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Sustainability and green building rating systems: LEED, BREEAM, GSAS and Estidama critical analysis

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ABSTRACT

In the built environment, a green building rating system provides the project team a framework and a tool to help achieving a better sustainable development. The research presents how Green Building Rating Systems (GBRSs) are environmental-oriented tools and should not be confused with Sustainability Assessment Systems; the latter is defined by the sustainability three pillars; environmental, social and economic. Achieving a green building certification does not necessarily mean that the building succeeded in achieving its environmental targets. The financial-driven and prescriptive implementation of GBRS are reasons behind a masked sustainability outcome.

This paper presents an objective analysis between two internationally applied GBRSs; LEED and BREEAM, and two particularly developed for the gulf region; Estidama and GSAS. Those four systems are analyzed with respects to them addressing and prioritizing the sustainability pillars. The study also quantitatively discusses the credit weighting given by these systems, focusing on energy and water criteria.

Limitations: of GBRSs' application and possible areas of improvement have been highlighted, such as climate change adaptability and the importance of sustainable communities and cities trend. The aim is to help designers and construction stakeholders in defining the development sustainability targets and objectives, without compromising on the local context and regional agenda.

1. Introduction

Environment, society, and economy are the three pillars of sustainability and the majority of sustainability rating systems have been developed in line with those pillars [1].

According to Brundtland [2], sustainable development is a development that meets the present needs and at the same time preserves the resources for future to meet the next generations' needs [2]. Mateus and Bragança [3] defined the sustainable development as the best trade-off between the three pillars; environmental, social, and economical, that strive for greater compatibility [3].

The sustainable growth debate is generally related to depending on strategies developed over a range of time and space scales based on the current practices and predictions [4]. Sustainability assessment tools contribute to balancing between these dimensions or pillars (environmental, social, and economical), and to enhancing practicality and resiliency. Therefore, they should be able to consider constant technological development and multi-level applications [5]. The chart in Fig. 1 illustrates the concept of sustainability as a scale depends on time and space.

Sustainability Rating Systems (SRSs) are considered to have three stages [6];

(1) Classification: Environmental change expectations determine the impact category based on various inputs and outputs.
(2) Characterization: Identify the impact of each input and output with relation to their category.
(3) Valuation: Category weighting in comparison to other categories.

A Green Building Rating System (GBRS), as defined by Nguyen and Altan [7], is a tool that the building industry uses to evaluate, enhance, and/or promote developments' sustainability. Those systems provide a tool, guidance, and/or better insights into sustainability through information analysis, valuations and comparisons [7]. They try to facilitate the following:

1. Enhance buildings' operational performance,
2. Minimize environmental impact,
3. Measure buildings' effect on the environment, and
4. Objectively evaluate and judge buildings' development.

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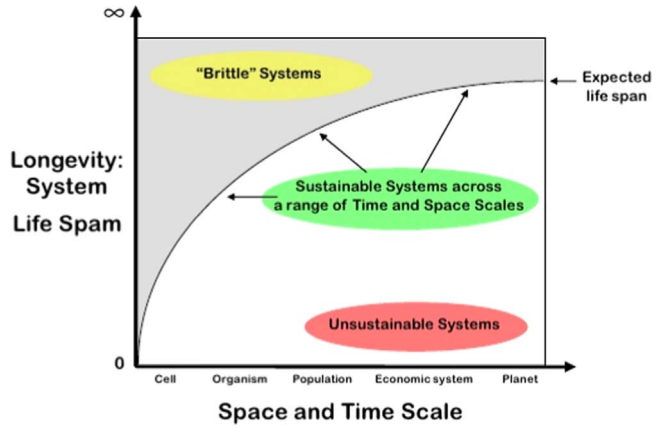

Fig. 1. Sustainability as scale (time and space) dependent concepts. Source: Costanza & Patten [4].

