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Rowaida Ali

Egyptian Russian University

Mohamed Afify

Cairo University

Walid Abdel-Meniem

Cairo University

Ayman Ahmed Ezzat Othman

The British University in Egypt, ayman.othman@bue.edu.eg

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Analysis of Sustainability Assessment Rating Systems for Existing Healthcare Buildings

Rowaida H. Ali ¹, Mohamed M. Afify², Walid Abdel-Meniem³ and Ayman A. Othman ⁴

¹ Assistant Lecturer, Department of Architecture, Egyptian Russian University, Egypt.

² Professor of Architecture and Environmental Design, Faculty of Engineering, Cairo University

³ Associate Professor of Architecture, Faculty of Engineering, Cairo University

⁴ Professor of Architectural Engineering Department, The British University in Egypt

Email: eng.rowidaelbehery@gmail.com

Abstract. Sustainability is the goal pursued by societies worldwide. Existing buildings have had their share of those issues, specifically healthcare buildings, as most governments encourage green new construction and neglect existing buildings. Additionally, the benefits of existing buildings in preserving the environment, and its resources and reducing energy and global warming crises. The research objective is to achieve a high-level performance of existing healthcare buildings within a framework of evaluating the most important determinants affecting these buildings.

The paper will focus on presenting the different rating systems such as LEED and BREEAM, by dividing and analyzing these systems, given that each system has its own standards and how it scores evaluation points. As the rating systems help in improving the existing healthcare buildings and get low-negative environmental impacts; they will reduce pollution, reduce carbon emissions, choose non-polluting and sustainable materials, encourage the use of recycled materials, and control waste management.

The paper presents an approach to find out which rating system will evaluate green existing healthcare.

Keywords: Sustainability; Healthcare Buildings; Green Rating Systems

1. Introduction

One of the issues that is now being addressed the most in academics, the government, and civil society is green building. According to their needs, many nations have developed their own green rating systems, and these attempts are seen as a global goal for greening the planet. [1] The rating system can be used as a tool of design by evaluating performance metrics to direct the urban design and even for measuring building environmental performance and incorporating sustainable growth into building and construction processes. [2]

The health sector has a strong influence on the economies of nations and their policies, incorporating a group of buildings where the quality of the indoor environment and energy conservation are quite significant. According to the intensive operation of their types of equipment for 24 h, the high number and movement of people is one of the key points that make them a specific case study.[3]

This research aims to study green healthcare building rating and certification systems in order to promote and allow better alignment of environmental considerations of cost and other conventional decision criteria, in specific the existing healthcare buildings. As the green healthcare buildings offer a lot of benefits and advantages for building owners and consumers, in addition to lower maintenance costs and longer life spans. as shown in Figure 1 below.



Besides it is intended at achieving a high building performance within the framework of evaluating energy, water, transportation, and health for individuals and carbon dioxide emissions. Accordingly, it started by asking:

- Is it possible to achieve high efficiency of energy consumption in existing healthcare buildings using green rating systems?
- Which rating system can be applied to existing healthcare buildings?



Figure 1. Green Healthcare benefits[4]

2. Sustainability Rating Systems

The effective recognition in certain countries that they were unable to determine how sustainable a building was was the main factor that promoted the development of technologies that facilitate environmental performance evaluation of buildings. Even organizations and design teams that thought they were authorities on the field of sustainable construction design could confirm to this. Later, experts and government organizations decided that the best way to illustrate the degree of sustainability of all types of buildings is through rating systems. [5] That can improve the education for a sustainable society because it can promote understanding between the principles of sustainable construction and the user. [6] These systems have contributed to the growth of the awareness of criteria and objectives of sustainability., and they have become a reference to assess the sustainability of buildings in particular and construction in general. [7]

3. Healthcare Buildings Rating Systems:

Sustainability assessment systems focus on new constructions, existing buildings and refurbishment/rehabilitation operations. Some systems developed specific methods for healthcare buildings. Green healthcare would be one that improves patient health and aids in the rehabilitation process while utilizing natural materials environmentally sustainable. The major targets are shown in Figure 2.



Figure 2. Green Healthcare Targets [8]

They all have sustainability assessment categories and indicators that allow the creation of a single total rating based on established of weights.

It is possible to discuss the following rating systems: BREEAM for Healthcare, LEED for Healthcare, Green Star-Healthcare, Estidama and Green Hospital Rating System – GHRS.

