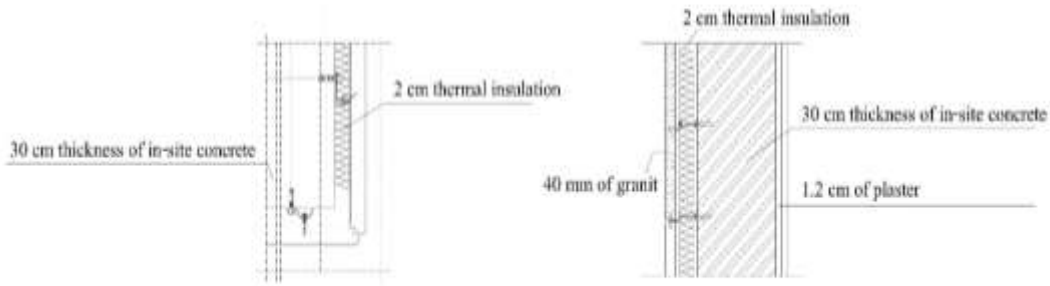

Figure 6: The external cladding on the wall includes 40 mm of granite

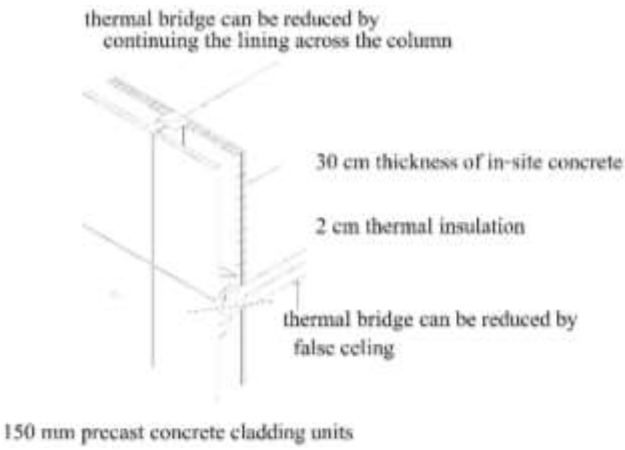

Figure 7: 150 mm precast concrete cladding units

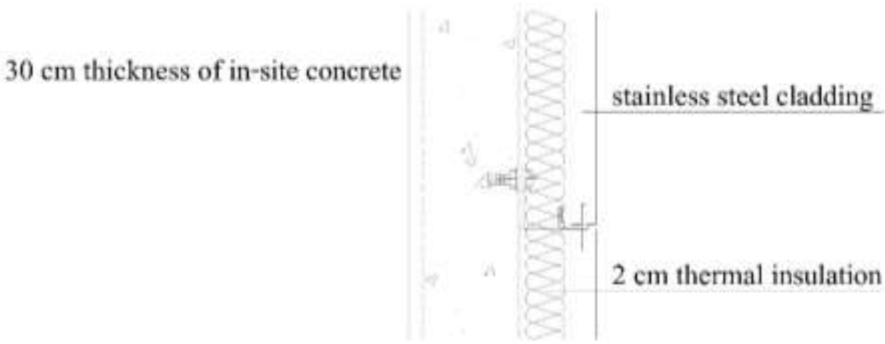

Figure8: Stainless steel cladding

Glazing to the office spaces is for the most part permanently shaded by the surrounding buildings and external shading system. All opening shave hardwood (as European Oak) frames and double glazed windows. Double armoured blast-resistant panes were used in the lower level, realizing a U coefficient value of 1.4 W/m^2. The external shading system for the towers is based on ‘trigger panels’ made of timber. Gas heaters were used to generate hot water. Office lighting generally consists of high

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frequency luminaries. Lamps are either linear or compact fluorescent. Two levels of control are provided, presence detection and manual switching. Lighting is ‘enabled’ during normal hours and switched off after about 6pm. After this time, lighting can be manually extended for a period as required. Designed luminance level is 500 lux in office areas. Office lighting will equate to approximately 15 W/m^2.