Knowing that there are substantial differences between GBRSs, sustainability-related outcomes could differ significantly depending on the system applied and the understanding and experience in sustainable design approaches of the project team [8,9]. With the focus on the Gulf region, this paper looked at the sustainability practices in line with the green building codes. The green building codes of Abu Dhabi and Qatar have been assessed and compared to two of the most-applied systems worldwide. An introduction to the study-related GBRSs is presented hereafter.

1.1. BREEAM, LEED, GSAS, and Estidama

Estidama Pearl Rating System, GSAS, LEED and BREEAM, are Total Quality Assessment (TQA) systems, whereby projects are awarded points for prerequisites and optional credits that are grouped under a number of categories.

The British Building Research Establishment Environmental Assessment Method (BREEAM) was first launched in UK, 1990. International versions have been released for certifying projects worldwide, and BREEAM International for New Construction 2016 is the latest. This system's evaluation is expressed as a percentage of success over total available points: 30% for pass classification, 45% for Good, 55% for Very Good, 70% for Excellent, and 85% for Outstanding. The categories for new construction projects are; Management, Health & Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use & Ecology, Pollution, and Innovation [10].

Leadership in Energy and Environmental Design (LEED) rating system was first released in 1998 by the US Green Building Council (USGBC). LEED is the most popular and widely used green building rating system. The last released LEED version 4 for New Construction (NC) in 2014 has four levels of certification, depending on the point thresholds achieved: Certified (40–49 points), Silver (50–59 points), Gold (60–79 points), and Platinum (80 points and above). There are seven evaluation categories to obtain up to 126 possible points [11].

In 2009, an integrated and performance based green building assessment rating system; GSAS, was established by the Gulf Organization of Research and Development (GORD) in Qatar. The Global Sustainability Assessment System (GSAS) was modeled on best practices from the most established global rating schemes including, but not limited to, BREEAM (United Kingdom), LEED (United States), GREEN GLOBES (Canada), CEPAS (Hong Kong), CASBEE (Japan), and the International SBTOOL. GSAS has 8 categories and 1–6 Stars certification can be achieved [12].

Looking into Estidama, it is mostly developed using LEED and BREEAM elements whilst applying the system to the unique local needs and environment [13]. Estidama Pearl Rating System was established by Abu Dhabi Urban Planning Council (UPC) in 2010. Under the Pearl Building Rating System (PBRS), five levels of certifications can be obtained as follow; 1 Pearl (only prerequisites), 2 Pearl (prerequisites+60 points), 3 Pearl (prerequisites+85 points), 4 Pearl (prerequisites+115 points), and 5 Pearl (prerequisites+140 points). Eight categories are available in the PBRS with 180 total available points [14].

In the author's opinion, the green building certification should not be the target but rather the process itself. The aim of this study is to identify the merits and limitations of GBRSs, and to highlight the need for setting a project-specific sustainability objectives based on the nature of the project, with relation to its context and regional targets.

2. Methodology

Four GBRSs have been selected based on how they best fit the objectives of the study and the area of the author's own experience. Two of the most commonly applied international systems (BREEAM International 2016 and LEED NC v4) and two regulatory systems in the Gulf region (GSAS 2015 and Estidama PBRS v1.0) have been studied in terms of their whole approach of addressing the three pillars of sustainability.

Quantitative analysis has been conducted as a method for categorizing each system credits under these pillars. Literature reviews are used as part of the discussion for support and further analysis. Taking the case of new construction commercial buildings, weightings given by these systems to energy and water categories and credits have been identified.

3. Results and discussion

3.1. GBRSs and Sustainability

The variety of available GBRSs can be argued to enhance sustainable building design, directly and indirectly [3]. Brophy [8] study confirms that these systems provide a good framework to integrate sustainability measures into a development, and the enhancement is relatively better when the project team are unfamiliar with sustainable design concepts [8]. Similar to other systems, where the rating system is used inappropriately it can result in a poor building performance with a sustainability mask. In his study, Brophy concluded that (1) only the design team commitment and expertise can guarantee the delivery of appropriate sustainable building design, and (2) that these systems must be simple to make them useful as design tools throughout the construction development [8].