3.1. Building Research Establishment Environmental Assessment Method (BREEAM): The environmental assessment method of BREEAM in the United Kingdom emerged in 1990 through buildings' environmental performance, and is considered first environmental assessment of buildings in the world, and was developed through Building Research Establishment (BRE). [9]

BREEAM system adopts nine basic criteria totaling 100 points, plus 10 points of innovation, each of these criteria comprises a set of conditions examined by the evaluators. Total result of evaluation of any building subject to BREEAM is calculated according to the number of points got. Some conditions, such as water consumption, the building must achieve at least one degree in this requirement, even if its overall grades qualify it for good classification. [10]

3.2. *Leadership in Energy and Environmental Design System) LEED(:*

The United States Green Building Council released the LEED Approach for the first time in 1998 in the United States of America, and it was adopted in the year 2000. This approach is considered the most widespread and famous in the world despite its emergence after the BREEAM Method. It has been updated with introducing a database for a wider range of building uses with some modifications.

LEED Healthcare's points rating system depends on the calculation of potential environmental affects and benefits to both the environment and humans caused by the assessed building, which result from carbon emissions, fossil fuel use, water and air pollutants, and other building impacts on the environment. It relies on the identification of relative weights and assessment points on two key references U.S. Green Building Council and National Institute of Standards and Technology (NIST) standards. [9]

3.3. *Green Star System for Environmental Assessment of Buildings in Australia (Green Star):*

The first edition of the Green Star curriculum was produced in Australia in 2003 as part of a collaboration between Sinclair Knight Merz and the British BRE Foundation, and BREEAM. There are great similarities between them, but some differences reflecting the local differentiation between Australia and the United Kingdom. [9]

The Green Star rating system covers a wide range of environmental issues related to the construction process, for example (internal environmental quality, energy efficiency, carbon emissions, reuse of building materials), etc., each of these issues represents a standard of evaluation. The main difference between Green Star and the former LEED and BREEAM systems is that the Green Star system was developed as Australia's environmental issues and local sustainability requirements. [11]

3.4. *Estidama – United Arab Emirates:*

The UAE's Urban Planning Council (UPC) is recognized for large-scale, sustainable urban planning and rapid expansion. Sustainability is a central theme in the Program Abu Dhabi 2030 urban master plan. The UPC has developed and produced an initiative called Estidama, which is Arabic for "sustainability." [12]

The rapidly developing built environment is the subject of Estidama. Project managers, architects and even customers must reconsider their approach to the planning and design process. Abu Dhabi (UPC) is influencing projects in the design, development and construction stages throughout the Emirate of Abu Dhabi.

Estidama Assessment Method aims to resolve a development's sustainability over its life cycle, from design to construction to service. The Pearl Building Rating System comprises the following two types of credits: Requirement Credits - these must be met by every project submitting for a Pearl Rating. Optional Credits – these are the voluntary performance credits from which points may be accrued. The quantity of credits and degree of achievement will differ from project to project depending on the Pearl Rating level that a design and development team is aiming for.[12]

3.5. *Green Hospital Rating System (GHR):*

In April 2018, Housing and Building National Research Center held a conference to announce and introduce the Egyptian green hospital evaluation system. The guideline for the design of

hospitals and green healthcare facilities in Egypt is after an update of the design standards for hospitals.

The Egyptian system in determining the relative weights of elements and evaluation points relied on Egypt's strategy for sustainable development 2030 within the framework of local challenges affecting Egyptian society. Green Hospitals Rating System adopts six basic categories totaling 156 points plus extra points of innovation. Certain prerequisites must be completed in the building submitted to evaluation, according to assessment criteria of different codes produced by Housing and Building National Research Center in many fields is linked to these conditions. [13]

Comparison of environmental rating systems for healthcare buildings as shown in Table 1, while Table 2 and Figure 3 show green healthcare rating Systems & Ratio of Categories.