Figure 9: Natural light diffuses into the chamber and is provided by "glass fins" which run down from light spaces in the ceiling. Curved slices have been taken out of the vaults to allow daylight to penetrate down. Source [10]

Heating is provided by under floor heating. Heating is provided by a combination of boilers all accommodated in the boiler house located in the lower basement. There are two cooling systems, a chilled water circuit serving IT rooms and kitchens, but not general office space and a cooling water system supplied with borehole water serving systems such as chilled beams, structural cooling, under floor cooling and displacement ventilation. Displacement ventilation is provided to large proportions of the occupied areas, in particular the debating chamber and committee rooms. Office areas are mostly naturally ventilated using both manual and motorized windows.

Approximately 20% of the office area is mechanically ventilated, representing areas in the central zone away from open able windows. System control is an automated Building Management System, given that the building will be controlled during unoccupied periods and systems such as the ventilation system will be switched off during this period [11].

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4. Efficiency of Environmental Performance in Egypt

Recent years have witnessed quite a significant increase in raising the awareness about the importance of green buildings and green architecture. The first seminar was held "Bioclimatic (Green) Architecture" in Egypt in 1996, followed by then several lectures and symposia centered around the concept of green architecture, and environment-friendly buildings and cities. Actually this is one of the recent trends in architectural thought, which is concerned with probing the relationship between the buildings and the environment. Despite growing environmental engineering expertise and well-established environmental concepts in the Egyptian academic engineering community, however, the number is still small compared to the size of the businesses [12].

Despite the issuance of Environment Law no. 4 of 1994 and the Unified Building Law no. 119 of 2008 and its regulations, the Legislator has nevertheless overlooked environmental performance efficiency requirements and didn’t request officially that all buildings abide by any requirements. However, there are individual efforts by some agencies, but which does not constitute a binding specific pattern to follow, like the project for the popularization of energy saving electric units or the project of the code on energy efficiency in buildings prepared by the National Centre for Building & Housing Research and which has not been included in the Unified Building Law. In January 2009, the Egyptian Green Building Council (EGBC) [13] was established including ministers and senior officials in non-governmental organizations, as well as some prominent businessmen, and some contractors operating mainly in the Egyptian construction market. The objectives of the Council are:

- Provide a mechanism for encouraging investors to construct green buildings in accordance with standards of energy efficiency and environmental conservation.
- Increase awareness of the benefits of applying the principles of green architecture.
- Focus on adopting the construction of green buildings as an objective for all new construction projects with the formulation of guidelines for efficient use of energy and resources in accordance with green building standards, as well as securing the approval of a having in place a national system for the classification of green buildings which will be referred to as “Green pyramid” and which is still under study [13].

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Consequently, we can say that the factors affecting the environmental performance efficiency of Egyptian high-rise buildings are:

- Absence of legislation
- None of the measures for the environmental performance efficiency for high-rise buildings has become operational though they are extremely important in terms of the high operational and industrial capacity, and the exhaustion of resources as well as the huge number of users.
- Lack of awareness on the part of Egyptian community of the benefits of the environmental performance efficiency of high-rise buildings.
- Absence of mechanisms to encourage the economic community to embrace a matrix that ensures efficiency of environmental performance during the design, implementation, operation, and demolition phases [14].

In light of what the literature review has critically presented, a measure of environmental performance efficiency of Egyptian high-rise buildings was proposed based on studied international best practices.

5. Proposed Measure for Environmental Performance of High-rise Buildings in Egypt

Probing the LEED rating system as well as other international rating systems (such as BREEAM) used in evaluating the environmental performance of buildings reveals that there is an agreement on the fundamental principles of green building. The LEED rating system is the most recognized international standard for green buildings. Therefore, it is decided to rely on the LEED 2009 system as a basis for the suggested measurement rating for the environmental performance of Egyptian high-rise buildings.

The proposed rating system is to maintain the same categories, credits and credit weightings used in the LEED system, while adding new credits to each of the 5 major credit categories in the LEED system and a completely new Integrative Process category (as shown in Table 3). The new credits are put forward based on:(a) the analysis of similarities and differences between LEED and BREEAM; (b)the principles of environmental value engineering and integrated environmental management; and (c) the specificities of the Egyptian context (as expressed in the Egyptian Building Code for Energy Efficiency and other relevant policies and researches).