On the other hand, Fenner and Ryce [6] study concluded that such systems could minimize the environmental unsustainability and fail to address social and economic measures [6]. The same study also summarized green assessment schemes critics as follow;

(4) No universal applicable scheme.
(5) Require regular on-going updates.
(6) Integrated approach is essential for efficient application.
(7) Assumptions are the base of environmental impact analyses.
(8) Occupancy and operation profile variations are somehow neglected.

According to Castro et al. [15] and based on the division proposed by ISO/AWI 21929; Energy, Materials, Waste and Pollution categories are directly related to the environmental pillar. Water category falls under environmental-economic, while Sustainable Sites category is environmental-societal related. Indoor Environmental Quality and Well-being categories are economic-societal related and transport category is the only one that relates to the three pillars together [15]. In order to examine how GBRSs address the three pillars of sustainability, the following four charts (Figs. 2, 3, 4 and 5) illustrate the weighting given for environmental, social, and economic pillars. Credit

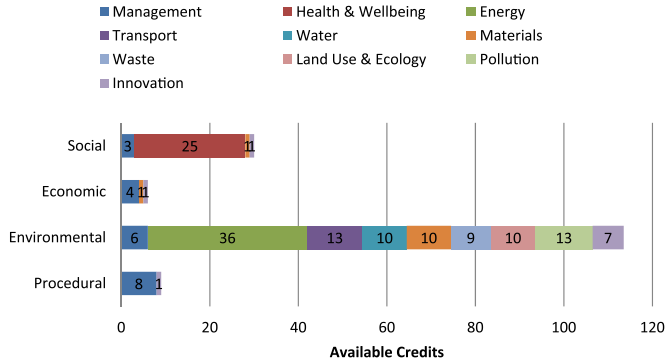

Fig. 2. BREEAM International 2016 credits weighting of Environmental, Social and Economic Pillars.

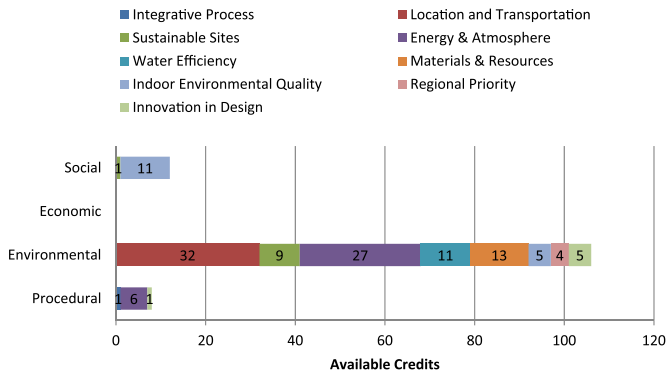

Fig. 3. LEED NC V4 credits weighting of Environmental, Social and Economic Pillars.

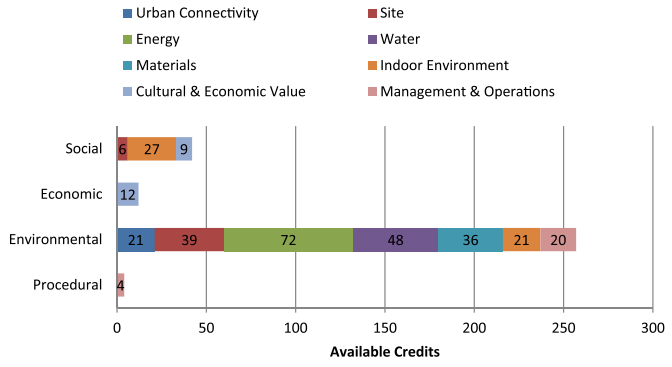

Fig. 4. GSAS 2015 credits weighting of Environmental, Social and Economic Pillars.