Table 1. Rating Systems for Healthcare Buildings[14] \

Elements of comparison	Comparison of Environmental Rating Systems for Healthcare Buildings				
Name of rating Systems	BREEAM for Healthcare	LEED for Healthcare (v4.1)	Green Star for Healthcare	Estidama	GHRS
Country	United Kingdom	United States of America	Australia	United Arab Emirates	Egypt
publication year	1990	1998	2003	2007	-
Publication year for health care	2008	2005	2009	-	2018
Determinants of evaluation	9 categories for evaluation + 1 category Bonus	7 categories for evaluation + 2 category Bonus	8 categories for evaluation	6 categories for evaluation + 1 category Bonus	6 categories for evaluation + 1 category Bonus
	Management-Health and well-being-TransportWater-MaterialsResourcesResilience - Land use and Ecology-Pollution	Integrative Process Location and Transportation Sustainable Sites Water Efficiency Energy and Atmosphere Materials and Resources Indoor Environmental Quality Innovation Regional Priority	Management-Indoor Environment QualityEnergy-Transportation - WaterMaterials-Land Use & Ecology-Emissions-Innovation	Integrated Development Process Natural Systems Livable Buildings - Precious Water -Resourceful Energy-Stewarding Materials Innovating Practice	Sustainable site Energy Efficiency Water Efficiency Materials and resources The quality of the internal environment and creating a healing environment Management and Operation Innovation

Elements of comparison	Comparison of Environmental Rating Systems for Healthcare Buildings				
Level and degrees of evaluation	<p>- acceptable ≥ 10 to < 25 with one star rating.</p> <p>- Pass ≥ 25 to < 40 with two-star rating.</p> <p>- Good ≥ 40 to < 55 with three-star rating.</p> <p>- Very Good ≥ 55 to < 70 with four-star rating.</p> <p>- Excellent ≥ 70 to < 85 with five-star rating.</p> <p>- Outstanding ≥ 85 with six-star rating.</p>	<p>An average of 40-49 points are acceptable to Certified.</p> <p>- 50-59 points, the building is Silver.</p> <p>- 60-79 points, the building is Gold.</p> <p>- < 80 points receive the Platinum rating.</p>	<p>An average of 10-19 points, the building gets 1 star.</p> <p>- 20-29 points, the building gets 2 stars.</p> <p>- 30-44 points, the building gets 3 stars.</p> <p>- 45-59 points, the building gets 4 stars and has the best performance (Best Practice).</p> <p>- 60 to 74 points, the building gets 5 stars, (excellent) - 75-100 points, the building gets 6 distinguished stars (Leadership World).</p>	<p>To achieve a 1 Pearl rating, all the mandatory credit requirements must be met.</p> <p>mandatory credit + 60 points, the building gets 2 pearls.</p> <p>+85 points, the building gets 3 pearls.</p> <p>+115 points, the building gets 4 pearls.</p> <p>+140 points, the building gets 5 pearls.</p>	<p>First level - certified.</p> <p>Second level - Bronze.</p> <p>Third level - silver.</p> <p>Level 4 - Gold.</p> <p>Level 5 - Platinum.</p>

Table 2. Comparison between the Green Healthcare Rating Systems & Ratio of Categories[14]

Evaluation standard	LEED HC	BREEAM HC	GREEN STAR	Estidama	GHRS - EGYPT
Management and operation		12	9		22
Integrated Development Process	1			13	
Sustainable sites	9		8		17

Evaluation standard	LEED HC	BREEAM HC	GREEN STAR	Estidama	GHRS - EGYPT
Livable Buildings				37	
Location and Transportation	9	8	7		
Pollution and harmful emissions		10	3		
Energy efficiency	35	19	24	44	35
Water efficiency	11	6	12	43	25
Materials and resources	19	12.5	17	28	27
Quality of the internal environment - health and well-being	16	15	20		30
wastes		7.5			
Land Use and Ecology Natural Systems		10	8	12	
Design Innovation	6	10	Bonus	3 Bonus	5 Bonus
Regional Priority	4				
Total	100 +10	110	100	177	156