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The suggested metric uses an impact assessment questionnaire as the basis for weighting each new credit. The questionnaire is addressed to key project stakeholders - be they natural or legal persons - that include: (i) the owner or the owner's representative; (ii) the financial/business advisor; (iii) the environmental professional; (iv) the project planner/architect; (v) the project manager; (vi) the project operator; and (vii) the end-user(s). The questionnaire covers both the original credits of LEED 2009 and the proposed new credits, and is designed according to the influence of each stakeholder on the compliance with LEED requirements. The comparison between the credit weights in LEED 2009 and those derived from the answers to the questionnaire serves to calibrate the allocation of points to the new credits. There is a maximum of 140 points in the proposed rating system, comprising 110 possible points in the LEED 2009 system and 30 points allocated to the new credits.

Table 3 shows the proposed measure for environmental performance of tall buildings in Egypt. (Source: Researcher)

Category	Credit		Point(s)	
Sustainable Sites	Credit 1	Site Selection	1	
	*Credit 1**	*Enhanced Site Selection*		*1*
	*Credit 1***	*Site Assessment*		*1*
	Credit 2	Development Density and Community Connectivity	5	
	Credit 3	Brownfield Redevelopment	1	
	Credit 4.1	Alternative Transportation—Public Transportation Access	6	
	*Credit 4.1**	*Alternative Transportation—Walk able Project Site*		*1*
	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	Storm water Design—Quantity Control	1	
	Credit 6.2	Storm water 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	
	Credit 9	*Noise attenuation*		*1*
		Possible Points	**26**	***30***
Water Efficiency	Credit 1	Water Efficient Landscaping	2-4	
	Credit 2	Innovative Wastewater Technologies	2	
	Credit 3	Water Use Reduction	2-4	
	Credit 4	*Cooling Tower Water Use*		*1-2*

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Category	Credit		Point(s)	
	Credit 5	*Enhanced Commissioning*		*1*
	Credit 6	*Water Use and Leakage Measurement*		*1-2*
		Possible Points	**10**	***15***
Energy and Atmosphere	Credit 1	Optimize Energy Performance	1–19	
	Credit 2	On-site Renewable Energy	1–7	
	Credit 3	Enhanced Commissioning	2	
	Credit 4	Enhanced Refrigerant Management	2	
	Credit 5	Measurement and Verification	3	
	Credit 6	Green Power	2	
	Credit 7	*Zero Carbon Emissions*		*2*
	Credit 8	*Demand Response Technologies*		*1-2*
		Possible Points	**35**	***39***
Materials and Resources	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1-3	
	Credit 1.2	Building Reuse—Maintain Existing Interior Non structural Elements	1	
	Credit 2	Construction Waste Management	1-2	
	Credit 3	Materials Reuse	1-2	
	Credit 4	Recycled Content	1-2	
	*Credit 4**	*Material Selection using Life Cycle Analysis*		*1-2*
	Credit 5	Regional Materials	1-2	
	Credit 6	Rapidly Renewable Materials	1	
	Credit 7	Certified Wood	1	
	Credit 8	*Responsible sourcing of raw materials*		*1*
	Credit 9	*Non-structural Materials Transparency*		*1-2*
	Credit 10	*Avoidance of Chemicals of Concern in Building Materials*		*1*
		Possible Points	**14**	***20***
Indoor Environmental Quality	Credit 1	Outdoor Air Delivery Monitoring	1	
	Credit 2	Increased Ventilation	1	
	Credit 3.1	Construction Indoor Air Quality Management Plan—During Construction 1		
	Credit 3.2	Construction Indoor Air Quality 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 5**	*Indoor Air Quality Assessment*		*1-2*
	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	
	Credit 9	*Acoustic Performance*		*1*
	Credit 10	*Water Quality*		*1*
		Possible Points	**15**	***19***
Innovation in Design	Credit 1	Innovation in Design	1-5	
	Credit 2	LEED Accredited Professional	1	
		Possible Points	**6**	**6**
Regional Priority	Credit 1	Regional Priority	1-4	
		Possible Points	**4**	**4**
Integrative Process	*Credit 1*	*Discovery – Analysis to Support Integrative Process*		*1*
	Credit 2	*Implementing Synergies*		*1-3*
	Credit 3	*Environmental Value Engineering*		*1*

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Category	Credit		Point(s)	
	Credit 4	*Integrated Management Systems*		*2*
		Possible Points	**0**	*7*
		Total Possible Points	**110**	***140***

The suggested system certifications are to be awarded according to the following scale:

- Certified 50–64 points
- Silver 65–79 points
- Gold 80–104 points
- Platinum 105 points and above

6. Application of the Proposed Measure to High-rise Buildings in Egypt

6.1 San Stefano Grand Plaza – Alexandria – Egypt

- Owner: TalaatMostafa Group &Associates
- Designer: Dar Al Handasah & WZMH Architects
- Location: Alexandria (Egypt) overlooking the sea.