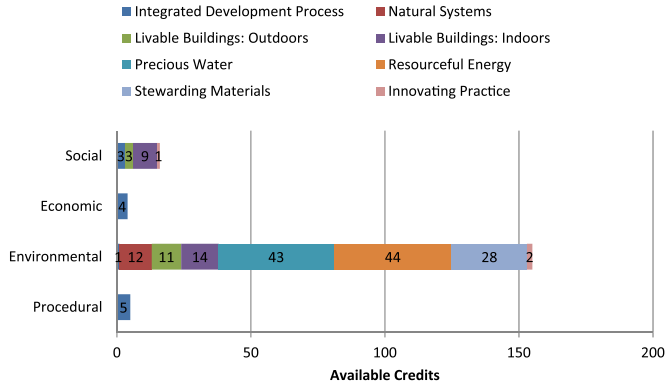

Fig. 5. Estidama PBRS V1.0 credits weighting of Environmental, Social and Economic Pillars.

points have been counted for the most related pillar, regardless to the category it belongs to. A few credits are categorized as procedural; these are related to commissioning and integrative process credits in LEED, GSAS and Estidama, and responsible construction and commissioning credits in BREEAM. Procedural credits could have an indirect influence on one or more sustainability pillar.

BREEAM International 2016 for New Construction rating system deemed to address the environmental, social, and economic pillars with the least unbalanced weighting. However, all four rating systems give the environmental pillar the most importance and the economic pillar the least. Based on this, the four GBRSs assess the environmental impact of developments rather than their sustainability. Cole [16] argued that although GBRSs are environmental assessment methods, they can certainly provide a useful framework for guiding project decisions towards a sustainable design outcome [16].

When it comes to the economic pillar of sustainability, LEED has not attributed any weighting for it; which is one element that gets the most resistance. As design is most likely driven by cost, the economic viability of a building is thoroughly covered automatically in project decisions. However, and in most cases, operational and maintenance costs are not considered. In the developing countries, where construction is continuously increasing, sustainability practices are more or less driven by the 'green certification' with less attention given to the operation stage. Estidama operational system has been developed but still in the piloting stage. In addition, operation and maintenance rating systems for existing developments are available under LEED and BREEAM which help in assessing and improving buildings' environmental practices during operation.

It must be noted that life cycle costing is an optional credit and is being given more attention recently in the Middle East. Most of GBRSs encourage considering the whole building life cycle assessment (LCA), while the bar is being brought up to consider the life cycle design within the integrative sustainable design approach. However, the design for climate change impacts and future adaptability is a new trend in buildings sustainable design which can be introduced through computer simulations and assessment tools.

In terms of the social pillar, it is at risk of not being adequately covered in projects' decision processes and not given significant weighting in GBRSs. BREEAM gives the social aspect the second priority after the environmental aspect, around 19% of the system available points. GSAS gives it around 13%, while Estidama and LEED social related credits' weighting does not exceed 10%. According to Berardi [17], addressing the social aspect of sustainable development requires contextual design and relating the building to its neighborhood [17]. LEED and BREEAM have looked into this through the neighborhood rating systems rather than building systems. The same is applied to Estidama Pearl Community Rating System (PCRS). Based on this, it is assumed that buildings are socially connected to their community/ neighborhood only if they are part of a rated/certified community. But in the case of building in a non-rated community, the social shortfall in the GBRS is much valid yet.

USGBC is piloting LEED of Communities and LEED for Cities new rating systems. The objectives of those newly introduced systems are [18];

1. **Improving quality of life** through cities' benchmarking, and educating residents, visitors and business owners.
2. **Verifying leadership** through tracking and reporting progress towards city's emissions targets and countries' climate action goals. In addition, consistently communicating the city's sustainability performance and goals around the world.
3. **Improving sustainability performance** by adopting policies that help to reduce energy, water, waste, pollution and CO2 at the city scale, and in turn improve air and water quality.