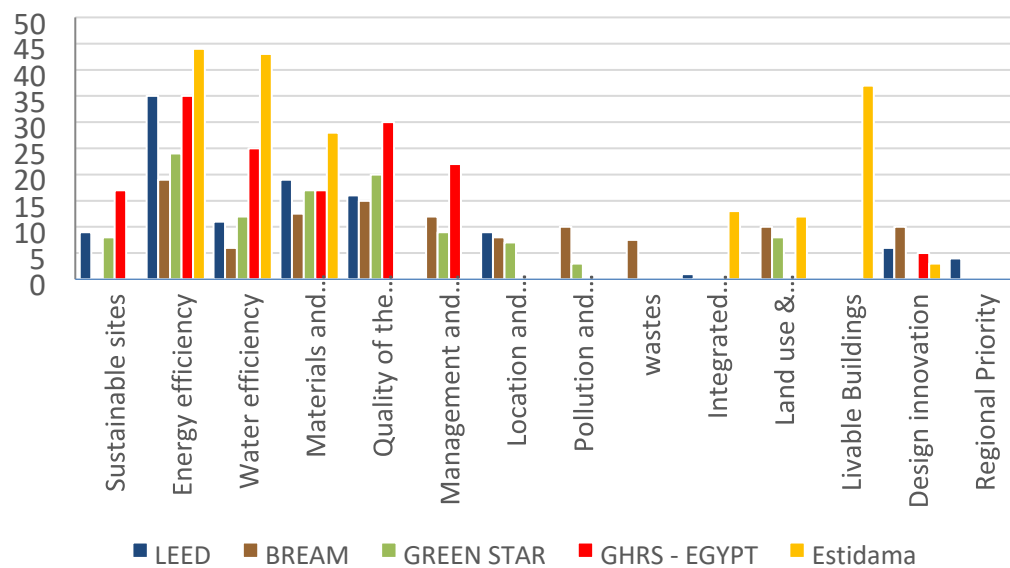


Figure 3. Green Healthcare Rating Systems & Ratio of Categories

Source: By Author

Table 3 shows the rating systems that applied among new construction and existing building.

Table 3. Rating systems applied among healthcare and existing building

Source: Author

	Origin Country	Type of Rating System	New construction scheme for healthcare	Rating Existing Buildings	Can be used to assess existing healthcare buildings
LEED	USA	International	√	√	√
BREEAM	UK	International	√	√	√
Green Star	Australia	Australia	√	√	X
Estidama	UAE	In UAE	√	X	X
GPRS	Egypt	In Egypt	√	X	X

From the previous comparison, several conclusions can be reached, first, the two rating systems (GHRSEgypt and Estidama) applied among new construction for healthcare buildings. Moreover, Green Star rating system is based on local rules and legislation, in locally conventional construction technologies, with the default weight of each indicator set according to the actual local socio-cultural, economic and environmental contexts. So, it could be clear that the previous three rating systems cannot be used as rating system to assess existing healthcare buildings.

LEED and BREEAM systems are global systems applicable anywhere for each State or institution to adopt such systems as general principles and build upon them a domestic evaluation system of its own, as some countries such as India and others have done. [15] The differences between the systems are not significant, if it reviews each system in detail, it will observe how much similarity there is between prerequisites and points. From the previous evaluation standards several things can be inferred, it turns out that the greatest weight of energy efficiency and water efficiency is the largest ratio in LEED. By comparing BREEAM and LEED credits are in four categories, as shown in Figure 4.

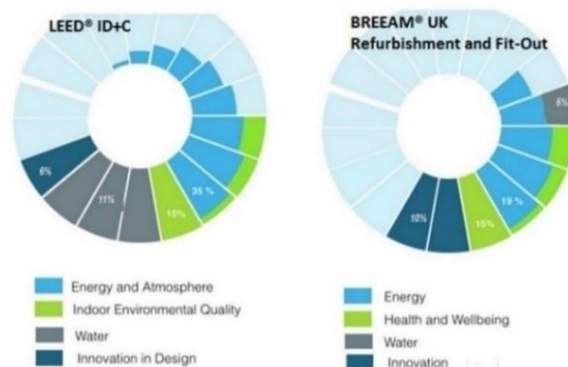


Figure 4. Energy and water efficiency weights in LEED and BREEAM Rating systems

Source: Author

As a result of what has been studied in previous tables, the LEED and its categories rely more on environmental than social and economic standards. So, it can be considered to be more environmentally oriented than socioeconomic and from the previous studies there are energy and water crisis, thus it's necessary to adopt a rating system that improves these two parameters. Additionally, LEED is more relevant of its policies, but is part of a global corporate policy. The LEED standard is also more flexible in its use and more widespread around the world. to be applied to existing healthcare buildings.

The following part includes an analytical study on healthcare buildings that succeeds in applying the LEED categories of existing buildings and getting LEED Certification.

4. Case study

4.1. The First Healthcare to receive LEED Existing Building certification in the World Norton Brownsboro Hospital - Louisville, USA

Norton Brownsboro Hospital is located in the state of Louisville Kentucky in the United States of America, which is one of the largest hospitals in the United States, and includes 127 beds, 10 surgical suites and 27 medical clinics as shown in Figure 5 and Table 4.