6.1.1 Description of the project:

- Number of floors: 35 storeys
- Height: 135 m
- Use: A commercial, administrative, residential and hotel complex
- Shape: 2 opposite crescent-shaped towers meeting in the middle and topping a 3 storeys shopping mall and 3 storeys service spaces, and 3 floors underground garage as presented in Figure 10.[15].

Figure 10: San Stefano Grand Plaza. Source [15]

6.1.2 Architectural Analysis

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- The crescent-shaped towers allows for 90% of the residential units to overlook the Mediterranean thus having a full sea view.
- The project was designed to ensure safety for its residents and was built in order to be capable of resisting earthquakes, air pressure and strong winds.
- The Design of the building also gives the highest standards of privacy and comfort, by insulating the buildings in such a way that blocks out exterior noise and wavering climates (variance in temperatures) as Figure 6 shows.
- The design took into consideration that there will be enough parking spaces by allocating 3 underground levels to cater to the needs of residents and shoppers.

6.1.3 The Building Materials Used:

First: Steel

Steel beams have been used along with flat slab structures in the Mall and meeting rooms to allow for wide spaces.

Second: Reinforced Concrete

The building comprises many towers that are mainly concrete structures with a main reinforced concrete core for the services.

Third: Glass

Double Glazing is used to cover most of the building envelope.

6.1.4 Analysis of the Results of the project questionnaire

The San Stefano Building is assessed using the LEED2009 rating system and using the proposed rating system. The Building scores 45 points on the 110-point LEED rating system scale. Meanwhile, according to the proposed measure, the Building receives 64 points out of 140 possible points. In both cases, the Building is simply *Certified* as shown in Table 4.

Table 4: shows the assessment of the environmental performance of the building according to the LEED system and to the proposed rating system. Source: Researcher

Elements of Evaluation	**Sustainable Sites**	**Water Efficiency**	**Energy and Atmosphere**	**Materials and Resources**	**Indoor Environmental Quality**	**Innovation in Design**	**Regional Priority**	***Integrative Process***	**Scored Points**
LEED Maximum	26	10	35	14	15	6	4	-	110

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Points									
LEED Estimated Points	13	4	13	1	13	0	1	-	45
Proposed Measure Max. Points	30	15	39	20	19	6	4	7	140
Proposed Measure Est. Points	16	7	16	5	15	0	1	4	64

6.2 Nile City Towers Project Cairo, Egypt

- Owner: Orascom Group
- Architectural Designer: Atelier d'Art Urbain
- Construction Designer: Orascom Engineering
- General Location: The Nile City building is located in the heart of Cairo overlooking the Nile as illustrated in Figure 11.
- Use: A commercial, administrative, residential and hotel complex
- The hotel is designed to allow for 90% of the hotel units to have full view of the Nile.
- The project is designed to ensure full safety and to resist earthquakes.
- To ensure maximum comfort and privacy, the building was designed to block out any noise pollution as well as variance in temperatures [16].

Figure 11: Nile City Towers. Source [16]

6.2.1 The Building Materials Used:

First: Steel

Steel beams have been used along with flat slab structures in the Mall and the meeting rooms to allow for wide spaces.

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Second: Reinforced Concrete

The building comprises many towers that are mainly concrete structures with a main reinforced concrete core for the services.

Third: Glass

Double Glazing is used to cover most of the building envelope.

6.2.2 Analysis of the Results of the project evaluation

The Nile City Towers Project is evaluated using the LEED 2009 rating system and using the proposed rating system. The Building is LEED Certified upon achieving 47 points out of a possible 110 possible points. In the meantime, according to the proposed measure, the Building scores 67 points out of 140 possible points, which is equivalent to a Silver level of certification as presented in Table 5.