3.2. Comparison between GBRSs

Comparing the Energy category points' weighting to the overall available points within the same system, Energy category points contribute the most in LEED, 26%, while it is around 23–24% in BREEAM, GSAS and Estidama. The second most contributing category differs between the four. BREEAM gives Health & Wellbeing category the second highest weighting, 16%. This category is related to Indoor Environmental Quality and Occupants comfort. LEED gives the second highest weighting to Location & Transportation category, 25%. Even though LEED and BREEAM are the most internationally applied systems, the difference is clear on giving the second highest weighting to out-of-building related category in LEED while it is indoor related category in BREEAM.

The Water and Indoor Environment categories in GSAS have the same weighting of 15% each; whereas the Water and Energy categories also weigh the same at 24% in the Estidama rating system for buildings. The scarcity of oil reserves' resiliency and water shortage in the Gulf region is mainly the reason of prioritizing Energy and Water categories.

An in-depth comparison between the systems in relation to energy and water efficiency has been conducted to further present variations between GBRSs. As the rating systems do not perfectly overlap, the following comparison cannot be parallel presented.

3.3. Energy category comparison

When it comes to the Energy category; energy efficiency, carbon emissions reduction, and renewable energy credits are the first to be accounted for in most GBRSs. In addition, commissioning, measurement and verification are highlighted in the four systems emphasizing the importance of performance monitoring and testing. Lighting systems impact has been addressed in all. Demand-based control and the automation aspect are considered in LEED, Estidama and GSAS through different approaches. Table 1 shows energy credits considered in those GBRSs.

Renewable energy generation is highly encouraged in Estidama through the allowance of 8 points under renewable energy generation. Where 20% of annual energy demand is provided through renewable energy, 8 points can be secured. BREEAM seems to be more demanding when it comes to renewable energy weighting; maximum of 3 points for 30% contribution. Up to 3 points can be earned under LEED for 10% renewable energy generation, while the same 10% entitles the project for 1 point only under BREEAM. This variation could be related to the local environment challenges, smart grid provisions, and government subsidies.

As for energy efficiency for new construction commercial projects, BREEAM is the most stringent system to earn points under this credit (maximum of 15 points that require 90% reduction below baseline is achieved), keeping in mind that the energy baseline differs from system to another. Estidama provides the same number of points (up to 15 points) under this credit with less energy reduction requirement (60% reduction below energy baseline). LEED v4 provides more points with less energy reduction requirement; 50% reduction entitles for 18 points. It is worth mentioning that LEED v4 energy baseline is following ASHRAE 90.1: 2010, which is more stringent than the Estidama baseline of ASHRAE 90.1: 2007.

Table 1
Energy related credits of BREEAM, LEED, GSAS, and Estidama.

Credit	BREEAM	LEED V4	Estidama	GSAS
Energy Efficiency	√	√	√	√
CO2 Emissions	√	√	√	√
Sub-Metering/ Measurement	√	√	√	√
Commissioning	√	√	√	√
Lighting	√	√	√	√
Renewable Energy	√	√	√	√
Demand Response		√		
Automated Control				√
Peak Load Reduction			√	

Table 2
Water credits of BREEAM, LEED, GSAS, and Estidama.

Credit	BREEAM	LEED v4	Estidama	GSAS
Baseline water consumption	√	√	√	√
Indoor water use reduction		√	√	√
Outdoor water use reduction		√	√	√
Leak detection system	√		√	√
Water metering	√	√	√	
Flood risk	√			
Water runoff	√	√	√	√
Heat rejection - cooling tower water		√	√	√
Water modelling during design		√		
Rainwater/ graywater reuse		√	√	√

3.4. Water category comparison

BREEAM is more focused on water monitoring, flooding and stormwater, which are significant concerns where the system is developed in, the UK. LEED, Estidama and GSAS prioritize water use reduction in addition to waste water reuse. The flood risk aspect is only considered in BREEAM while design water modelling is mentioned under LEED v4 only. Water metering is not addressed within the GSAS system only. Table 2 provides breakdown for water credits available under each system.