Figure 5. Norton Brownsboro Hospital [16]

Table 4. Information about Norton Brownsboro Hospital

Norton Brownsboro Hospital			
Project name	Norton Brownsboro Hospital	Area	27685 m ²
		climate	Humid subtropical
Site	State of Louisville Kentucky in the United States of America	End date	2012
Hospital designed by	Karlsberger	The cost	155 million\$
Building type	General Hospital	Number of beds	127 beds

Norton Brownsboro Hospital - Louisville, USA started in 2008 an energy management program, the program was created by a team with extensive experience in system efficiency, where energy efficiency is achieved through an energy use strategy through two ways: energy conservation and energy generation resources first to increase the efficiency of the building's energy use and rationalizing consumption, and the second is to try to find power generation elements in the building and exploit renewable resources in the operation of the building.

By focusing on the island savings in energy conservation in Norton Hospital using Natural lighting and Ventilation, beside they are located at specific openings in the outer shade to act as natural light reflection and refraction systems to direct light in the space as needed, Louvers and Blinds for example: Horizontal louvers and vertical fins installed on the facade at precisely measured angles corresponding with the orientation of the sun provide shade to the rooms, reducing the need for air conditioning and lowering energy use and finally three-story glass atrium in the third-floor ceiling provide enough natural light during the daytime as shown in Figure 6.



Figure 6. Natural lighting and ventilation at Norton Brownsboro Hospital [16]

The Norton Brownsboro Hospital is fully committed to an energy conservation program that is focused on infrastructure improvements, automation and technology as shown in Figure 7 and as shown in Table 5 summarize energy efficiency strategies that can be achieved through the readiness of the building for rehabilitation and the use of the lowest costs to improve energy efficiency. [17] Table 6 shows the average score for LEED Certification for the Norton Brownsboro Hospital.



Figure 7. architecture plans of Norton Brownsboro Hospital

Table 5. Energy Efficiency Strategies at Norton Brownsboro Hospital Source: Author

Energy Efficiency strategies				Norton Brownsboro Hospital			
				Accommo dation area	Clinical departments	General Spaces	Support Services Sections
Lightning System	Natural	direct lightning	External walls opening (windows)	■	■	■	■
			Skylights		■	■	
			Indoor open courtyard	■	■		
	Artificial	Lightning units that is more efficient energy		■	■	■	■
		Light sensors usage		■	■	■	
		high-tech lamps		■	■	■	■
Ventilation systems		Natural	Dependence on natural ventilation	■	■	■	
		Artificial	HVAC system (new chiller)	■	■	■	■
Architectural treatments		Shade formation by the building itself		■	■		
Systems or methods of reducing heat transfer		Using light colors for hospital facade shells		■	■	■	■
		High performance glass		■	■	■	■
		Roof planting		■	■	■	■
		Ventilation openings and Curtains		■	■	■	■

Table 6. Average score for LEED Certification for the Norton Brownsboro Hospital [18]

LEED for Norton Brownsboro Hospital: 2009 V3 after achieving an average of 40 points		
1	Sustainable site	1/26
2	Water use efficiency and	3/14
3	Energy and the atmosphere	24/35
4	Materials and Resources	0/10
5	Indoor Environmental Quality	8/15
6	Innovation in design	3/6
7	Regional Priority	1/4
8	Integrative process	0/2

5. Conclusion

Sustainability assessment rating systems work to improve the image of buildings to be low-negative environmental buildings. They establish the standards and regulations that must be satisfied in sustainable and green buildings. They are recognized by the highest categories of the evaluation system and work to achieve the quality of the internal environment of spaces.

This paper results from a critical review, aimed at comparing the best-known Healthcare Building Sustainability Assessment (HBSA) methods. Based on the environmental, societal, and economic relevance of healthcare buildings, different countries and institutions have developed or are developing domestic assessment methods for this type of building, it is expected that the existing HBSA methods should develop in order to accommodate some aspects, such as

- recent developments in the sustainability standardization of construction works and healthcare buildings (i.e., their sustainability categories).
- energy efficiency of the healthcare building.
- specific adaptability and flexibility in healthcare building.

Finally, the LEED rating system is one of the main goals of green building development and is based on environmental objectives. These include achieving overall project management and efficiency of various energy sources, materials, water, and indoor air quality in new and existing construction buildings.

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