Table 5: The assessment of the environmental performance of the building according to the LEED system and to the proposed rating system. (Source: Researcher)

Elements of Evaluation	Sustainable Sites	Water Efficiency	Energy and Atmosphere	Materials and Resources	Indoor Environmental Quality	Innovation in Design	Regional Priority	Integrative Process	Scored Points
LEED Maximum Points	26	10	35	14	15	6	4	-	110
LEED Estimated Points	11	5	17	2	11	0	1	-	47
Proposed Measure Max. Points	30	15	39	20	19	6	4	7	140
Proposed Measure Est. Points	14	8	20	6	13	0	1	5	67

6.3 Results of the Applied Study

The study has identified the factors that impact the environmental performance in Egyptian high-rise buildings.

First: Site sustainability

As far as the site sustainability is concerned, the San Stefano Grand Plaza is rated slightly higher than the Nile City Towers, mainly due to emphasis given to site development, storm water design, and heat island effect (areas that are slightly warmer than nearby rural areas due to human activities).

Second: Water efficiency

It is noteworthy that the two sample buildings attained close levels of efficiency .In both cases, there is a moderate water use reduction and a limited reliance on innovative wastewater technologies.

Third: Energy efficiency

The Nile City Towers Project is rated higher than San Stefano Grand Plaza, mainly due to special attention paid to the optimization of energy performance. In both examples, there is a failure to use on-site renewable energy or green power. Also, the results are almost the same for the remaining credits.

Fourth: Materials and resources

The two buildings achieved close scores in respect of materials and resources .It should be highlighted that, in both cases, there is a failure to give priority to regional materials.

Fifth: Indoor environmental quality

San Stefano building is rated higher than Nile City Towers, primarily due to the use of low-emitting materials and indoor chemical and pollutant source control.

Sixth: Innovation in Design

As there are no Egyptian metrics for green buildings that can be used as benchmarks ,no proper attention was accorded to innovative performance in the two examples.

Seventh: Regional Priority

Because there are no enforced Egyptian regulations for green buildings, geographically specific environmental priorities are not binding. Accordingly, poor performance of both buildings in this respect has been witnessed.

Eighth: Integrative Process

The two buildings achieved almost the same scores in respect of the integrative process.

7. Results

A. Results related to the legislative and legal community (the State)

- The absence of incentives programs for organizations and entities that implement standards of environmental performance efficiency.
- Lack of awareness on the part of society with regards to the rationalization of the use of resources, water, energy, as well the optimal utilization of sources of energy being new or renewable.
- Putting into operation the Egyptian Green Building Council to become the official body in charge of environmental performance.

B. Results related to the technical and engineering community (consulting bodies concerned)

- Lack of concentration on local environmental alternatives for elements used in the implementation and operation of projects
- Lack of focus on methodologies used to upgrade the energy efficiency and rationalizing the use of energy in buildings and effective management of buildings.

C. Results related to the local community

- Giving importance to the economic factor in its immediate effect over the environmental factor.
- The absence of the community and the local governance in the decision making process and the prediction for the environmental impact.
- The absence of the principles and regulations as well as awareness programs to help the community to rationalize the use of resources such as water, energy and materials

D. Results related to the economical and industrial community

- The absence of plans and programs in which priorities of environmental development are incorporated for the sake of areas and regions where projects will be launched. Equally, there's an absence of the social and the developmental role for these projects on the respective sites.
- The absence of essential industries necessary for the provision of recyclable materials.
- The importing of most of the components of the ecological technology which results in a remarkable hike of prices in such projects and consequently most property owners avoiding it all together.

8. Recommendations:

A. Recommendations aimed at the legislative and legal community (the State):

- Putting into effect the role of the Egyptian Green Building Council
- Setting up a national platform for plans of reuse and recycling of materials and linking the operational licensing of buildings to the adoption of these plans.

B. Recommendations related to the industrial and economic community

- Giving importance to the environmental aspect as well as the long-term economic return.
- Giving importance to waste recycling and the sewage water treatment to be used later in the irrigation of gardens.
- Giving importance to increase the output of the components of the new and renewable energy.

C. Recommendations aimed at the engineering and technical community (the consulting bodies concerned)

- Developing standards to assess the environmental performance of different projects and codes that cover the elements of environmental management of projects.
- Raising the awareness of students enrolled in faculties of engineering and junior engineers as far as the basics of green architecture are concerned as well as those of efficiency of environmental performance.

D. Recommendations aimed at the local community

- Putting into effect incentives programs to motivate the local community to embrace the programs and plans for rationalizing the use of resources such as water and materials.
- Encouraging the consumption of products of efficient or low energy and that are found to be the least harmful to the environment and which have long-term economic returns.

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