Because of water scarcity in the gulf region, Estidama encourages indoor water efficiency the most. In offices, 15 points can be earned where no more than 10.8 l/person/day of water is being consumed. In BREEAM and LEED, the points available are 6 for offices project. No more than 15 l/person/day of water shall be consumed in order to achieve all 6 points. Water consumption prerequisite in BREEAM is easy to comply with; 37 l/person/day or less. LEED and Estidama are more stringent as interior water consumption baseline should not exceed 25 and 27 l/person/day, respectively.

The differences between GBRSs are related but not limited to; (1) considering various and interrelated categories, (2) emphasizing the need for communication or not, (3) prioritizing and weighting concerns. Moreover, the structure of each system is not always accessible and criteria do not perfectly overlap. The same study also indicated the necessity of improving the communicability of the assessment systems [19]. Lack of communicability could hinder the take-up rate of the green building rating tools and also be a barrier to increasing the knowledge about sustainability in the built environment [20]. Moktar [21] research confirmed the impact variation as a result of adopting different GBRSs, but all systems showed positive impact on the environment, building operational performance and occupants' well-being [21].

According to Reed et al., each country or region should have its own sustainability standard but at the same time, standardizing a rating system should not consider the local environment as the highest priority over global needs [20]. Voinov and Farle [22] study also supports a case that global solutions should drive local level action [22]. This will prioritize different subsystems' sustainability based on its place within the system hierarchy. Kibert [23] study stated that the following parameters are the main contributors toward achieving sustainable development [23];

1. Regulation and public policy integration
2. Finance and insurance industries
3. Education and construction stakeholders

It can be argued that those systems that are policed more stringently, through detailed reviews and construction site audits, can offer higher substantiation of sustainability claims. Estidama is a very good example supporting this statement where it is mandated for all new projects within the emirate of Abu Dhabi, UAE. Masdar City is another good example of setting a city sustainability targets and based on those establishing the sustainability key performance indicators (KPIs) on both, building and infrastructure levels. Masdar City, within its context, plays a main role in supporting the country agenda and educating its residents.

4. Conclusion

BREEAM, GSAS and Estidama systems give the highest weighting to the Energy category while LEED prioritizes the Indoor Environmental Quality category. Because of the energy aspect importance, enhanced energy performance credit is given the highest weighting in the four systems. Achieving enhanced energy performance and renewable energy related points under BREEAM is the most rigorous. LEED is the most lenient in energy performance credits while Estidama is lenient for renewable energy generation. On the other hand, Estidama is the easiest to earn high number of points for water reduction while LEED and BREEAM follow. Estidama and LEED interior water minimum reduction requirement is more stringent than BREEAM's. This constructive comparison shows the need to focus on the process toward sustainable design rather than targeting the certification or higher rating, as the last is subjective.

In terms of addressing the environmental, economic and social pillars of sustainability, all four rating systems are focused on the environmental pillar while giving the social pillar the least importance. Despite the arguments of GBRSs ability of structuring environmental criteria, they tend to help to include sustainability as part of the decision-making more commonly, integral and consistently, in addition to setting out a sustainability-focused design team.

It should be noted that this study does not consider the rigor of application of a GBRS. The author would argue that GBRS is a useful framework for guiding the environmental sustainability of a project but it is also important to consider the sustainability targets of the project with respect to overall social and economic perspectives. Nevertheless, integrative approach, systematic analysis and innovative thinking need to be adopted in conjunction with the assessment tools throughout the project development. Life cycle design, climate change adaptability, along with computer modelling and tools are the new trend in sustainable buildings' design.

The presented analysis highlights the importance of identifying a project-specific sustainability targets in line with the contextual objectives. Green Buildings can support their surroundings sustainable growth but might not be able to address the social and economic aspects. On the other hand, they can better serve a community or city sustainability targets and collaborate toward a holistic approach.

Acknowledgements

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